THE

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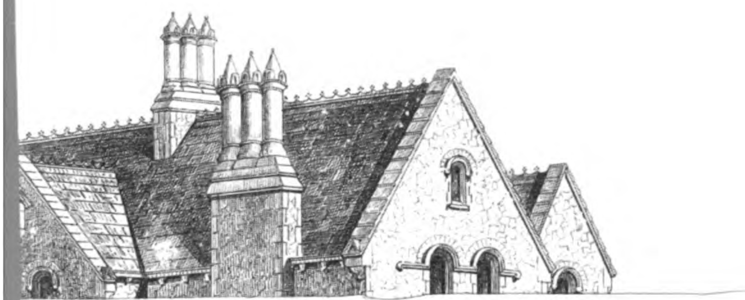
Pl. 1.



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THE

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CHURCH OF ST. PHILIP THE EVANGELIST, ARLINGTON SQUARE, ISLINGTON.

(*With an Engraving, Plate* I.)

This structure, the subject of our first Plate, is in the Anglo-Norman style of the 12th century, and is constructed with Kentish rag-stone in random walling, and Bath stone dressings, and contains accommodation for 1054 persons, chiefly seated on the ground floor. The ancient basilical form has been adopted, with certain additions, to render it suitable for a modern church, It consists of nave, side aisles, and transepts, with a semicircular apse for the altar at the eastern termination of the nave. The peculiarities of the style will be seen to consist in its massive solidity and boldness of outline, with a prevalence of horizontal lines and a vast variety of surface carving, for which Anglo-Norman work, in its final development, was so remarkable. The tower is a low, square structure at the north-east angle of west front, flanked with broad flat buttresses. Its elevation consists of three stages; the lower part forming one of the principal entrances to the Church, and the upper part the belfry, the louvres of which are in pairs, within deeply-recessed semicircular arches, the stringcourses dividing the lower stages of the tower; small arcades above; and the cornices are all decorated with surface carving; circular pinnacle shafts at the angles terminate with carved coned caps; and a low, timber, pyramidal roof covered with lead and surmounted by a vane, finishes the tower. The principal entrance doorway is in the west front, and as well as that in the tower, consists of a series of semicircular deeply-recessed arches, with a considerable amount of carving upon them. Chevron moulded work, saw-tooth and beaded enrichments, twisted cable shafts, rosettes, and varied significant devices, three semicircular headed windows, also enriched with carving, and a large circular wheel window, fill up the western gable, which is surmounted by a characteristic stone cross. A small stone turret is attached to the west end of south aisle; the lower stage is square, with its circular-headed carved doorway; the upper part is brooched into circular form, and surmounted by a conical carved stone roof. The north transept has a similar doorway, varied in detail, in which the saw-tooth billet and zig-zag moulding prevail. Two semicircular-headed windows above, exhibit a further variety of carving, in which the double chevron and beaded enrichments are effectively applied. A single-light circular window in the gable above is surmounted by a plainly cut stone cross. The side aisles are lighted by a plainer description of semicircular-headed windows, in pairs, between the flat massive buttresses, by which the thrust of the roofs is sustained. Small circular windows also light the clerestory; carved corbel tables and continuous molded gutter-stones are lined with lead. The apse contains five windows of equal size, and the semi-domed roof to the same is covered with lead,—the main roofs with pale green Westmoreland slates with ridges, and ornamental crest tiles of corresponding colour.

It is in the interior, however, that the more important features of the style are seen to advantage. There is a sombre grandeur and repose pervading the unbroken line of nave with its arched timber roof, terminating with its deeply-recessed and elaborately carved circular chancel arch. A long range of circular piers divide the aisles and transepts from the nave, with their semi-circular arches, and characteristic saw-tooth cutting, together with subordinate arches of connection at the transepts, springing as they do from boldly carved corbels, producing an exceedingly good effect. Open arcade work encloses a position for the organ, and corresponding blank arcades the vestry, at the end of north and south aisles. A dwarf stone screen forms the communion rail, open at the ends. It is composed of a series of small columns, supporting interlaced arches. The pulpit, also, is of stone, circular in form, and is placed upon a massive square stone base. It consists of blank arcade work, with the twisted cable and other effectually carved mouldings. The font is square, of massive character, upon a raised dais, and supported by a large central and four smaller shafts, with carved caps, cable mouldings, and beaded enrichments. It occupies the south side of nave at western entrance into the Church. The reading-desk and pewing-stall seats in chancel and roof timbers are all stained dark oak colour. A western gallery provides accommodation principally for children, without breaking in upon the main lines of the structure, or injurious to the general effect. The gas fittings by which the Church is lighted are iron corona, suitable in character, and embellished with colour and gilding, suspended from the roof. The warming is effected by six of "Tozer's ventilating gas stoves." The paving of the gangways generally is of red and grey Staffordshire tileing. The chancel is laid with

Minton's encaustic tiles, in lozenge compartments; and the apse with blue tiles of interlaced pattern. The enclosure is by a dwarf wall and low horizontal iron rails, and gates with ornamental standards. The entire outlay is included in an amount of 5000*l*. It has been executed from the designs and under the direction of Mr. A. D. Gough, Architect, of Lancaster-place, by Messrs. Dove Brothers, Contractors, of Islington.

It is intended, we believe, to complete the design, as represented in our Plate, by the erection of a Parsonage, on the south side of the Church, in Arlington-square, and a complete set of School buildings for boys, girls, and infants. We hope this intention will be fulfilled.

The incumbent is the Rev. James Sutherland, B.A., formerly senior curate of the parish church.

SUGGESTED REMOVAL OF THE LAW COURTS.

It is high time that the present Law Courts were removed from their present situation at Westminster: to the large majority of the legal profession and the public they are exceedingly inconvenient, they being at a distance from the Law Offices, the chambers of counsel, the offices of the attorneys, and the business portion of the metropolis. They are also so inconvenient that it is with great difficulty the jurymen, counsel, and witnesses attending the various trials can be accommodated. In the event of new courts being erected, an excellent situation might be readily obtained in the space bounded by St. Clement's-inn, Carey-street, Chancery-lane, Fleet-street, and the Strand. The Chancery and Common Law Courts, and Westminster and Nisi Prius Courts at Guildhall, might be both concentrated at this spot, as there would be ample space. A deputation from the Incorporated Society lately waited on Sir Benjamin Hall, as Chief Commissioner of Works, to ask his assistance, but he very properly pointed out to them that the initiative lay with the principal law officers of the Crown rather than with him; at the same time he expressed his willingness to aid the work as far as was in his power. The proposition made by the deputation was to the effect that out of the funds in the Court of Chancery, law courts of fitting accommodation should be erected either in or near Lincoln's-inn-fields, so that all the different courts might be concentrated on one spot. In the new building rooms should be provided for reference meetings. At present, on a cause being referred, the parties and their witnesses are compelled to withdraw and wait several days before an appointment can be made convenient to all parties; whereas, if rooms were provided for the purpose, the reference could be at once proceeded with and great expense and trouble saved.

NEW STREET NOMENCLATURE.

The Committee appointed by the Metropolitan Board of Works have put forth their report, recommending an entirely new nomenclature with respect to those streets in the metropolis which bear the same generic name. It appears from the report, that there are no fewer than 571 streets requiring to be re-christened, since only 17 names fall to the share of that large number. These are as follows, viz.:—

George-streets	62	New-streets	33	James-streets	25
Charles ,, ...	55	William ,, ...	31	York ,, ...	25
John ,, ...	45	High ,, ...	30	York-places	24
King ,, ...	44	Union ,, ...	30	Park ,, ...	21
Queen ,, ...	38	North ,, ...	28	Edward-streets ..	20
Church ,, ...	34	Duke ,, ...	26		

In proof that the committee have bestowed much labour on the task entrusted to them, they have taken the pains to suggest fresh names in the case of each street, the names of places in the country being avoided. To prevent confusion, it is proposed to place the old name of the street in very legible characters above, and the new name below, prefixing to the latter the word "new." This would meet the inconvenience arising from a sudden change of names. The two names might be kept up for three or four years, and then the old name taken down.

In reference to the New-road and a few other great thoroughfares, there are some peculiarities which have received the special attention of the committee. The great thoroughfare which runs from the Edgware-road to the Angel Inn, Islington, known as the New-road, comprises at present 55 places, separately numbered under different names, and in every instance, except one (Bath-place), the names of the places on the north and south sides, opposite each other, are totally different. Many of the above names are repeated frequently in other parts of the metropolis. The committee recommend that, from the Edgware-road to Park-square East, it be called the Marylebone-road; from Park-square East to Tottenham Court-road, St. Pancras-road West; from Tottenham Court-road to King's Cross, St. Pancras-road East; and from King's Cross to the Angel Inn, Pentonville-road. The names of the separate places being altogether abolished, and the numbers commencing at the Angel Inn, King's Cross, Tottenham Court-road, and Park-square, respectively.

The Committee make the following suggestions:—

1. There should not be two streets of the same name in London.
2. The names of streets, places; &c. should be painted conspicuously at the corners and at all points of intersection, the initial letters of the postal districts being placed below.
3. The numbers of the houses should follow in regular order, and not be interrupted in their course by places, terraces, rows, &c. The odd numbers should be on one side, the even numbers on the other, and the order of counting should proceed in a direction from some central point—say St. Paul's Cathedral, so as to provide for the gradual extension of suburban streets into the country.
4. The convenience of the Post-office would be greatly consulted if the names of the principal streets or roads were made to commence and terminate at points of intersection by other principal streets; and also, if in the case of streets or roads of great length, the line could be divided into sections not exceeding half a mile in length, with corresponding separate series of numbers and distinctive names.

DRAINAGE OF THE METROPOLIS.

On the 22d ult. a deputation from the Metropolitan Board of Works submitted the drainage plans agreed upon by the Board, when Sir Benjamin Hall, having received the plans, made the following statement:—

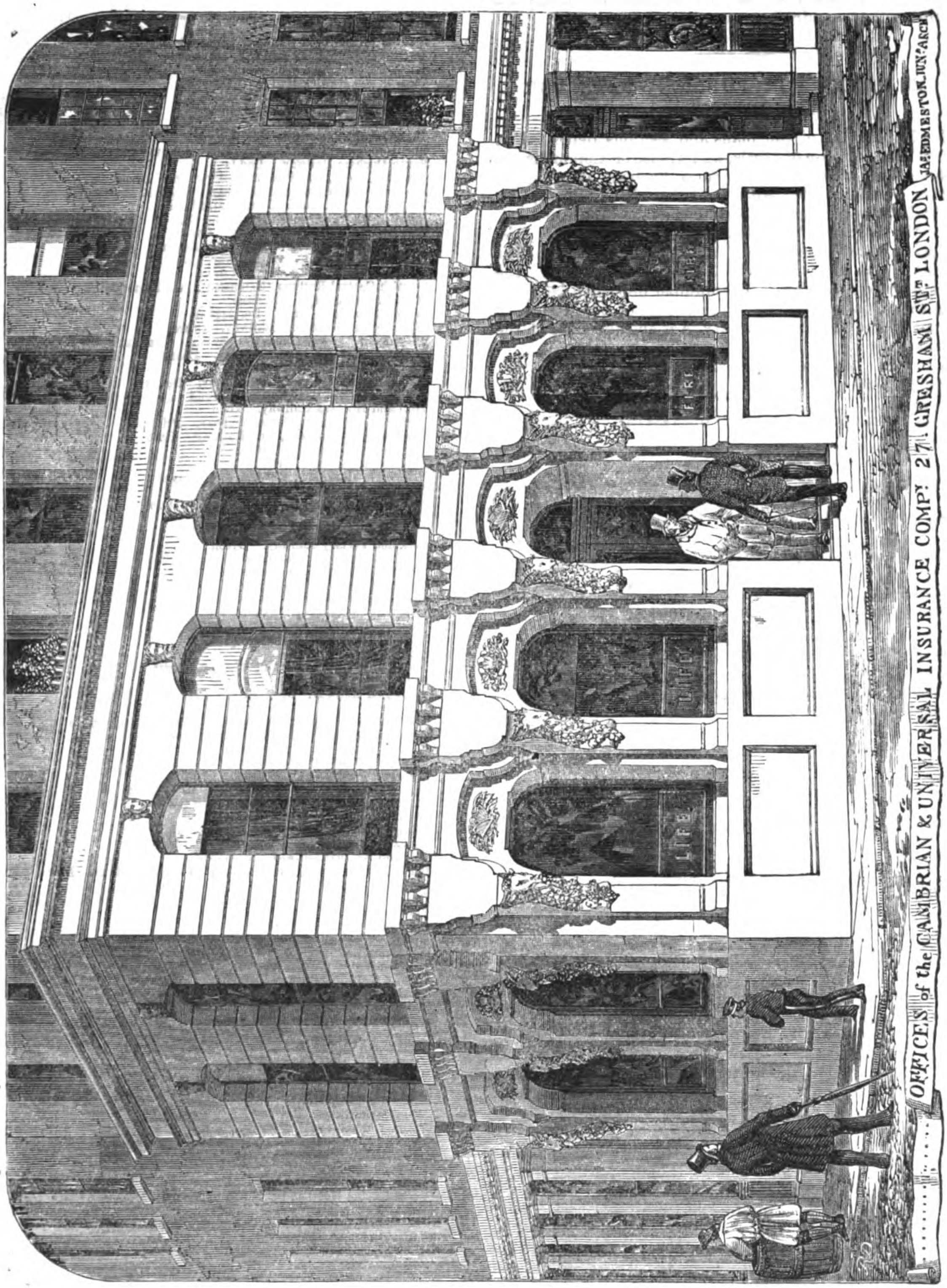
"I see by your plans that the outfall proposed is precisely in accordance with the suggestions of Captain Burstal, and I wish members of the Board to understand that Captain Burstal named that as the nearest point of outfall required of you in compliance with the provisions of the statute. The Metropolitan Board of Works having, therefore, complied with the provisions of the Act as to the outfall, I accept the plans; and in doing so, I will explain the course I shall adopt as clearly as I can. I think it desirable, in carrying out a work of such immense magnitude, that we should obtain the best counsel and advice, and the course I intend to take is to nominate three gentlemen, to whom I shall refer the plans—viz. two civil engineers and one military engineer selected from the most experienced men I can find, to whom I shall send the plans, with such instructions as I shall now inform you of. There is one point to which I shall call their particular attention. In the reports presented to the Metropolitan Board of Works, there appeared to be a great discrepancy as to the amount of sewage to be discharged, and I shall draw their attention to this fact, as the size of the drains must greatly depend on the amount of sewage that will flow down into the river. Then I think that we ought to have the best plans which the ingenuity of man can devise, and I shall tell them that they are not to confine themselves to the consideration of the plans submitted by the Metropolitan Board, and if they can devise any other scheme better calculated to carry out the object in view, and that might appear desirable to them, that they should set it forth in their report, so that I may lay it before your board for your consideration. Parliament will desire that the plan should be examined in the way I have sketched out, and if they saw that its merits had been examined by the most qualified minds of men of talent, they would be more likely to grant the money than if they had confined themselves to one particular plan. I shall desire the engineers to report whether it is desirable that there should be a more distant discharge to meet the requirements, and the best means for securing that object. I shall get from them an account of the cost from the extension at B* of the works which would be for the benefit of the districts through which they would pass. It would be desirable to state this, so that each district may contribute to the works having relation to the benefits derivable from such extension. Of course it is not my intention to impose on the metropolis a larger amount of taxation than for the outfall at B*, and so long as the metropolis complied with the requirements of the act, to that extent only should it be taxed. I shall tell them that a great number of plans have been sent in upon this subject, and I shall refer all persons having plans to them; and I feel assured they will give those plans all the attention they require."

LIST OF PLANS FOR PUBLIC WORKS FOR SESSION 1857.

The following is a list of the plans and sections deposited at the Board of Trade, House of Lords, and House of Commons, up to 30th November, 1856, by the various Parliamentary agents whose names are enumerated, with the titles of the bills, by Mr. Conroy, Mr. Fanshawe, and Mr. Stebbing, at the House of Commons; Hon. Mr. Stonor and Mr. Haines, at the House of Lords; and Mr. Mackenzie, at the Board of Trade. The total number of plans deposited was 176, of which 109 were railways, and the rest for miscellaneous purposes. The number deposited last year was 122, so that this year there is an increase of 54, in spite of the operations of the Limited Liability Act and the state of the money market.

Natchet Harbour. Parliamentary agents, Gregory and Co.
Milford Improvement. Marriott
Admiralty Lands (Chatham). W. F. Robson
Portland Breakwater. Robson
British and Irish Grand Junction Railway. Dyson and Co.
Keith and Dovetown Railway. Martin
Newquay Pier, Harbour, and Railway. Scott and Co.
Par Canal, Harbour, and Railway. Scott and Co.
Banff, Portsoy, &c., Railway. Martin
West Somerset Mineral Railway. Gregory
Lowestoft, &c., Ferry and Roads. Dorrington
Newtown and Machynlleth Railway. Pritt and Co.
Orkney Roads. Martin
Aberdeen Junction Railway. Dyson
Oldham and Ashton &c., Railway. Hoddings
Hormantine and Buchan Railway. Dyson
Stockport, Disley, and Whaleybridge Railway. Hoddings
Kinross-shire Railway. Dodds and Grieg
Banff, Macduff, and Turriff Extension Railway. Dyson
Leslie Railway. Dods and Co.
Dublin and Wicklow Railway. Muggeridge
London and South Western Railway. Dorrington
Birkenhead Docks. Pritt and Co.
Birkenhead, Lancashire, and Cheshire Junction Railway. Pritt and Co.
Lowestoft Water, Gas, Market, and Railway. Gregory
Townhope, &c., Bridge. Underwood
North Western Railway. Dyson
South Shields Gas. Dyson
Tyne Improvement. Dyson
Sunderland Gas. Dyson
Lewes and Uckfield Railway. Dorrington
Guildford Gas. Dorrington
Wearmouth Bridge, &c. Dyson
Mid-Sussex Railway. Holmes
Great Yarmouth Britannia Pier. Baker
Taff Vale Railway. Pritt
Manchester Corporation. Pritt
Metropolitan Sewage (outfall to the sea). Dyson
Manchester, Sheffield, and Lincolnshire Railway (Buxton). Pritt
Torquay and St. Mary Church, Gas. Toogood
Dundalk and Enniskillen Railway. Dorrington
Victoria Gas Company. Toogood
Reading Railways. Dorrington
Blyth and Tyne Railway. Dyson
Stockton New Gas Company. Durnford
Gosport Waterworks. Tyrell and Co.
Mid-Kent and South Kent Railway. Tyrrell
Cardigan Markets and Improvements. Durnford
Hartlepool Extension and Headland Improvements. Durnford
Midland Great Western Railway. Muggeridge
East Somerset Railway. Dyson
Tilbury, Maldon, and Colchester Railway. Dyson
Manchester, Sheffield, and Lincolnshire Railway (Romily). Pritt
North Eastern Railway. Pritt
Stamford and Essendine Railway. Dorrington
Border Counties Railway. Toogood
Portsmouth Waterworks. Dorrington
Sittingbourne and Sheerness Railway. Durnford
Dewsbury, Earlsheaton, Ossett, and Great Wakefield Railway. Durnford
Portadown and Dungannon Railway. Dyson
Aldershot Railway. Holmes
Lynn and Huntstanton Railway. Dyson
Dewsbury, Ossett, and Wakefield Railway. Pritt.
Bagenalstown and Wexford Railway. Pritt
Limerick and Hoynes Railway. Pritt
Great Southern and Western Railway of Ireland. Pritt
Cork and Bandon Railway. Pritt
Colne and Bradford Railway. Dyson
Carlisle and Liddesdale and Hawick Railway. Dyson
Loughrea and Midland Junction Railway. Bryden
Athenry and Tuam Railway. Bryden
Bourn and Essendine Railway. Whitelock
Brighton, Shoreham, &c., Railway. Dorrington
Thames and Medway Railway. Haddow
Poulnasherry Embankment. Pritt
West Metropolitan Railway. Haddow
Metropolitan New Streets and Improvements. Dyson
New River Company. Dorrington
South Shields Improvement and Quay. Fearon
Margate Waterworks. Fearon
South Eastern Railway (Reading). Pritt
West Somerset Railway. Dyson
Walton-le-Soken Improvement. Dyson
South Eastern Railway (Greenwich). Pritt
Lancashire and Yorkshire Railway (Dewsbury Branch). Pritt
Swansea Harbour. Pritt
Stratford-upon-Avon Railway. Toogood
Dartmoor and Torbay Railway. Toogood
Longport, Somerton, &c., Roads. Walmisley
Carlisle and Hawick Railway. Grahame
Dumbarton Waterworks. Grahame
Public Offices Extension. Gardiner
Bury Gas. M'Dougall
Birkenhead District Gas. M'Dougall
Farnborough and Ightham Railway. Johnson and Co.
South Durham Railway. Dodds
Brighton, Hove, and Preston Waterworks. Dyson
Aberdeen, Peterhead, &c., Railway. Holmes
West of Fife Mineral Railway. Maitland
Mordon, Carrs, Drainage. Bell and Co.
Newry and Enniskillen Railway. Dyson
Doncaster and Wakefield Railway. Dyson
Newry, Warrenpoint, &c., Railway. Dyson
Deeside Extension Railway. Holmes
Scottish Central Railway (Extension). Grahame
Monklands Railway. Grahame
Watchet Harbour Trust. Dorrington
Waterford and Tramore Railway. Cruse
Caledonian Railway (Lines to Granton). Graham
Hamilton and Strathaven Railway. Deans
Hamilton Improvement. Deans
Edinburgh and Queensferry Railway. Deans
South Yorkshire, &c., Railway. Todd
Hull and Hornsea Railway. Todd
Maidstone and Loose Valley Railway. Pritt
Staplehurst, Cranbrook, &c., Railway. Pritt
Bathgate, &c. Railway. Deans
Blackburn Railway. Pritt
Prestwich, Bury, &c., Roads. J. S. Player
Norwich and Spalding Railway. Dyson
Newport, Abergavenny, &c., Railway. Dyso
Hainault Forest Railway. Dyson
Cannock Mineral Railway. M'Dougall
Cork and Fermoy Railway. Dyson
South Staffordshire Waterworks. Dyson
Manchester Corporation. Pritt
Clyde Navigation. Richardson
Metropolitan Railway. Dyson
Cwm Ammon Railway. Dorrington
Pulteney Town Harbour. Richardson
Victoria London Dock. Dorrington
Mid Kent Railway. Pritt
Forest of Dean Central, &c., Railway. Pritt
Shropshire Union Railway. Pritt
West End Railway. Johnson
Wycombe Railway. Dyson
Midland Great Western Railway of Ireland. Muggeridge
Salisbury and Yeovil Railway. Hoddings
Charing Cross Bridge. Dorrington
East Kent Railway (Strood, &c.) Dorrington
Ely Tidal Harbour and Railway. Pritt
Herne Bay and Faversham Railway. Dorrington.
Mayfield and Heathfield Railway. Le Blanc
South London Railway. Dyson
Allsager and Audley Railway. Durnford
Lancaster and Carlisle Railway. Pritt
Fife and Kinross Railway. Richardson
Bristol, South Wales, and Southampton Union Railway. Dyson
Ringwood, Christchurch, &c., Railway. Hoddings
Dublin and Meath Railway. Dorrington
Finsbury Park. Ludlow
Elie Harbour. Richardson
Backwater Bridge and Road. Deans
Ely Valley Railway. Wyatt
Westminster Improvement. Wyatt
Eastern Counties Railway Extension. Pritt
North Level Drainage. Pritt
Cork Gas Consumers Company (Limited). Pritt
Dorset Central Railway. Toogood
North Derbyshire Railway. Toogood
Richmond and Kew Extension Railway. Toogood
Coniston Railway. Toogood
Mid-Kent (Bromley to St. Mary's Cray). Wyatt
Briton Ferry Docks. Dorrington
Hammersmith Railway. Toogood
Rhymney Railway. Roy
Wimbledon and Dorking Railway. Roy
Great Northern and Western Railway of Ireland. Pritt
Southampton, Bristol, and South Wales Railway. Dyson
Portsmouth Railway. Pritt
Chatham District Waterworks. Fearon
City of London Hotel and Building Company. Martin
Conway Valley Railways. Holmes
St. George's Harbour Act Amendment. Holmes
Southwark Improvement. Slee
Direct London and Sydenham Railway. Young

At a meeting of ratepayers of Southwark, it was resolved that a deputation be appointed to wait on Sir B. Hall to recommend the adoption of Mr. Pennethorne's plan, in opposition to that of the Board of Works. The plan proposed by Mr. Pennethorne is for a street commencing near the Town Hall and going in a straight direction through property of small value compared with the board's line, to Waterloo Bridge Station and thence through Vine-street and the waste ground in that neighbourhood to York-road, Westminster-bridge.


OFFICES of the CAMBRIAN & UNIVERSAL INSURANCE COMPY. 27 GRESHAM STT. LONDON
JAS. EDMESTON, JUNR. ARCH.
LIFE
FIRE
FIRE
LIFE

THE CAMBRIAN AND UNIVERSAL INSURANCE COMPANY'S OFFICES, GRESHAM STREET.

In this building the old supports had to be retained as far as possible, and the old bressummer was left undisturbed, which will account for some of the points in the design. The object of the architect was to connect the two stories together, and to bring the width of the upper piers pleasantly and easily into the lower supports, so as to obtain wide windows and light piers, sufficiently strong without appearing heavy. The building being situate in a rather narrow street, attention has been paid to reveals and soffits. All the work is executed in Bath stone. Mr. J. Edmeston, jun., 5, Crown-court, Old Broad-court, City, is the architect.

ARCHITECTURAL EXHIBITION.

The rooms of the Suffolk-street Gallery are again open as above for the winter season, and the space available is, as heretofore, well filled. Some 500 framed drawings, and a goodly stock of fittings and furniture in the "Department for Materials," form in themselves no mean collection; and when it is remembered that the majority of these present some claim to notice, and that all are *new* (the Committee having wisely adhered to their former resolution of excluding such as had been exhibited before), it will be presumed that there is abundance to satisfy the eye, and to offer suggestions to the mind.

In a first glance round the large room the attention is not arrested by more than two or three productions, and by scarcely one on a very large or elaborate scale. The prevalence of polychrome, as a medium of constructive as well as decorative utility, is not this year so apparent as last; that of alternately red and white brick, almost universally treated merely on the horizontal or banded principle, retains however its hold and it is perhaps the most reasonable and judicious method of treatment. In one large drawing (178), to which we shall have occasion again to refer, the coloured material is used but sparingly, but in so felicitous a manner that it vastly aids the making out of the architectural features, binds together as it were the several parts, and enlivens the general effect. In the "Material" apartments, several kinds of productions are submitted which bear upon the external appearance of buildings, such as the Cornice Bricks (30), Stucco Wash (28), Terracotta Air Brick (31), Serpentine Marble (43), Ransome's Siliceous Stone (37), and the contributions of the Architectural Pottery Company, Poole (51). Without laying too much stress on the value of these specimens—for many of them are comparatively untried—the production of so many varieties, aiming at agreeable results combined with sterling utility, must be hailed as a satisfactory indication of the disposition of the times. But to return.

We have always urged the importance of constituting this annual Architectural Exhibition a medium of representing as fully as possible the existing state of the art, by the displaying such drawings as shall illustrate works in progress; and, in cases of competition, the unsuccessful as well as approved designs, in order that the profession and the public at large may have an opportunity of comparing and judging for themselves. On the present occasion there are not a few drawings of this kind, and in three instances they are sufficiently numerous to require a distinct classification. We refer to the competition designs for the Lille Cathedral, for the Liverpool Free Library and Museum, and the Rotherham Grammar School. The former of these was, undoubtedly, the event of the year; and, in a challenge to the world, it is no small credit to our countrymen that the two chief premiums were awarded to Englishmen, and it will be doubtless a source of gratification to learn that the principal drawings of one of these successful sets find a place in the present Exhibition in company with other less fortunate rivals. The much-canvassed design, "*Quam dilecta*," &c., which ultimately obtained the second prize, proved to be by Mr. Street, of Oxford, who has forwarded a plan, perspectives, and parts at large, of his design—in all, nine drawings; and it may be remarked at once that they immeasurably surpass in talent of design and manipulation those by which they are here surrounded. Why the Committee did not adjudge them a place on the line we are at a loss to conceive. The plan is more complete and better proportioned than either of the others. It consists of nave and single aisles, seven bays in length to the intersection of the transepts (which are rather shallow); the east end is apsidal, and clustering around it are the several chapels, after the custom usual on the continent. From the intersection at the cross rises a slender *flèche*. At the west end are the principal entrances and the two towers, which are flanked respectively by the baptistery and the mortuary chapel. Externally, the design has a bold and massive appearance, attributable chiefly to its buttresses. The least successful part of the design appears to be the western towers, which in their upper stages are not very happy either in outline or detail. The spires are dwarfish, and look still more so from the belt of large gabled lucarnes which surround it. The interior view shows a fine massing of colour as well as architecture. In this view the tapestry and metal screens, so beautifully detailed on another sheet, are seen to great advantage. The organ is designed in two parts, so as not to conceal a large marigold window behind. The other details of furniture, such as lectern, ambo, confessional, stalls, and font, are each in its kind excellent and well studied; perhaps the pulpit, which is the most ambitious, is the least deserving of praise. Having said thus much respecting Mr. Street's drawings, it will not be needful to enlarge on those of other competitors, which, as we hinted before, fall lamentable into the background. A very highly finished set by Mr. C. Brodrick (336—340) partakes very much of the horizontality of the classic styles; its best features are palpably copied from Rheims Cathedral. The general proportions are better than most, as also is the plan, which in many particulars accords with that just noticed. One peculiarity in this design is that it has but one central tower at the west end, whereas the others exhibit two. Messrs. Lee and Jones (324—329) have evidently borrowed the Margaret-street steeple, engrafting fragments from the Abbaye aux Hommes, Caen. Three lofty arches flush with the towers form the portals; and the whole is constructed inside and out in red and white bricks alternately. The detailed portions are wretchedly managed. Mr. Robinson's drawings (330—332) have not the advantage of either good outline or colouring, nor is the plan complete; its small octagonally-terminated transepts have an odd look. The altar, as detailed, is by far the best part of the design. Mr. Kelley's ideas in (334, 335) seem but a slight remove from those of the Batty Langley age. Mr. Thrupp's (352, 353) is a sort of coarse Early English, acutely pointed, but with an abominably classic-looking excrescence at the intersection. Messrs. Evans and Pullan (355—359) somewhat more appropriate.

The recent decision respecting the Liverpool Free Library and Museum will cause general dissatisfaction, if not disgust; and the more so since in the outset everything promised so fair. No less than 53 of the competition drawings are exhibited in the present collection, the productions of twenty individuals. Copies of those by Mr. Allom, to whom was awarded the first premium, are included in this number (174—177). It is essentially a classic design, one that would assort well with St. George's Hall, its neighbour,—which is apparently imitated in some of the schemes for lighting. It has a hexastyle Corinthian portico, on a well-designed stylobate, and flanked by masses of walling, freely relieved by niches and sculpture. Internally, the central Hall or Museum for sculpture and painting is a prominent feature, and most cleverly planned and delineated in (176). A vista through some columns above produces a charming effect. Among the others, that of Mr. Huggins has most claim to notice. The elevation, quite Palladian, is well composed. Mr. Grayson's plan (235) has the novelty of a circularly planned reading-room; the librarian's office being in the centre,—a good idea, perhaps taken from the new room at the British Museum. The external appearance of (236), by Messrs. Hay is, on the whole, good; but there is no occasion for the exact repetition of the features of the front in the side elevations. Mr. Truefitt's design (178) has at least the merit of originality: on the score of appropriateness we cannot say much. Where is all the needed light to come from? Mr. Hewitt, one of the sixteen whose first sketches were selected, has ten drawings illustrative of his finished design, which looks best in elevation: the plan would seem very defective. The same may be said of that of Mr. Huggins (229—231), whose view is cleverly but mysteriously tinted.

In the drawings for the Rotherham Grammar School, which comprise nine in number, there is little to call for notice. Some of the better designs were exhibited last year in the Royal Academy. That by Mr. T. D. Barry (413, 414) is by far the best both in the general disposition of the masses and the originality in design. Mr. E. B. Lamb's (260), in another style, is perhaps nearly as good.

The Architectural Association contributes, as usual, a large sheet (271) of selected sketches from its Class of Design—not so good this year as formerly. Mr. Clarke and Mr. Richardson have most distinguished themselves in a "Domestic Gothic Window without Mullions," and a "Landing Pier."

Generally speaking, the public buildings exhibited this year are by no means striking on the score of merit. The group by Mr. Walters (1), and those by Mr. Colling (98), and Mr. T. Roger Smith (8), are among the best. The "Carpet Warehouse erected at Kidderminster" (69), by Mr. J. G. Bland, is also good. It is of red brick, with blue brick occasionally introduced as chequered ornament. Its simplicity of treatment is its great recommendation. Mr. Lockyer's "Premises erected in Tottenham Court Road" are good specimens of the kind, and well detailed in the elevation exhibited (149). Nor must we omit the "New public buildings about to be erected at Singapore" (12), by James Edmeston, jun., as a handsome and characteristic pile. Mr. Edmeston also exhibits (73) the "Offices of the Cambrian and Universal Fire and Life Insurance Company, 27, Gresham Street, as altered by him. Early in the catalogue list is Mr. Murray's "Baptist Chapel at Coventry" (11), a strikingly original and clever Gothic design; further on (14), Mr. Walter's "Free Trade Hall, Manchester," equally good in another style. Mr. Petit's half-dozen sketches are, as usual, powerful, and a welcome feature in the room. So is Mr. Rawlins' "Cave of Elephanta" (46), a beautiful specimen of colouring. The group of designs exhibited by Mr. Messenger (50) are noticeable more on account of the boldness with which the tinting is washed in. A lady contributor named Travers has three drawings, all really architectural (50, 123, 449). Professor Donaldson revives one of his ancient classic studies in (65, 66). The show of Independent and other chapels is this year most miserable: we observe scarcely one that is even tolerably decent. What kind of genius can provoke such a design as (70), or (341, 342)? The latter, avowedly "suited to the times," is in truth as ill-conceived and *un*suitable as possible. To make the absurdity more apparent, the drawing is placed among the Lille pictures, as if in burlesque. Two or three half-timbered houses "in progress" show that that style of building is not quite out of vogue: (76), by Mr. Coe, is designed in the true feeling. The three drawings exhibited by Mr. Owen Jones stand prominently forward: (84) is an elaborate view of the interior of the proposed St. James's Hall, where much is contemplated by the aid of colour, and (111, 112) show his design for the Manchester Exhibition building, in section a complete semicircle, of iron construction, and springing directly out of the ground,—a novel, but not prepossessing appearance. Mr. E. B. Lamb's designs continue to exhibit his peculiar mannerisms and ingenuity: his churches are the least satisfactory. Mr. T. E. Knightley is a frequent contributor; the group of little drawings in (108) will attract notice: their proportioning is unusually picturesque. Mr. Gray has but one drawing (116), in a style that he has almost made his own. The present work seems scarcely equal to some shown heretofore. Mr. G. G. Scott exhibits (158) a beautiful design for a recumbent monument to the late Dr. Mill, of Cambridge; and also (through Mr. J. D. Wyatt), the "Porch now erecting at St. Michael's, Cornhill" (245). Mr. Truefitt's productions are unmistakeable; in matters of detail, and ironwork especially, he most excels: some very good proofs may be seen in (136). Mr. Philip Brannon's "Brickwork on Æsthetic principles" (162, 164, 293), must for almost every other be rejected. Among the general sketches from the Continent deserving of notice, may be mentioned those by Mr. R. N. Shaw, Mr. Eastlake, and Mr. Aitchison. Some of the plans for the Middlesex Industrial Schools will be conned with interest. Messrs. Morgan and Phipson's (300—302) are on a quadrangular scheme; Messrs. Reeves and Butcher's on a radiating one (299, 303). Mr. Clayton has a large drawing (371) of the "Study for the colossal figure of Our Lord, painted on the choir ceiling of Peterborough Cathedral," of which we gave a description last month; also some good geometrically patterned stained glass (132). A folio of designs for Grisaille glass also is forwarded for inspection by Messrs. Heaton and Butler.—It would be easy to extend our remarks on the contents of this Exhibition, but we have endeavoured to seize on only its most interesting or suggestive features. In many of the departments there is a manifest room for great improvement, which careful *study* in such a collection as this will do much to effect. On every account, therefore, let each well-wisher to the art pay a visit to the Exhibition, and invite others to do so likewise.

The Department for Materials will be noticed in the next *Journal*.

INSTITUTION OF CIVIL ENGINEERS.

Dec. 2, 1856.—Joseph Locke, M.P., V.P., in the Chair.

The Paper read was "*On Recent Improvements in Water Meters.*" By T. T. Jopling.

After alluding to the generic merits and defects of piston and bucket meters,—merits which were generally appreciated, and defects which were apparently inseparable from these machines, and had only as yet been partially removed,—the author proceeded to describe a meter constructed on the piston or diaphragm principle, which appeared to meet the objections hitherto made to that class of meter. It consisted of two measuring cylinders, set parallel to each other, with working pistons, the rods of which projected out of the cylinders in opposite directions, carrying at their extremities slide-valve frames, for supporting and operating on the slide valves that governed the ports of the cylinders. These measuring cylinders were contained in a cast-iron case, or tank, into which the water to be measured entered under a certain pressure. The water thence passed into the cylinders, from which, after having acted upon one or other of the pistons, it made its escape. Through the agency of suitable counting apparatus connected with one of the piston rods, the reciprocating movements of the piston were counted, and thus the quantity of water passed through the meter in a given time was indicated. The measuring chambers were made somewhat like ordinary steam-engine cylinders, as respected the inlet and outlet ports, but in one of the cylinders the direction of the inlet ports was inverted, in order that the right hand port might pass the water to the left hand end of the cylinder, and the left hand port to the right hand end. By this means the two pistons were enabled to follow each other in the same direction, and to maintain a continuous stream of water, without the use of cranks. The slide valves were pressed up against the ports of the cylinder by means of springs, in order to retain them in contact with the faces when the meter was at rest. They were free to remain stationary during the greater portion of the progress of the pistons; but just as the piston of one cylinder was completing its stroke, one of a pair of tappets on the valve-frame, carried by the piston-rod of that cylinder, would strike against the valve which that valve-frame carried, and altered its position over the ports of the other cylinder, whereby the direction of the flow of water into that measuring cylinder was reversed. For transmitting the reciprocating motion of the pistons to the index, one of the valve-frames was furnished at the back with two ribs, or feathers, set parallel to each other, but one in advance of the other. These feathers acted as teeth, and in sliding backwards and forwards with the piston-rod, they entered alternately the teeth of an escape-wheel, and so drove it round tooth by tooth. The arbor of this wheel led through the water-case to the counting apparatus; and thus motion was communicated directly to it, without the aid of pawls and ratchet-wheels.

By this arrangement the meter became a very simple and inexpensive machine, not liable to derangement, or if injured, it was easily repaired, as the only moving parts were the two valves and two pistons. There was an entire absence of concussion; the pressure of the head was preserved; and being similar within and without the cylinders, there was no friction upon the pistons; and the water-tight external case, or chamber, served as a deposit for sand, or other extraneous matter. These merits were admitted by the engineers of the Sunderland Waterworks, where the meters had been connected with meters by other manufacturers, and exhibited identical results.

Models of Jopling's, Kennedy's, Siemens', and Chadwick's Meters, were exhibited in action during the evening. In the course of the discussion, descriptions were given of Kennedy's, of Chadwick's, and of Siemens' meters. The former was described as consisting of a single vertical cylinder, wherein a deep piston worked, with a packing consisting of a vulcanised india-rubber ring, made to roll between the piston and the cylinder, allowing for easy motion, and yet being perfectly water-tight without friction. The alternate action of the piston was communicated to the counting apparatus, by means of a rack and pinion, and action was given to the inlet and outlet valves by means of a tumbling weight. This machine, it was contended, was very durable, and easily kept in order; the elasticity of the packing, and the peculiar rolling motion diminished the friction; the pressure of the water was preserved through the meter; the action of the valves was regular and simple, and under the most extreme trials the variation had never been found to exceed 1 per cent. The meters were stated to have been extensively employed and much approved by water works engineers.

Chadwick's new meter was described to consist of three or more rollers, revolving on their axes, attached to the periphery of a wheel, the spindle of which worked in journals in two upright supports; these rollers rested upon a bag, or piece of prepared leather, with inlet and outlet passages, and so fixed upon a concave bed-plate of brass, as to form the measuring chamber of the meter. The water being admitted to the bag, propelled the rollers forward, so that they each in turn passed over every part, and expressed the fluid before them by the outlet pipe. The motion was regulated by a governor, moving in an opposite direction to the rollers; and the counting apparatus was identical with that in the old meter, described on a former occasion at the Institution. These meters had not been very long in use; but, as far as could be at present seen, they might be called successful.

Siemens' meter was of the class termed "inferential" measurers, and so many of them were in use that it was not considered necessary to give any minute description of their construction, beyond stating that its action was similar to that of the Barker's mill, the water entering at the centre, and being expelled through numerous curved orifices at the periphery of the revolving meter.

It was contended that the chief desiderata for high-pressure meters were:—accuracy of measurement under very varying pressures,—free passage for the water without loss of pressure,—compactness and lightness of construction,—with durability and cheapness.

Good meters were made both of the piston and diaphragm class, and many did register excellently during laboratory experiments and for short periods; but the real test was the action after twelve months constant work, and it was generally found that some injury had occurred to piston meters, from the introduction of sand, or other extraneous matter, whereas the action of the differential meters was as perfect, after several years, as when first they were erected. Arguing that a certain force was required to cause motion, it had been stated, that these meters were not capable of registering small quantities of fluid at low velocities. This was, however, an erroneous opinion, in proof of which it was mentioned, that a small house-meter had registered accurately so small a quantity as half a gill per minute. These meters gained in sensitiveness as they worked, whereas piston and other meters were liable to wear and tear. The former could be so applied as to present little more resistance than a bend in the pipe;—they were so compact in form, and so small, that they could be adapted to almost any situation, however restricted; and under either high or low pressure, and with constant or intermittent action, they had been found to give satisfactory results.

It was stated that the East London Water Works Company had two hundred of Siemens' meters now at work. They had cost on an average 10*l.* a-piece; but new failures had occurred, and those quite capable of being remedied, so that casualties were likely to be even less frequent in future. They were also almost exclusively used at Bristol, where they were tested every three months, and it had been observed, that they gained from 1 to 2 per cent. The new meters were consequently adjusted so as to allow for that gain.

It was admitted, that both Jopling's and Kennedy's meters had, when tested, been found to act very satisfactorily, and that practically they could be received as very good efficient machines, both for the water companies and the consumers.

It was shown, that there had been at least eleven distinct classes of meters, and probably not less than ten varieties in each class; which could be taken as 110 distinct inventions. They might be divided into two great classes:—high-pressure meters, *i. e.* working under the direct pressure of the mains, and delivering the water without any sensible diminution of the pressure; and low-pressure meters, which, receiving the water under pressure, merely delivered into a cistern, or other receptacle, generally situated at the top of the building to be supplied. The latter class was asserted to be generally the best, especially in those cases where the consumption was large and irregular,—as that of brewers, dyers, bleachers, calico printers, &c. Of this class, Parkinson's was said to register accurately under all circumstances of change of head, and velocity, or quantity delivered.

SELF-ACTING PENSTOCKS, OR FLUSHING MACHINES.

At a late meeting of the Institution of Civil Engineers, Mr. Roger Salter explained two models of self-acting Penstocks, or Flushing Machines, for cleansing house drains and sewers. They were of two kinds, the one having a valve hung horizontally, the other a valve or gate hung vertically. In house drains, a tank or cesspool was formed for the collection and retention of all the waste water running from the house, say in the course of one day, and thus this water which would otherwise possibly help to create the necessity for flushing, would itself act as a flushing medium. If the rain water also was allowed to run into and collect in this tank, then the number of flushings would be increased. Although it was not contended that the construction of flushing tanks was a new idea, yet it was believed that the mechanical arrangements for making them self-acting were novel and important. The mode of accomplishing this for the tank was very simple:—A cast-iron pipe was fixed to the bottom of the tank, and on a level, or nearly so, with the bottom of the drain. A valve was hung so as to fall on the outlet of this pipe, the beat for the valve having a considerable angle. To keep this valve closed, and to prevent the water from escaping, a strut or stopper, working on a centre, fell dead on the valve, and held it close to its seat, thereby securing a water-tight joint. To release the water when it had risen to the discharging point in the tank, a waste pipe conveyed the overflow to a tilting basin, or bucket, hung on centres, at a convenient height above the valve. Beyond these centres an arm or lever, extended, to which was attached a weight to counterpoise the bucket, and a rod connecting the lever with the strut. When the weight of water in the bucket caused it to tilt or drop down, the lever and connecting rod at the opposite end of the basin or bucket, rising by the tilting of the bucket, carried up the strut and released the valve, and the contents of the tank were suddenly discharged into the drain. By means of a moveable lid, the bucket was made to empty itself, while the contents of the tank were being discharged. When the water was all out of the bucket, the balance-weight caused it to recover itself, and in doing so again fixed down the valve, by means of the strut before referred to. These machines had neither latch, catch, nor spring, which by corrosion would impede their action. They were made of cast-iron, and were said not to be liable to get out of order. They had been used by the Board of Ordnance for the cleansing of barrack-drains. The arrangement in these cases consisted of an elongated cesspool, or invert, having a self-acting flushing machine fixed at the outlet, so that when the water in the invert had risen as high as was required, the machine acted, and the whole of the contents of the cesspool, or invert, were at once discharged into the drain, and swept away. In cavalry barracks large quantities of hay, straw, and other matter, were thrown into the invert, yet no inconvenience had hitherto arisen in their use. It would be readily seen that these machines could be applied to tanks to all situations, as no head of water was required, and they might be of any capacity. In the self-acting flushing gate, the gate was entirely closed the whole width of the sewer, and was of any convenient height. The gate was kept closed by means of a strut jointed in the centre; one end of the strut worked in an eye fixed in the centre of the gate, whilst the other end worked in an eye fixed to the wall of the side entrance. The tilting basin was hung on centres within the side entrance, so as not to interfere with the opening of the gate; the lever extended beyond the centres and underneath the joint of the strut. The water having risen behind the gate to the discharging point, a waste pipe took the overflow water into the tilting basin, or bucket, when the lever raised the joint from the horizontal position, and the weight of water pressing against the gate, caused it immediately to fly open, and the scour took place. The legs of the strut, by the two extremities being brought closer together, formed the two legs of the letter A. When the rush of water had subsided, the legs of the strut, from their position, had a tendency to thrust the gate from them, and the more nearly the legs of the strut assumed a horizontal position, the greater was the thrust, and the gate was eventually forced home.

CLITHEROE WATERWORKS.

The inhabitants of this borough, long feeling the serious inconvenience of a defective water supply, determined, in 1849, to call upon the General Board of Health to apply the Public Health Act to their district, which request was complied with in the following year, upon the report and recommendation of their inspector, Mr. B. H. Babbage. In the report made by Mr. Babbage, a scheme for supplying the district with water was proposed; the Local Board, however, preferred taking further advice as to the best means of doing this, and secured the services of Mr. Park, of Preston, then engineer to the Preston Waterworks, and subsequently those of Mr. McLandsborough, civil engineer, of Bradford, who both reported upon the subject. In 1853, a company was formed for supplying the borough with water, and in the following session of 1854, an Act of Parliament was obtained for such purpose, to which there was some local opposition. Upon the Act being procured, the directors had the works carried out with as little delay as possible. Contracts were entered into in the autumn of the same year for the whole of the works, which have recently been completed at a cost rather more than ten per cent. under the parliamentary estimate, which estimate included such per centage for contingencies. The mains through the streets are now charged with water, and the inhabitants are being supplied therefrom as rapidly as the company can put branch pipes into the houses, of which about 950 have already been fixed. The company have also fixed fire-plugs to the mains in all the public streets, at the expense of the corporation, and by their use have already, in one case of fire, been the means of saving considerable property. The recent supply of water for culinary purposes was procured principally from public and private wells, which sources yielded an abundant supply of water, bright and clear, but unusually hard; the principal town well (one of the softest) being 23 degrees of hardness, and the others varying as high as 34 degrees, while the new supply is only 4 degrees, and this reduceable by boiling to 2½ degrees. Not only in point of softness does the new supply contrast favourably with the recent supply, but also in its comparative freedom from organic and solid matters; and, as the following table will show, it bears favourable comparison with the water of other towns, including those supplied from the purest sources known:

	Organic matter in grains per gallon.	Total solid contents in grains per gallon.
Clitheroe—Recent supply from public wells (many of the private wells contain much larger proportions of both organic and inorganic matter)	0·79 ...	22·30
Clitheroe—New supply	0·23 ...	3·71
Glasgow—Lock Katrine, new source of supply	0·82 ...	2·23
Whitehaven—Ennerdale Lake, new source of supply	0·91 ...	3·10
Dewsbury—New source of supply ...	1·18 ...	3·51
Liverpool—Rivington Pike, new source of supply	0·75 ...	5·75
Leeds—River Wharfe, new source of partial supply	0·80 ...	14·84
Hull	3·20 ...	18·00
London—New River Company	2·79 ...	19·78
London—Supply from Thames Ditton ...	2·29 ...	21·33
Malvern	Not known	3·00
Aberdeen	Ditto ...	3·50
York...	Ditto ...	9·00
Ilkley Wells...	Ditto ...	10·79
London—Hampstead Water Company ...	Ditto ...	35·59
Glasgow—Well water	Ditto ...	15·00 to 96·00
London—Well water	Ditto ...	28·00 to 180·00
Liverpool—Well water	Ditto ...	13·80 to 417·02

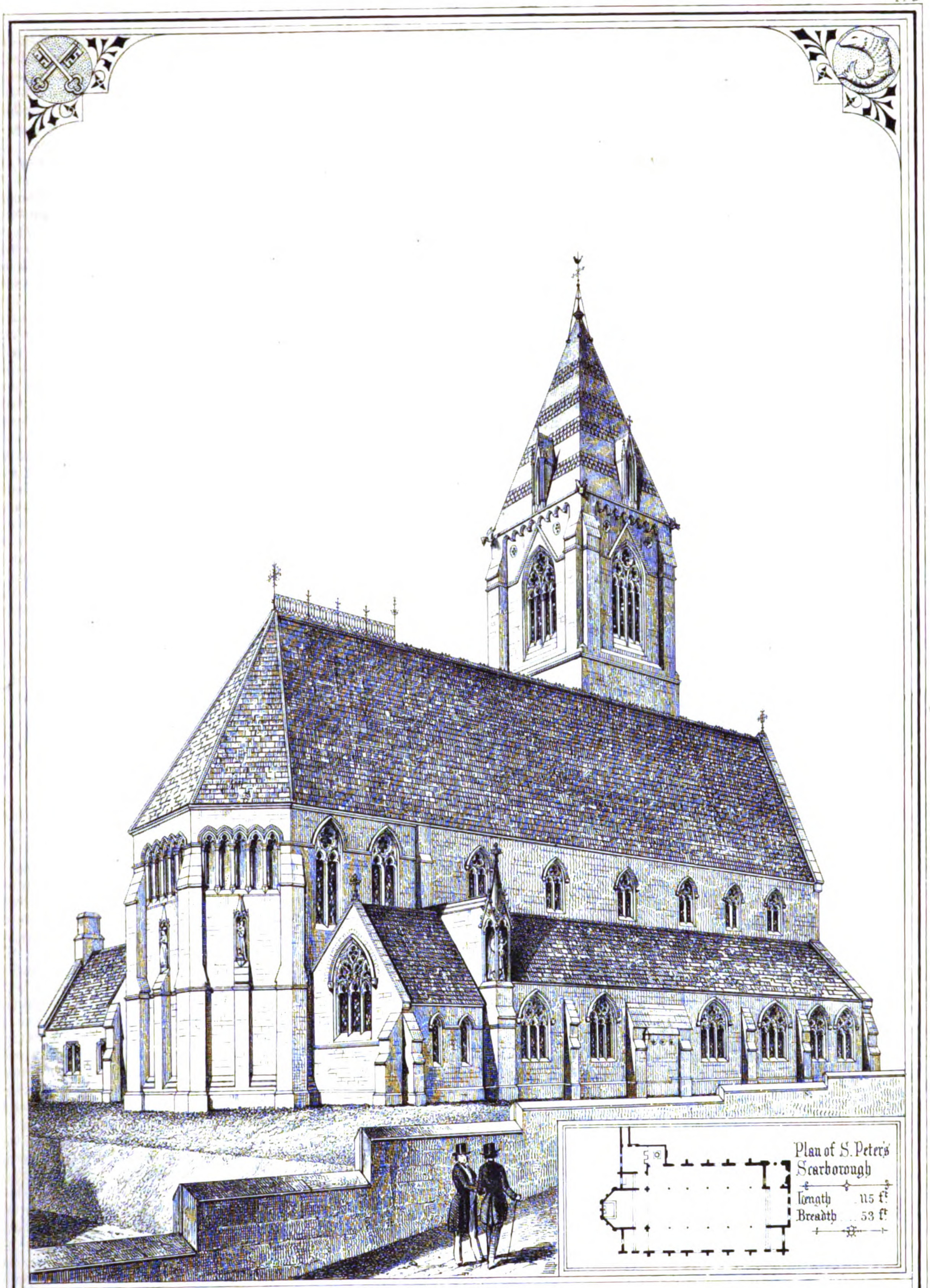
This water, so unexceptionable in quality, is procured from a number of copious springs, that rise on the adjacent fells, the district being from 3¼ to 4½ miles north of Clitheroe. The formation being of millstone grit and from 560 to 1300 feet above the mean level of the sea. The minimum yield of the sources in the most droughty seasons is over 300,000 gallons per diem, for the immediate supply of which amount the works have been consructed. The conduits and pipes, however, have been laid down of sizes to admit of their conveying a much larger quantity, which, without further powers being required, can be supplied at a nominal expense. Although the population of Clitheroe in 1851 was only 7244, in 1854 it had so far increased as to induce provision being made for an immediate supply to not less than 10,000 persons, at 30 gallons per head per diem. The supply is collected by means of earthenware conduits, and conveyed to a reservoir, situated about two miles north of the borough, at an elevation of 75 feet above the level of the Castle, which is the highest part of the district, and of 250 feet above the level of Low Moor, the lowest part. The main from the reservoir to the town consists of 9-inch cast-iron pipes, which, after descending for a length of 7 furlongs, and a fall of 250 feet, crosses under the bed of the river Ribble for rather more than 200 yards. From the river the main ascends towards the town for a distance of half a mile, rising, in that length, about 94 feet; thence with a gradual fall it crosses below the Blackburn railway to its terminus in the market-place, from which place branch pipes diverge to all parts of the district. The conduits and iron mains extend to a length of twelve miles. The cost of the works, inclusive of all extras, coating-pipes, &c., but exclusive of land, parliamentary, legal, and engineering expenses, is 13*s*. per head, and inclusive of parliamentary, legal, engineering, and every other expense, the works and land have cost 1*l*. per head on the above population. When the quality and quantity of water supplied; the efficiency of the works executed for present and future requirements; the facilities they possess for economical extension, and their cost, are considered, it is conceived they will bear favourable comparison with those executed in any part of the United Kingdom. The works were designed and carried out by Mr. McLandsborough, C.E., of Bradford, Mr. J. Barker acting as clerk of the works (since appointed manager), and Mr. Booth as inspector. The earthenware pipes were supplied by Messrs. Hayes, Brough, and Co., of Liverpool; the iron pipes by Mr. Clark, of Clitheroe; the fire-plugs, &c., by Messrs. Guest and Chrimes, of Rotherham; and the formation of reservoir, conduits, pipe-laying, &c., were executed by Mr. J. Metcalf, of Bradford.

ST. PETER'S CHURCH, SCARBOROUGH.

(*With an Engraving, Plate* II.)

The want of accommodation for the resident Catholics, and numerous visitors at this fashionable watering-place, has been long felt in the present building used as a chapel, and it was therefore resolved to erect a new church, of which we present our readers with a view. The site, upon a rapid decline, and on too narrow a piece of land to enable the plan to be reversed, has offered considerable difficulty to the architects; resulting, however, in a gain of picturesqueness. The plan, as will be seen, consists of a nave and aisles, apsidal chancel with lateral chapels, baptistery, tower, and sacristy. The style adopted is the Geometrical Decorated, verging upon the Flowing Decorated; but throughout there is an evident desire to attain to originality as opposed to servile copying, without, however, casting aside the eloquent teaching of the church builders of old. The most remarkable feature in the building is the "blind" apse, in which an effort is being made to avoid the great objection to the overflowing flood of light which proceeds from an eastern window, and utterly destroys the effect of any sculpture or adornment in the way of reredos, &c., which may be beneath it. In this case abundant light will be thrown into the church from quoin clerestory windows, two on either side; leaving the walls of the apse proper, free for frescoes and sculpture. The exterior is "veiled" with an arcade adapted from the Lombard arcadings of the Rhenish apses, &c. The tower (which is not included in the present contract above the level of nave walls) is treated with considerable novelty, and is adapted to resist the sweeping winds to which the building will be of necessity exposed from its elevated position. The contract was taken after a spirited competition by Mr. Falkinbridge of Whitby, for the amount of 3350*l*. for the fabric, exclusive of all fittings, and the upper portion of tower as we have said above. The whole of the ashlar and wallstone are from quarries in the neighbourhood of Whitby. The walls are lined throughout with brick, having a two-inch cavity. Messrs. Weightman, Hadfield, and Goldie, of Sheffield, are the architects.

Pl. 2.



S: PETER'S: CHURCH: SCARBOROUGH:

G. Goldie. del. WEIGHTMAN HADFIELD & GOLDIE ARCHTS SHEFFIELD. J.R. Jobbins

ON THE DESIGN AND CONSTRUCTION OF HARBOURS.*

By Thomas Stevenson, C.E., F.R.S.E.

Harbours are either natural or artificial. Some parts of the British coasts are amply provided with natural bays and creeks, while in other parts the accommodation and shelter for shipping have been entirely supplied by artificial means. Thus, Ireland and the west coast of Scotland are plentifully intersected by excellent deep water bays and anchorages; but on the east and south-west shores of Britain there are but few natural harbours. Cromarty Bay is 200 miles distant from the Firth of Forth, which is the nearest southern natural harbour; while there are no less than 400 miles between the Firth of Forth and the Thames, which may be considered as the next really unexceptionable harbour of refuge. On the west coast there are about 200 miles of coast between the nearest natural harbours of Holyhead and Loch Ryan. The construction of artificial places of refuge becomes therefore a very important matter in a country where every winter's lists of shipwrecks and loss of life, remind us how much nature has left for art to accomplish. For the most complete body of evidence regarding the ports of Britain, we cannot do better than refer to the volumes of reports by the Tidal Harbour's Commission, for the completeness of which the public is mainly indebted to the zeal of Captain Washington, the present indefatigable hydrographer to the Admiralty.

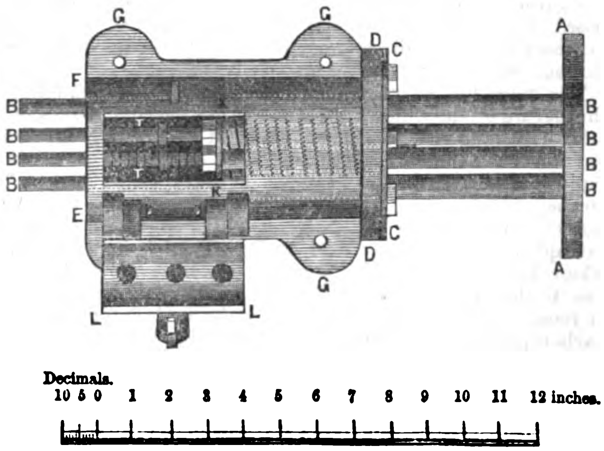
The designing of harbours constitutes confessedly one of the most difficult branches of civil engineering. In making such designs, the engineer, in order to avail himself of the advantage which is to be derived from past experience, must endeavour to the best of his power to institute a comparison between the given ocality and some other, which he supposes to be in *pari casu.* Perfect identity, however, in the physical peculiarities of different stations, seldom if ever exists, and all that can be done is to select an existing harbour, which appears to be as nearly as possible similarly circumstanced to the proposed work.

In considering the subject of the construction of harbours in exposed situations, the first and most important subject deserving our attention is the destructive action of the element with which we have to deal,—what are its energies when excited by storms, and what the direction of its forces on the barriers which have been raised to control it?

Smeaton, in his history of the Eddystone, when speaking of the objection that might be raised against the necessity for using joggles in the masonry of that building, says, "When we have to do with, and to endeavour to control *those powers of nature that are subject to no calculation*, I trust it will be deemed prudent not to omit in such a case anything that can without difficulty be applied, and that would be likely to add to the security." This statement of our greatest marine engineer, indicates the propriety of carefully collecting any facts that may help us to a more accurate estimation of those forces which he regarded as being "subject to no calculation." We shall therefore state a few facts which have been recorded of the destructive power of the waves in inland lakes, and in the open ocean.

The writer has seen at Port Sonachan, in Loch Awe, where the fetch is under 14 miles, a stone weighing a quarter of a ton, torn out of the masonry of the landing slip and overturned. Mr. D. Stevenson, in his 'Engineering of North America,' describes the harbours in Lake Erie as reminding him of those on our own sea-girt shores, and mentions having seen one stone weighing upwards of half a ton which had been taken out of its bed in the pier at Buffalo, moved several feet and overturned. The Comte de Marsilli, in his 'Histoire Physique de la Mer,' published at Amsterdam in 1725, states that the highest wave observed by him on the shores of Languedoc in the Mediterranean Sea, where the breadth is about 600 miles, was 14 ft. 10 in. At the mouth of a harbour on the German Ocean, with a fetch of about 600 miles, the writer had observed for him the height of the waves during south-easterly gales, and on one occasion the result was 13½ feet from the crest of the wave to the trough of the sea. In deeper water, and with a north-easterly gale there is no doubt that the waves of the German Ocean will attain a height considerably greater than this. In November 1817 the waves of the German Ocean overturned, just after it had been finished, a column of freestone 36 feet high and 17 feet base. The diameter at the place of fracture was about 11 feet. In the Atlantic Ocean, Dr. Scoresby stated, in a communication to the British Association in 1850, that during several hard gales he had measured many waves of about 30 feet, but the highest was 43 feet from the hollow to the crest. Waves of such magnitude could scarcely, however, reach our artificial harbours, from the shallowness of the water near the shore. To these facts it may be added, that we know (from the testimony of an eye-witness) of a block of 50 tons weight being moved by the sea at Barrahead, one of the Hebrides; and what is far more extraordinary, we know and can vouch for the fact, that blocks of 6 tons weight have been quarried, or broken out of their beds *in situ*, on the top of the Bound Skerry of Whalsea in Zetland, which is elevated 70 feet above the level of high-water spring tides. The Bound Skerry and neighbouring rocks, which are in the German Ocean, certainly furnish by far the most wonderful proof that has yet been discovered, of the great force which is developed by the billows of the ocean when suddenly checked by opposing rocks.

The writer has stated (in the 'Trans. Roy. Soc. Edinburgh') that, from the observations which he had made with the marine dynamometer (a self-registering instrument designed by him for the purpose), he had found the force of the waves of the *German* Ocean during hard gales, to be 1½ *ton per superficial foot* at the Bell Rock, and of the Atlantic Ocean to be 3 *tons per superficial foot* at the Skerryvore Lighthouse. But these results may still be far short of the maxima. As the marine dynamometer has often been found useful in indicating the force of the waves in situations where harbours were to be built, it may be proper to give such a description of it as will enable any one to have it made.



D E F D is a cast-iron cylinder, which is firmly bolted at the projecting flanges G, to the rock where the experiments are to be made. This cylinder has a circular flange at D. L is a door which is opened when the observation is to be read off. A is a circular disc on which the waves impinge. Fastened to the disc are four guide rods B, which pass through a circular plate C, which is screwed down to the flange D, and also through holes in the bottom EF. Within the cylinder there is attached to the plate C a powerful steel spring, to the other or free end of which is fastened the small circular plate K, which again is secured to the guide rods B. There are also rings of leather, T, which slide on the guide rods and serve as indices for registering how far the rods have been pushed through the holes in the bottom, or, in other words, how far the spring has been drawn out by the action of the waves against the disc A.

In comparing an existing harbour with a proposed one, in order to ascertain the dimensions which are necessary to insure stability, perhaps the most obvious element is what may be termed the *line of maximum exposure*, or, in other words, the line of greatest *fetch* or *reach* of open sea, which can be easily measured from a chart. But though possessed of this information, the engineer still does not know in what ratio the height of the wave increases in relation to any given increase in the line of exposure.

As this inquiry is one of great moment in the practice of marine engineering, and has not been in any way investigated, the writer has for some time back been making occasional obser-

* From the Eighth Edition of the 'Encyclopædia Britanica.' Edinburgh: Adam and Charles Black.—1856.

vations on the subject, when favourable circumstances occurred. These observations have been but limited in extent, and cannot be regarded as deserving of confidence unless in cases where the two harbours are not far different in their lines of exposure. So far as these experiments have gone, the waves seem to increase in height most nearly *in the ratio of the square root of their distances from the windward shore.*

It does not follow, however, that the line of maximum exposure is in every case the line of maximum effective force of the waves; for this must depend not only on the length of *reach*, but also on the angle of incidence of the waves on the walls of the harbour. What may be termed the line of *maximum effective exposure*, is that which, after being corrected for obliquity of impact of the waves, produces the maximum result, and this can only be taken from the chart after successive trials. Let $x =$ the greatest force that can assail a pier, $h =$ height of waves which produce (after being corrected for obliquity) the maximum effect, and which are due to the line of maximum effective exposure. Sin $a =$ sine of azimuthal angle formed between directions of pier and line of maximum effective exposure, radius being unity. Then $x \propto h \sin^2 a$ when the force is resolved normal to the line of the pier, but if the force is resolved again in the direction of the waves themselves, the expression becomes $x \propto h \sin^3 a$.

It should not be forgotton, in connection with this subject, that there are various qualifying elements to which special attention requires in some cases to be given. The waves, for example, may often be noticed, when approacning the land obliquely, to alter their direction when they get close to the shore (in consequence of the depth changing), so as to strike it more nearly at right angles to the general line of the beach. In this way a swell from the ocean may enter a bay which is not directly exposed to it. It should also be observed, that the lines of exposure cannot be directly compared if the depths of the water through which they pass are materially different.

The tides, too, exert in many places a very decided effect on the nature of the billows, in some places causing waves of an unusually dangerous character, while at others they are found to *run down* the sea. If a marine work is situated in a *race* or rapid tide-way, such, for example, as those called "roosts" in Orkney and Shetland, the masonry will be exposed to the action of a very trying and dangerous high-cresting sea. As an example of this, we may refer to Port-Patrick in Wigtonshire, where the violence of the waves is, we have no doubt, much due to the rapidity of the tides. If, on the other hand, the race or roost runs in such a direction as to be entirely outside of the harbour, and at some distance off, it will have a decided tendency to shelter the works, and to act as a breakwater. Thus it appears, from observations specially made for the writer at Sumburgh Head Lighthouse in Shetland during a south-westerly storm, that so long as the Sumburgh roost (one of the most formidable in those seas) was cresting and breaking heavily, one could have easily landed in a small boat at a creek or bay called the West Voe; but no sooner did the roost disappear towards high-water than there came in towering billows that totally submerged cliffs of very considerable height. The study of the modifying and intensifying effects of tide-currents on the waves of our British seas seems to have been entirely neglected in the late discussions regarding the merits of vertical and sloping walls, which will be referred to in another section of this article.

We think it right to mention that we consider as erroneous the opinion expressed by a writer in the 'Edinburgh Philosophical Journal'—that the cause of races or roosts is the meeting of two rapid currents; neither do we believe that they are occasioned by the projection of rocks from the bottom of the sea as many sailors suppose.

From careful inquiries, as well as from actual personal experience, of such formidable breaking waters as the Boar of Duncansbay, and the Merry Men of Mey in the Pentland Firth, and several others, we are of opinion that the true cause is the *swell of the sea encountering a tidal current running in a direction more or less opposed to that of the waves.* While it is obvious that two rapid tides may meet each other without any dangerous effects, it is also quite true that when two tides meet each other in a rough sea, as in coming round such islands as Stroma or Swona in the Pentland Firth, the effect of their union being to increase the current at that place, there will be produced a highly dangerous sea; but the fact of their meeting, though calculated to aggravate, is not, we think, the primary cause. The races which occur in open seas, as, for instance, off headlands and turning-points of the coast, are certain portions of those seas in which the waves *break* to a greater or less extent, although the water may be very deep, and there may be no wind at the time. At all such places it will be found that there are rapid tides. The roosts on the west coast of Orkney or of the Pentland Firth, for example, are worst with *ebb* tides and *westerly* swells, because the Atlantic swell and current of ebb are opposed. Those again on the east coast are worst with *flood* tides and *easterly* swells from a similar cause. Thus at the east end of the Pentland Firth the Boar of Duncansbay is well known to rage with easterly swells and a flood tide; whereas, at the west end of the same firth, the Merry Men of Mey are equally well known to be worst with ebb tide and a westerly swell, at which time no boat could enter them without the risk of being overturned. The dangerous surf which exists at the mouths of some rivers is, we believe, not solely due to the want of depth at the bar, but also to the meeting of the outward current with the waves of the sea.

When a swell encounters a rapid opposing current, the onward motion of the waves seems to be arrested, and their width becomes visibly decreased. They get higher and steeper, crest, and at last break, sometimes very partially, and at other times almost as they would on a shelving beach. It appears to us possible that several waves may ultimately combine in such disturbed waters into one mountainous billow; for the wave that has partially broken may have its onward motion so much checked as to allow the wave behind to overtake it, and having thus coalesced, they may, as one large wave, acquire a superior velocity so as to overtake those in front, and be farther augmented by the union of other waves which have been reflected from the shore.

It is to this cause we are inclined to refer such wonderful effects as that to which we have already alluded, where blocks of 6 tons weight were quarried out of the solid rock at an elevation of 70 feet above the sea. Were such violent action common to all the shores of the German Ocean, instead of being restricted to one or two similar places, half of our eastern seaport towns would, without any doubt, be washed into the sea during the first stormy winter. As a further proof of the great effect of the tides in exasperating the waves, we may mention that the time when most damage is done to seaworks which are in tolerably deep water, is from one to two hours before and after high-water, which nearly corresponds to the time when the tide runs strongest outside. We have found this to hold true at many different parts of the coast, but will only refer to one well-marked instance. At Peterhead harbour, which projects prominently into the sea on an isthmus, the tides, at but a short distance seaward of the harbour, run very rapidly. On the 10th January 1849 there was a very heavy sea, and a crowd of people were down, about *two hours before high-water*, helping to secure the whalers and other vessels in the harbour, when three successive waves carried away 315 feet of a bulwark, founded 9½ feet above high-water springs, which had stood for many years. One piece of this wall, weighing 13 tons, was moved 50 feet. After this outbreak of the sea the waves became more moderate, until about *two hours after high-water*, by which time the large whalers had taken the ground, when other three enormous waves again swept over the harbour, submerging the quays to the depth of from 6 to 7 feet of solid water, by which sixteen people were drowned. These waves filled the harbour to such a depth as to set all the whalers afloat again, and they continued so for several minutes, until the excess of water had run out through the harbour mouth.

These gigantic waves were, in our opinion, clearly the result of some such action as has been attempted to be described. We should not have dwelt at such length on this subject were it not that we might again refer to the facts when we come to treat of the subject of vertical and sloping walls for harbours of refuge, where it is of importance to show that even in the deepest water the waves are not purely oscillatory, but that wherever there is a tide-way the waves will more or less partake of the qualities of waves of translation.

Another circumstance affecting the exposure of any marine work is the depth of water in front of it. The great mountainous billows so commonly met with in the Atlantic Ocean cannot be generated in the shallower waters of the German Ocean, unless, perhaps in such peculiar circumstances as have just been adverted to. It becomes, therefore, of great consequence to ascertain the maximum possible wave in a given depth of water.

Mr. Scott Russell, whose observations on what may be called the marine branch of hydrodynamics are of such great value, has stated that if waves be propagated in a channel whose depth diminishes uniformly, the waves will break when their height above the surface of the level fluid becomes equal to the depth at the bottom below the surface ('p. 425 Brit. Assoc. Rep. on Waves'). This statement, the meaning of which seems doubtful, Mr. Russell elsewhere ('Instit. Civ. Eng., p. 136') defines thus: "The author has never noticed a wave so much as 10 feet high in 10 feet water, nor so much as 20 feet high in 20 feet water, nor 30 feet high in five fathoms water; but he has seen waves approach very nearly to those limits." It is presumed that the datum here referred to is the mean level of the surface of the sea. We have had no opportunities of verifying these observations; but as the subject is very important—because the depth of water in front of a work may be said to be the ruling element which determines the amount of force which it has to resist, whatever be the line of maximum exposure, we shall simply state what has come within our own knowledge and observation. We have repeatedly seen at different parts of the coast breaking waves of from 4 to 5 feet, measuring from hollow to crest, in from 7 ft. 8 in. to 10 or 11 feet of water, measuring from the bottom up to the mean level; and on one occasion we were told of waves which were estimated an 9½ feet it 13 feet water. It must, however, be borne in mind that these observations, and we conceive also those of Mr. Russell, apply only to common waves of the sea, or those short, steep, and superficial waves which are due to an existing wind, and not to the ground swells which are almost constantly to be found in the open ocean, and which may be the result of former gales, or are the telegraph, as Mr. Russell terms them, of those which are yet to come.

From what has been stated, it would appear that in most cases the heaviest waves should assail any tide-work at high-water. This, however, as mentioned in the last section, is not always the case, the greatest damage being often found to occur at the times when the tide runs strongest.

Mr. Leslie found that the Arbroath Harbour-works were in general less severely tried by the very heaviest waves than by a class of waves somewhat smaller than these, owing to the outlying rocks, which, from the small depth over them, had the effect of *tripping* up the heavier seas, and thus destroying them before they reached the harbour, while the depth was sufficient to allow the smaller waves to pass over the shoals unbroken. In some cases of severe exposure the waves might to some extent be reduced by dropping very large stones outside of the harbour, so as, by forming an artificial shoal, to cause them to crest and break.

One great difficulty connected with the subject of the generation of waves still remains unsolved, viz.,—What are the minimum line of exposure and area of sea which are compatible with the existence of a ground swell? This question, we fear, cannot be answered in the present state of our knowledge.

Deep Water Harbours.

Harbours of refuge are distinguished from tidal harbours mainly by the superior depth of water which they possess, and the larger area which they enclose. The requisites are shelter during storms, and easy access for shipping at any time of tide. There has been much discussion as to whether piers for harbours of refuge should be *vertical* or *sloping*. Col. Jones. R.E., has especially advocated the superior merits of the vertical wall; and the discussions on his plan at the Institution of Civil Engineers, and the able protest by Sir Howard Douglas, will be found, from their interest and importance, to merit a careful perusal.

The principle which is asserted is, that oceanic waves in deep water are purely oscillatory, and would occasion no impact against vertical barriers, which would be the most eligible; as they would only have to encounter the simple hydrostatic pressure due to the height of the advancing billow, and would reflect the waves without causing them to break.

Were it even admitted that the waves were purely oscillatory, and were reflected by a vertical barrier, would no force, it may be asked, be expended when the motion of the particles was reversed? The reflection of a wave was equivalent to the nearly instantaneous creation of a wave in the opposite direction, for which a very considerable force must surely be required.

We believe, however, that from the effect of tide currents, to which we have already referred, and perhaps from other causes whose action seems to have been overlooked by the advocates of the upright wall, any form of barrier, in whatever depth it may have been erected, must be occasionally subjected to heavy impact. We conceive that the possibility of waves of translation being generated in the deepest water has been already established, if we succeeded in satisfying the reader of the truth of the following assertions: First, That waves break in deep water during calm weather; a fact which is apparent to the eye and familiar to all sailors: and secondly, and negatively, That to leeward of those races or portions of broken water, which certainly do not reflect the incoming waves, there is comparatively smooth water both at sea and on the adjoining shores, until such time as the strength of the tide is exhausted, and the roost has disappeared, when violent action is again fully manifested.

It may be argued that these are extreme cases, and that such high velocities in the current of the tide are seldom met with. This objection has, no doubt, truth in it; but still the tendency is shown, and though the velocities may be less in other quarters, there may yet be quite enough to destroy the condition of *stagnation* which the oscillatory theory assumes. The breaking of waves at sea, and the existence of races, seem to prove beyond question that waves of translation are possible in the deepest water. Is it not also a probable case that waves which have been reflected by a vertical wall, and have (irrespective of the question of tide currents) combined with the advancing waves, may then become waves of translation, possessing all the elements which endanger the stability of a sea work? Or, again, how much more damage would result to a vertical wall than to a slope of loose stones, from the sinking of the foundations, or from their getting underwashed by the reaction of the waves? It therefore appears that the method generally resorted to of forming deep water harbours of masses of rubble stone with long slopes, so as to form an artificial beach for the waves to spend on, is, in most circumstances, the best and cheapest kind of construction. We incline, however, to the adoption of an upright wall, founded on the rubble as a basis (similar to that at Cherbourg, about to be described), in preference to long paved slopes, as there is always experienced a great difficulty in founding the toe of such talus walls among the loose rubble. When pitched slopes are adopted, great benefit will be found to accrue from leaving at the bottom or toe of the slope a wide fore-shore. Much, however, depends on local peculiarities in selecting the best design for any work; and the nature of the bottom is all-important. Where the bottom is soft, a vertical wall can hardly, if ever, be attempted.

In making these remarks, we must not be understood as condemning the adoption of vertical walls in cases where the foundation is good. All that we assert is the opinion, that waves of translation do exist in deep water, and therefore that harbours of refuge will prove failures unless they are built in such a manner as to resist the impact of those waves of translation. The Cherbourg breakwater has been often referred to as a successful instance of the application of a vertical wall, and has been contrasted with the Plymouth breakwater, which has a long slope But this appeal is quite fallacious, as the profile of that work is, as already hinted, of a composite character, consisting of a talus wall sloping at the rate of 10 horizontal to 1 perpendicular, surmounted by a plumb wall; so that whatever merit may be supposed to belong to the vertical profile is entirely nullified at Cherbourg by the long talus wall in front, on which the violence of the waves is much broken. Moreover, the heaviest waves at Cherbourg come from the north-west, and do not assail the breakwater at right angles to its direction, but come more nearly *end on* to the work, so as to a great extent to run along the outer wall. The north-west waves are propagated from the Atlantic, while the waves which are most trying to the work come from the north, in which direction the line of exposure is only about 21 leagues. These facts we obtained during a recent visit to Cherbourg, undertaken for the special purpose of ascertaining the physical characteristics of the place. The attempt to make out a parallelism between Plymouth, which faces the Atlantic directly, and Cherbourg, which is comparatively land-locked, cannot, in our opinion, stand the test of a candid inquiry.

Other comparisons may be referred to which have been advanced on equally untenable grounds. Thus, the old pier of Dunleary, which is vertical, and has stood well, has been compared with the talus walls of Kingstown Harbour, which now protect Dunleary, and which have often received much damage. The all-important element of depth of water has been in this instance entirely overlooked; for at Kingstown there is a depth of 27 feet, while Dunleary is all but dry. An able writer on the same *questio vexata* in comparing different sea walls in the Firth of Forth, has, in like manner, not sufficiently adverted to the great differences in the depths opposite the works to which he refers.

An important advantage of the sloping wall is the small resistance which it offers to the impinging wave, but it should also be borne in mind that the weight resting on the face stones in a talus wall is decreased in proportion to the sine of the angle of the slope. If we suppose the waves which assail a sloping wall to act in the horizontal plane, their direct impulse, when resolved into the force acting at right angles to the sloping surface of the talus wall, will be proportional to the sine of the angle of incidence. The effective force when estimated in the horizontal plane, will be proportional to the square of the sine of the angle of incidence. But if we assume the motion of the impinging particles to be horizontal, the number of them which will be intercepted by the sloping surface will be also reduced in the ratio of the sine of the angle of incidence, or of elevation of the talus wall. Hence the tendency of the waves to produce horizontal displacement of the wall, on the assumption that the direction of the impinging particles is horizontal, will be proportional to the cube of the sine of angle of elevation of the wall.

If it farther happens that there is obliquity of action in the azimuthal as well as in the vertical plane arising from the relative direction of the pier and of the waves, there will be another similar reduction in the ratio of the squares or cubes of the angle of incidence according as the force is resolved into that at right angles to the line of the pier, or to that of the direction of the waves.

Let ϕ = vertical angle of incidence or angle of elevation of wall;

ϕ' = azimuthal angle of incidence;

f = horizontal force exerted on unit of surface at right angles to the line of harbour wall;

h = height of greatest assailing waves;

$$f \propto h\,(\sin\phi \sin\phi')^3.$$

The above expression assigns, we think, too great a reduction, as the motion of the particles may not be horizontal, and no account is taken of the effects of friction against the rough surface of the masonry. Experiments are therefore wanting to determine the constant for correcting the theoretical results due to this expression.

Mr. Scott Russell recommends the parabolic curve as that best suited for the profile where the object is to *break* the waves, and not to reflect them, as is the case in sloping breakwaters. This curve possesses, according to Mr. Russell, the advantages of superior strength, of economy in the materials, of breaking the wave early, and of continuing an uniform action over the longest period of time. When the tide is low, the toe of the slope, which springs out of the *foreshore* and forms the vertex of the parabola, would, we fear, be found rather weak, and perhaps difficult to form. On the whole we rather incline in such cases, simply to throw in the materials, and to allow the sea to form its own slope.

According to Sir John Rennie ('Account of Plymouth Breakwater,') rubble breakwaters with slopes formed at the angle of repose, were adopted by the Greeks in the moles of Tyre and Carthage, and by the Romans at Athens and Halicarnassus. The same design was also followed at Venice, Genoa, Rochelle, Barcelona, and other places. In this kingdom the first example on a large scale which we find is at Howth. Kingstown, Holyhead, and the noble breakwater at Plymouth, were afterwards carried out on the same principle, and chiefly under the directions of the late Mr. Rennie. The great national harbours of refuge at present in progress in this country, according to Mr. Rendel's designs, at Holyhead and Portland, are on a similar principle; while those under Messrs. Walker, Burges, and Cooper, at Dover, Alderney, and Jersey, are more nearly vertical.

On the best Forms of Walls for Tidal Harbours.

Having now considered the few facts of which we are in possession regarding the disputed nature of the impulse of the waves in deep waters, we shall direct the reader's attention to their effects in shallow water. Those in deep water were chiefly *whole waves*, and regarded by many as being purely oscillatory, while those in shoal waters are breaking waves, and therefore regarded by all as waves of translation. We have hitherto been considering breakwaters erected in deep water, and which were constantly exposed to the waves; we now to turn to piers and sea walls which are placed within the range of the surf, and which are exposed to its force for a limited period only, being sometimes left nearly, or altogether dry by the receding tide.

The impulse of the waves against a sea-wall or pier may be resolved practically into four directions:—1st, The direct horizontal force which tends to shake loose, or carry before it, the blocks of which the opposing masonry consists. This force may also blow up the pitching, or overturn the inner or quay-wall by condensing the air, or pressing upon the water which occupies the interstices of the rubble. We know two cases in the German Ocean where, in consequence of want of width in the pier, coupled, in one instance, with insufficient workmanship, the inner or quay-walls were observed first to bulge and fall, before the sea-wall was injured. One of these piers measured 26 ft. 4 in., and the other 24 feet on the roadway. 2nd. The vertical upward force which may act on any projecting stone or protuberance. 3rd. The vertical downward force of the water which results either from the wave breaking upon the toe of a talus wall, or from the wave passing over the parapet, and falling upon the pitching behind, so as to plough it up. 4th. The *back-draught* which tends by reaction from the wall to plough up the soft bottom, and thus to undermine the lower courses of the work, or perhaps by *suction* to pull out the facework. We may conclude from the above that the points which require to be carefully attended to are—1st. The contour and quality of masonry of the wall itself; 2nd. The parapet, which, if not of sufficient height, or built in a proper direction, leads to damage in the pitching behind it; and 3rd. The foundation courses, in the design and construction of which, if similar precautions be not attended to, underwashing of the bottom may in some situations take place, so as to leave the lowest courses without protection.

We shall in the first place consider how far those remarks are applicable where the bottom is solid rock. Such a supposition will render unnecessary any precautions arising from the wasting of the bottom, and, *cœteris paribus*, there does not seem to be any reason for preferring a talus to a vertical wall. The question of preference in such a case will in the main depend upon the kind of material which can be obtained. Should the stone be scarce or costly, and the quality such as to warrant the introduction of masonry of the best description, the vertical wall may be found to be the most economical. Where freestone is to be used, it is not only desirable that it should be got in large blocks, but that the face stones should possess considerable hardness. This precaution is particularly necessary in selecting the stones for the lower courses, and especially where the beach consists of hard gravel. For the same reason it is highly important that all stones which are subject to decay from atmospheric influence should be either entirely rejected or assembled in the upper courses of the parapet.

Where the materials are abundant, but of an unworkable nature, a long talus wall will generally be found most economical. For such walls the rate of slope must depend very much upon the exposure of the place, and upon the plentifulness of rubble-stone hearting. The easily-dressed and naturally flat-bedded materials, which the stratified rocks of the secondary formation very often furnish, are especially applicable for the construction of vertical walls; while the uncouth blocks of the primary and igneous formations are better suited for talus walls. Such rocks as gneiss, the schists, basalts, greenstones, amygdaloids, and the tougher kinds of granite, are best fitted for that purpose. With some of those rocks the angularity of the pieces, and the excessive difficulty of dressing, render it necessary to assemble them without almost any alteration of their shape, by an adaptation of their salient and re-entrant angles, so as to make a kind of random rubble face-work. In this kind of work, mortar is very seldom employed. The parapet generally consists of squared masonry, surmounted by a heavy cope, and it should in every case be set in good lime mortar.

Where the materials are light and of small sizes it is desirable to equalise the action of the sea over the whole work, and not to concentrate it against any particular place. Mr. Russell states that the cycloidal form was recommended for this purpose by Franz Gerstner of Bohemia. The only instance with which we are acquainted of the adoption of this curve was in a sea wall erected at Trinity, near Edinburgh, by the late Mr. Robert Stevenson, in 1822.

It has been already stated that, irrespective of the quality of the masonry, the two points in the structure which are weak or dangerous are the top and bottom of the wall. With a rocky bottom the risk of failure at the foundations is removed; on the other hand, where the shore consists of rotten rock, moving shingle or sand, it is obvious that provision must be made for both those sources of evil. In fact, if we consult the history of harbours, we shall find that by far the most frequent cause of damage is the reaction of the sea against the shore.

The general slope of a fragmentary beach must depend upon the size and nature of the particles and the force of the sea. The dissimilarity between the slopes of a beach near the levels of high and low water, arises from a decrease in the force of the waves, owing to their being broken before they reach the high-water mark. The great object, therefore, is to design the profile of our wall so as to alter as little as possible the symmetry of the beach. Where isolated rocks or large boulders are seen projecting above the surface of a sandy beach, there will generally be formed around them hollows, corresponding in depth to the kind of obstruction which the rocks present. The principal point in the design, therefore, must be to avoid great and sudden obstructions to the movement of the water. The best form which could be adopted in any situation would of course be the same as the cross section of the beach itself, but this would answer no possible purpose: and, as the wall is to consist of heavy blocks of stone instead of minute particles of sand, it is clear that a much steeper slope may be adopted than *the profile of conservancy* of the coast, provided the lower part of the slope be flattened out so as to meet the sand at a low angle. The action of a bulwark is to arrest the waves before they reach the general high-water mark, and to change the horizontal motion of the fluid particles to the vertical plane, or to compel the waves to destroy themselves on an artificial beach consisting of heavy stones. To prevent underwashing, the two following requisites should therefore be as far as possible secured:—1st, the foundation courses or bottom of the wall should rise at a very small angle with the beach, so that their top surfaces may be coincident with the profile of conservation of that portion of the beach out of which the wall springs; 2nd. the outline of the wall should be such as to allow the wave to pass onwards without any sudden check till it shall have reached the strongest part of the wall, which should be as far from the foundation as possible.

Those two requisites show clearly how inapplicable a vertical wall must in most cases be for a sandy beach. Instead of altering the direction of the wave at a distance from its foundation, the whole change is produced at that very point, and unless the wall be founded at a great depth, its destruction is all but certain. Where the materials are costly, but admit of being easily dressed, we are disposed to think that a horizontal, or nearly horizontal wall connected with a vertical one by a quadrant of a circle may be found suitable. Such a form will prevent to a considerable extent the danger of reaction by causing an alteration in the form of the wave at that part where the wall is strongest and at the greatest distance from the toe or curb course. Where the materials are abundant and of a rougher nature, a cycloidal wall, with vertical and horizontal tangents somewhat similar to that erected at Trinity, to which we have already referred, may be adopted with advantage.

A special caution may not be out of place regarding clayey bottoms. Many are apt to suppose that there can be no better foundation than clay; and it is indeed true that some kinds of hard clay form a satisfactory subsoil. But there are others of a softer kind, and permeated by sandy beds, which are extremely treacherous. If there be the slightest dip seawards, there is always a risk of any pier that may be built on such a base slipping bodily into the sea. This holds especially true of inland lochs, where the sides very often slope suddenly. In one instance, the particulars of which we got on the spot shortly after the accident, a pier built on a clayey beach, sloping below low water at the rate of 1 in 12½, suddenly began to move, and after two hours it had slipped seawards 150 feet, and had by that time descended bodily a height of 34 feet, the top of the pier being then no less than 23 feet below low-water spring tides.

Construction of Harbours.

Our space will not admit of our going much farther into the subject of the construction of harbours than the few remarks we have already made. A knowledge of such matters may to some extent be acquired by a careful perusal of the published histories of marine works; but, after all, it must be confessed that the only valuable teacher in this wide practical field is *experience*. It is, in truth, impossible to lay down any general rules of guidance as to matters of this kind. All that can be done within our space is to notice very briefly some of the more important methods of working. And first, with regard to that invaluable piece of apparatus, the diving-bell, we would refer to Smeaton's 'Account of Ramsgate Harbour,' published in 1721, where it was first applied by him to harbour works. The diving-helmet is a most useful and convenient modification of the diving-bell, and is now very generally employed.

Of late years Mr. Walker has introduced from France the use of *beton* as a substitute for backing. This artificial concrete is sometimes used in enormous masses. We have seen at Cherbourg blocks of 50 tons prepared in boxes, whose sides and tops are removed after the concrete has set, in order to be again similarly employed. The proportions used at Cherbourg by M. Rebeille were two of sand or fine gravel, to one of Portland cement.

We may also mention that the method of assembling stones on their edges, instead of on their beds, which formerly was in use in some old Scottish harbours and sea-walls, as at St. Andrews, Prestonpans, &c., deserves to be more generally known and adopted, from its superior strength.

The proposal of Mr. Bremner, of Wick, for putting in the foundations of low-water piers also merits notice. Mr. Bremner proposes to construct, in some adjoining place of shelter, enormous pontoons of timber, on which the under parts of the work are built, and afterwards floated to the desired spot in favourable weather, and carefully grounded. Such a plan might, we have no doubt, be found economical and useful in some situations.

Mr. Rendel has introduced an improved method of assembling the *pierres perdues* or rubble used in the construction of large breakwaters; this method he employed at Millbay Pier, near Plymouth, in 1838, in a depth of 38 feet; and he is at present carrying out the same principle on a still larger scale, in the construction of the breakwaters at Holyhead and Portland. The improvement consists in depositing the rough materials from stagings of timber elevated a considerable height above high water. The stones are brought on the staging in wagons, through the bottoms of which they are discharged into the sea. The principle on which the stagings are designed is that of offering the smallest possible resistance to the sea, the under structure consisting of nothing more than single upright piles, there being only one line of piles for each roadway.

Mr. Rendel, in a letter kindly communicated to us, states, "I use no timber braces of any kind, as these offer more resistance to the sea than strength to the staging. At Portland, however, where any accident would be a serious evil, owing to our employing convicts in the quarries, we stay the piles with iron guys, fixed to Mitchell's screw moorings, and also truss the outer piles in each row with iron rods. We also fix the piles in the ground with a screw.

"At Holyhead, however, we only attach to each pile boxes filled with small stones, for the purpose of getting them into a vertical position, and use no stays or guys of any kind.

"The superstructure consists simply of balks of timber, with rails laid on them to carry the wagons. The piles are placed in rows 30 feet apart, and the ease and certainty with which the staging is constructed is such that a length of 30 feet, including the screwing in of the piles, the laying down of the roadways, and all minor works necessary to make them fit to carry the wagons, never occupies more than one working day and a half, and often less. The length of the piles that we are now using varies from 84 to 90 feet, the depth of water at both Holyhead and Portland being about 11 fathoms.

"Of the strength of the stage you may judge from its carrying on each roadway as much as three wagons, weighing in the gross 12 tons each.

"The advantages of the staging are obvious. It contributes greatly to the consolidation of the stone, it makes a greater length of breakwater to be under construction at the same time, and it enables the deposits to be carried on without interruption, almost in the heaviest weather. As an instance of this, I may remark that my resident at Portland informs me that the wagons and locomotives were engaged yesterday at a time when such a sea was running that large bodies of spray were thrown 55 feet above the water level. As a proof of the facilities which the stage affords for rapidity of construction, I should state that we have deposited this year at Holyhead, where free labour is employed, nearly one million tons of stone. The loss from accidents to the stage is comparatively small on its first cost, and when spread over the cost of the whole works it is a mere trifle. I find the sea-slopes are, in the deep water and exposed parts, from $5\frac{1}{2}$ or 6 to 1 between 6 feet above high-water and from 12 to 15 below low-water, from which point they rapidly become about 1 to 1. The inside slopes are never more than $1\frac{1}{4}$ to 1, and seldom more than 1 to 1. The materials are excellent."

Mr. Walker has also kindly contributed some facts connected with the construction of the great works now going on under the direction of Messrs. Walker, Burges, and Cooper at Jersey, Alderney, and Dover. At Alderney, which is a very exposed place, the *base*, up to 12 feet below low-water, is formed by stones thrown, or rather dropt in from barges. Up to low-water the work is all done by diving-helmets. The wall is faced with granite, backed with blocks of *beton* made of sand, shingle, and Portland cement. Above low-water it is faced with stone of the island, a kind of millstone-grit, and is backed with blocks of rubble set in Roman cement. The millstone-grit is raised in very large blocks. The profile is to consist of a quay, an esplanade, and a parapet.

Jersey is much the same as Alderney, but the *pell-mell* work is carried to low-water, having nearly vertical walls of conglomerate built above. Dover has nearly vertical walls, faced with granite from the very bottom, which is now 45 feet below low-water. This work was done with diving-bells.

Sir J. Rennie, in his 'Account of the Plymouth Breakwater,' says, "From the bottom to within 8 feet of low-water springs, we find that the slope is $2\frac{1}{2}$ or 3 to 1. Here the effect of the waves is comparatively small, being neutralised by the mass of water. From thence to low-water of spring-tides the slope increases from 3 or 4 to 1, but between low-water of spring-tides and high-water, when the effect of the waves is greatest, there we found that the rubble would not lie at less than 5 to 1, whilst, on the inside, the slope stands generally at from $1\frac{1}{2}$ or 2 to 1."

The above interesting details regarding these national works show, from the variety which they exhibit how difficult it is to lay down any general rules for the construction of harbours, and confirm the principle that each work must be judged of *per se*.

Miscellaneous Observations.

The ultimate object of constructing harbours is, by lowering the height of the waves, to preserve the tranquility of the area of water which is enclosed by the piers; and this property is variously possessed by harbours of different forms, and depends much upon the relative widths of the entrance, and of the interior, the depth of water, the shape of the entrance, and the relation between the direction of its opening, and that of the line of *maximum exposure*.

The only formula of which we are aware is that by the writer of this article ('Edin. New Phil. Journal,' 1853), which gives an approximation to the *reductive power*, or is, in other words, a numerical form of expressing how much a wave of given height becomes reduced, after it has entered a harbour. Though the results obtained by the formula may not be absolutely correct, this will be no objection where the object is merely to obtain a comparative value, as, for example, in comparing one design for a harbour with another.

When the piers are high enough to screen the inner area from the wind, where the depth is uniform, the width of entrance not very great in comparison with the width of the wave, and when the quay walls are vertical, and the distance not less than 50 feet,—let

H = height in feet of waves in the open sea.
x = reduced height of waves in feet at place of observation in the interior of the harbour.
b = breadth of entrance to harbour in feet.
B = breadth of harbour at place of observation in feet.
D = distance from mouth of harbour to place of observation in feet.

$$x = H\left\{\sqrt{\frac{b}{B}} - \frac{1}{50}\left(1+\sqrt{\frac{b}{B}}\right)\sqrt[4]{D}\right\}$$

This formula has been found to give good approximations at several harbours where the heights of the waves were registered. When H is assumed as unity, x will represent the *reductive power* of the harbour.

In situations where the highest waves cross the harbour mouth at an oblique angle, a farther reduction is due to this cause. We have been unable to find any observations that have been made on this subject by others, and for want of better, we shall give three observations made under our directions at Latheronwheel Harbour:

Angle of obliquity.	Distances run through by waves.	Height of wave after passing through angle.
0°	16 feet	1·00
50°	32	0·68
140°	68	0·21

These must, however, be regarded as but approximations. It is obvious that as the wave may be deflected through more than 360°, the curve representing the reduction must be a spiral; but more observations are wanted to determine of what kind.

Booms are logs of timber placed across the mouth of a harbour or the entrance to an inner basin or dock, having their ends secured by projecting into grooves cut in the masonry on each side of the entrance. The booms are dropped into these grooves to the number of from 10 to 20, or as many more as will ensure close contact of the lowest one with a sill-piece placed in the bottom of the harbour, without which precaution the swell is found to enter the harbour from below the booms. By this contrivance, which forms a temporary wall, the waves are completely checked and prevented from spreading into the interior basin. The longest booms we have seen are about 45 feet, and in some places, as at Hartlepool and Seaham in Durhamshire, they are taken out and in by steam-power.

Though perfectly successful in their tranquilising effect (provided they are kept in contact with the sill-piece at the bottom), booms are not suited for the mouths of harbours where there is much traffic, as the shipping and unshipping of so many logs of timber can hardly take less than a quarter of an hour—a delay which might in many cases be attended with serious consequences.

It is very desirable, and in some cases essential, that there be either a considerable internal area, or else a separate basin opposite the entrance for the waves to destroy or *spend* themselves. Such a basin should, if possible, be made so as to preserve a portion of the original shore for the waves to break upon, and when circumstances render this impossible, there should at least be a flat talus of 2 or 3 to 1. Talus walls of 1 to 1, or steeper, will not allow the waves to break fully, but will reflect them in such a manner as might in some cases make the entrance difficult or even dangerous of access, and the berthage within unsafe. There are many instances of harbours being materially injured by the erection of a quay wall across a beach where the waves were formerly allowed to expend their force.

It may be observed that when there is an inner harbour or stilling basin, the elliptical form seems to be the most promising. Let one focus be supposed to be on the middle line of the entrance and to coincide with the point from which the waves in expanding into the interior radiate as from a centre (which they do approximately), and if the other focus is situated inland of high-water mark, the waves will tend to reassemble at the landward focus, and on their way will be destroyed by breaking on the beach. This appears from the well-known property of the ellipse, that if two *radii vectores* be drawn from the two foci to any point in the curve they will make equal angles with the tangent at that point; and as the angles of incidence and reflection of a wave from any obstacle are practically equal, each wave will be nearly concentrated at the focus opposite to that from which it eminated.

Another cause of disturbance in harbours, which is often not sufficiently considered, is the indiscriminate deepening of th entrance without a proportionate enlargement of the internal area or the execution of other works for counteracting the effect. As the depth of the water is more and more increased, waves of greater height become possible at the entrance, so that larger waves gain admission to the interior. The writer has had repeated proofs of this in the course of his practice. At the port of Sunderland, Mr. D. Stevenson recommended the removal of nearly the whole of the south stone pier, and the substitution of works of open framework in order to tranquilise the interior. These works, which have been quite successful, were rendered necessary by the frequent dredging of the channel at and near the entrance.

The preservation of the depth of harbours where there is a tendency to deposit is often attended with great difficulty and expense. Where the deposit of silt is confined to the space between high and low-water marks, the scouring by means of salt or fresh water is in general comparatively easy, but where there is a bar outside of the entrance the case becomes most materially changed. The efficacy of the scour, so long as it is not impeded by encountering stagnant water, is kept up for great distances, but soon comes to an end on its meeting the sea. Probably the only way in which this difficulty might to some extent be obviated would be by conducting the water in iron pipes to the bar, a plan which the author proposed in 1843 for Hynish harbour, but the expense was considerable and the success doubtful. The same plan was proposed by Mr. Alexander Swan for Kirkcaldy some years later. When the volume of water liberated is great compared with the *alveus* or channel through which it has to pass, the objection based on the stagnancy of the water originally occupying the channel does not hold to the same extent as when the scouring is to be produced by a sudden *finite momentum*. In the one case the scouring power depends simply on the quantity liberated in a given space of time, while in the other it depends on the propelling head and the direction in which the water leaves the sluice. Mr. Rendel's scheme for Birkendead was on the former principle. The first example of artificial scouring in this country seems to be due to Smeaton, who used it effectually at Ramsgate in 1779.

At Bute Docks, Cardiff, designed by Sir W. Cubitt, the access to the outer basin is kept open most successfully by means of artificial scouring on a gigantic scale. The entrance was cut through mud banks for a distance of about three-fourths of a mile seaward of high-water mark. The initial discharge when the reservoir is full, is stated to be 2500 tons per minute. The writer has known even so limited a discharge for an hour to two as one ton a minute, produce very useful effects in keeping a small tidal harbour clear of sand.

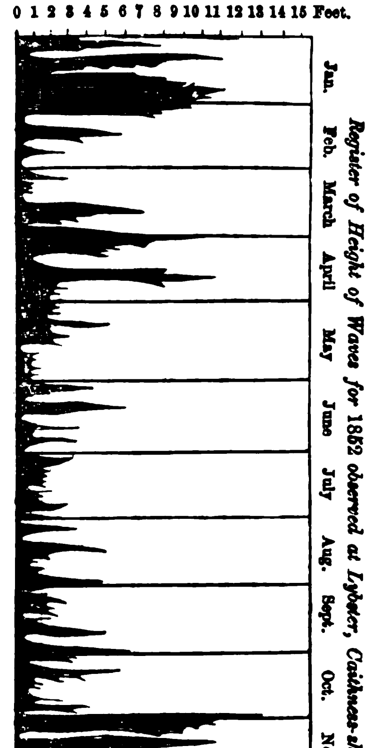
Many proposals have from time to time been made for mooring in the open sea floating frameworks of timber with the view of sheltering the space enclosed by them. The objections to floating breakwaters are so great and obvious that there seems little chance of their ever being much used. From what was stated on the subject of booms, it will be recollected that it is a requisite that they should fit closely to a sill-piece at the bottom, otherwise the *run* is found to extend into the harbour. From what will be afterwards stated regarding the liability of timber to speedy destruction from the marine worm, and to iron by chemical action, it is obvious that floating structures of wood connected by iron and moored by iron chains, cannot possibly be of long duration. If to all these sources of evil we add the risk of their being broken by the sea we think the case may be almost regarded as hopeless. No doubt green-heart might be employed so as to resist the ravages of the worm, but its high specific gravity and its great expense would prove bars to its employment.

In some situations where there is a long shallow beach, a harbour or pier of timber or masonry may be made at or near the low-water mark, which may be connected with the shore by means of a suspension bridge. The inducements to adopt the suspension principle are its economy, and the free passage it affords to the currents, which in this way are prevented from forming accumulations of sand, silt, or gravel. These advantages are, however, much reduced by the great wear and tear consequent upon the perishable nature of the structure. The late Sir Samuel Brown erected two chain piers, the one at Brighton and the other at Newhaven, near Edinburgh, both of which are still in existence.

In every situation where it is easily practicable to make two entrances to a harbour, it will be found well worth the extra expense, provided they can be so placed that the one shall be available when the other has become difficult of access. In harbours which have but one mouth, vessels are often detained for a great length of time by the continuance of the wind in the direction which throws a heavy sea into the entrance. Whereas if there are two entrances situated as we have supposed, vessels are at once able to take their departure by the sheltered side. At the port of Peterhead, the north and south harbours were some years ago united by a canal, according to the writer's plans, and there the advantage has been of the most marked description. Vessels can now clear out as soon as loaded, either by the north or south mouth, according to the state of the sea. Some caution is necessary, however, as the *run* is apt to extend from the one harbour to the other unless there be a considerable area.

There is generally much prudence required in the alteration or repairs of existing marine works. The risk of having the whole structure destroyed by a gale coming suddenly on while there is an open breach in the works, must be obvious; and in one instance, where the exposure of the place was great, and the evil was a hidden one, the writer could not recommend the facework being disturbed. The cause of failure in this instance was supposed to be the decay of the backing, which having deprived the face-stones of support allowed them to be driven inwards by the force of the waves. Instead of removing the facework, the only recommendation that could be given was to inject the whole pier with fluid cement, so as, if possible, to render the mass *monolithic*. An alternative of this kind is obviously of very doubtful success, and can be regarded as nothing short of a last resort, for there is but a small chance of getting the injected fluid to permeate the whole mass of the pier. The system of permeating the masonry with fluid matter could, however, be employed with more chance of success in the *formation* of a pier, while each course lies open to view. In 1844, at a harbour that had stood for very many years, two or three faulty stones had been incautiously taken out of the facework by a mason who intended to replace them by others, when a sudden gale came on, and nearly the whole of the work was levelled with the beach.

As an example of the suddenness with which our eastern coast is visited by gales, and as indicating graphically the relative eligibility of the summer and winter months for carrying on harbour works, we give the accompanying diagram of the heights of waves, as observed for the writer, by Mr. William Middlemiss, resident engineer at Lybster harbour.



Register of Height of Waves for 1862 observed at Lybster, Caithness-shire.

In landlocked bays, where a deep-water landing-place is all that is required, and where the bottom is sandy or soft, timber may be employed with great advantage. Even in exposed situations, timber can also be used, but the fatal disadvantage attending its employment in most places where there is no admixture of fresh water, is the rapid destruction occasioned by marine worms.

The damage occasioned to harbours in this way is noticed by Semple in his treatise 'On Building in Water,' in 1776, and very probably by much earlier writers. Indeed, the ravages of the *Teredo navalis* are very ludicrously described by Hector Boece, in his "Croniklis of Scotland,' printed at Edinburgh *circa* 1536. In the Atlantic Ocean the *Teredo navalis*, and at many places in the German Ocean the *Limnoria terebrans*, are the animals which are found to destroy any structure of timber which is exposed to the water. They are found to eat most rapidly between the bottom and low-water mark, but above low-water the damage is not so great; and what is singular, they do not appear to exist at all below the bottom where the pile is covered with sand. These observations do not, however, quadrate with Mr. Hartley's at Liverpool, for he found the parts which were alternately wet and dry to decay faster than the parts which were constantly immersed. Even solid limestone is often destroyed by the persevering efforts of another marine animal called the *Pholas*.

The late Mr. R. Stevenson made several experiments on the ravages of the *Limnoria terebrans* at the Bell Rock in 1814, 1821, 1837, and 1843, by fixing pièces of different kinds of timber to the rock, and getting regular reports on their decay. From those experiments it appeared that green-heart, beef-wood, and bullet-tree, were not attacked by the worms, while teak stood remarkably well, although suffering at last. The kyanizing fluid and other preparations have been tried, but were not found to be of permanent service. In addition to these experiments on timber, no fewer than 25 different kinds and combinations of iron were tried, including specimens of galvanised irons. Although separate specimens of each were tried in places where they were always under water, and also in places were alternately wet and dry, yet all the ungalvanised specimens were found to oxidise with much the same readiness. The galvanised specimens resisted oxidation for three or four years, after which the chemical action went on as quickly as in the others.

Kind of Timber.	Decay first observed.	Unsound and quite Decayed.	Quite sound for	Remarks.
	yrs. mo.	yrs. mo.	yrs mo.	
Green-heart	......	......	13 0	
Teak-wood	......	......	13 0	Affected in one corner.
Ditto	5 6	......	...	Nearly sound 7¼ yrs. after being laid down
Ditto	4 7	12 0	...	
Treenail of locust	......	5 0	3 0	
Beef-wood	......	......	13 0	
Treenail of Bullet-wood	......	......	5 0	
African Oak	4 11	10 0	...	
Ditto	5 6	......	...	Nearly sound 7½ yrs. after being laid down
English Oak	1 1	3 1	...	
Ditto	2 4	4 7	...	
British Oak	1 6	5 0	...	
English Oak, kyanized	4 7	10 0	...	
American Oak	2 11	4 7	...	
Ditto	1 6	5 0	...	
Ditto, kyanized	4 3	......	...	Decaying but slowly 5 yrs. and 7 months after being laid down
Italian Oak	1 1	3 6	...	
Dantzic Oak	1 1	2 6	...	Much decayed when first observed
Scotch Oak	2 4	......	...	
Baltic Oak	2 4	4 3	...	Decaying but slowly 5 yrs. and 7 months after being laid down
Plane Tree	2 11	......	...	
Ditto	1 6	5 0	...	
British Ash	3 0	5 0	...	
Ash	2 11	4 3	...	
English Elm	2 11	4 7	...	
Ditto	1 1	1 6	...	
Scotch Elm	3 0	5 0	...	
American Elm	1 9	3 1	...	
Canada Rock Elm	1 1	1 6	...	Nearly sound 3¼ yrs. after being laid down Washed away six months later
Honduras Mahogany	2 1	......	...	
Do. teak treenails.	1 6	5 0	...	
Beech	1 6	5 0	...	
Do.	1 9	3 1	...	
Do. Payne's pat. pro.	10 7	......	...	A little holed at one end underneath
Cedar of Lebanon	1 1	2 6	...	
Scotch Fir, teak treenails	1 6	3 0	...	
Do. from Lanarksh.	1 6	3 0	...	
Do. do.	1 6	3 0	...	
Do. locust treenails	1 6	3 0	...	
Memel Fir	1 6	5 0	...	
Riga Fir	1 1	1 6	...	
Dantzic Fir	1 1	1 6	...	
Norway Fir	2 4	3 1	...	
Baltic Red Pine	2 9	4 3	...	A good deal decayed when first observed
Ditto kyanized	2 4	4 7	...	
Pitch Pine	2 4	4 3	...	Going fast when first observed
Ditto	1 6	2 6	...	
Virginia Pine	1 1	1 6	...	A good deal gone 18 mos. after being laid down; swept away by sea 7 months after
Yellow Pine	1 1	1 6	...	
Red Pine	1 1	1 6	...	
Cawdie Pine	1 1	1 6	...	A good deal decayed when first observed
American Yellow Pine.	2 4	3 7	...	
Ditto, locust treenails	0 8	3 0	...	
American Red Pine	2 4	3 1	...	
Ditto, kyanized	2 4	4 7	...	
Larch	2 4	4 3	...	
Polish Larch	1 1	1 6	...	Going fast when first observed
Birch, Payne's pat. pro.	0 10	1 10	...	

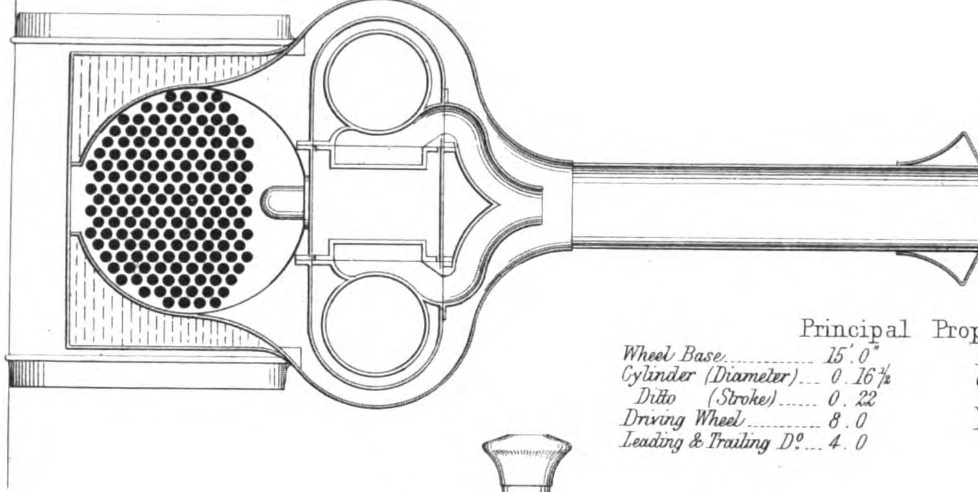
The annexed table shows the different kinds of wood which were made the subject of experiment at the Bell Rock in 1814, 1821, 1837, 1843, with their relative durabilities.

Green-heart timber is now generally had recourse to in places where the worms are destructive. It appears to have been first used by Mr. J. Hartley, of Liverpool, who published in the 'Minutes of Institution of Civil Engineers' an account of its virtues in 1840, as ascertained at the Liverpool Docks. Its cost is considerably greater than Memel or than most of the other timbers generally used. Memel logs for the inner piles of piers might perhaps, from their not being exposed to abrasion from ships, be clad with green-heart planking at those parts which are exposed to the worm. Copper sheathing and scupper nailing are often and successfully employed as protections for piles in exposed situations. *Breaming* or scorching the wood, and afterwards saturating it with train oil, also forms a partial protection.

It is much to be regretted that timber is so expensive in this country, and that some simple and economical specific against the worm has not been discovered for protecting Memel and the cheaper kinds of pine. The grand desideratum in harbour works, which is the *want of continuity in the structure*, would then be supplied. It follows, from the known laws of fluids, that each individual stone in a pier which is equally exposed throughout its whole length, is subjected to a force which it can only resist by its own inertia, and the friction due to its contact with the adjoining stones. The stability of a whole hydraulic work may therefore be perilled by the use of small stones in one part of the fabric, while it is in no way increased by the introduction of heavier stones into other parts. By the use of long logs of timber carefully bolted together a new element of strength is obviously obtained. A pier could be erected almost free of sea risk if constructed of rectangular or other shaped prisms, consisting of logs of timber treenailed and bolted together, so as to form boxes, say 10 feet square and 30 or 40 feet long. The interior of the boxes would be filled with rubble or *beton*. The first layer would be arranged across the pier, so as to fit the irregularities of the bottom, and above that, they might be arranged lengthways of the pier, so as to form its outer and inner walls; the space between being filled with common rubble or *beton*.

In many ports the original depth has been decreased by the deposit of silt, sand, and gravel. This is, indeed, a great evil, and one which unfortunately is most difficult of cure. So obscure and apparently capricious are the causes which lead to the formation of shoals, that in the present state of our knowledge it would be little short of *quackery* to lay down any general rules for the guidance of the engineer. In fixing on the site for a harbour, all existing obstructions should be examined to ascertain whether there be a tendency to deposit, and the works should be kept as far as possible from places where the tendency is most strongly developed. The agents which occasion bars at the mouths of harbours are the waves, the tide currents, and land streams where they exist. Rivers are often more pernicious than beneficial in their effects, especially where they intersect a gravelly soil; but in some cases the descending gravel may be successfully intersected by the erection of weirs, from which the accumulations must be from time to time removed. We agree with Sir H. De la Beche in believing that the bars at the mouths of rivers are most generally formed by the constant tendency of the waves to preserve the *continuity* of the beach profile. It is therefore not to be wondered at, that heavy gales should distort and fill up the narrow trench which the back waters cut in gravelly or sandy beaches. The erection of breakwaters on each side has undoubtedly a good effect in protecting the channel, but

F. PRESTAGE'S LOCOMOTIVE.

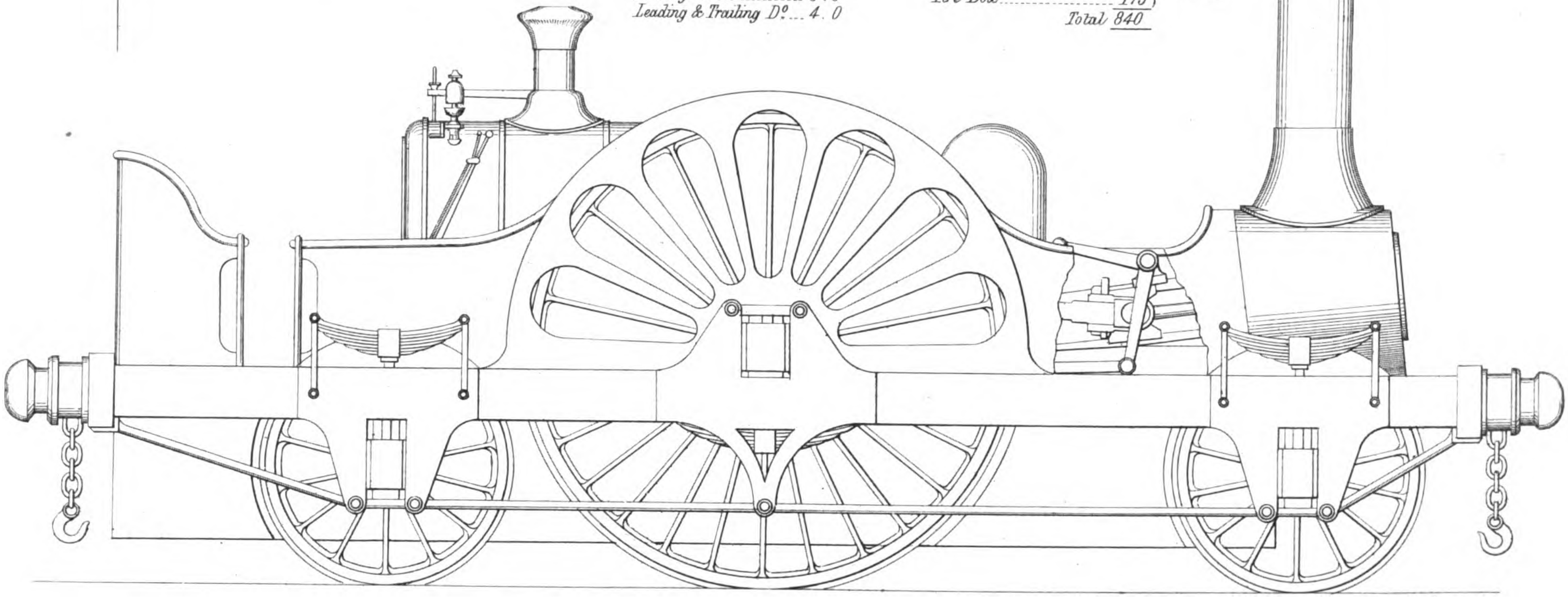


Transverse Section

Principal Proportions.

Wheel Base	15'. 0"
Cylinder (Diameter)	0. 16½
Ditto (Stroke)	0. 22
Driving Wheel	8. 0
Leading & Trailing D°.	4. 0

Area of Grate	12'. 8"	
Capacity of Tank	600	Gallons
Tube heating surface	665	Sup!. feet
Fire Box	175	Sup!. feet
Total	840	



Side Elevation.

J R Jobbins

still a bar is very apt to form outside of the breakwaters. In some cases the depth of the track might probably be maintained by driving, on each side of the mid-channel, dwarf piles to which continuous walings should be attached so as to confine the current at low-water. The timber framework should not project more than a foot or two above the bottom, which in some cases might be planked. This, however, is but a hint, and has, so far as the author is aware, never been tried. The principle on which the proposal is based is that of contracting the low-water channel to a smaller width than that of the high-water channel, and thus by fixing the low-water track, to prevent a tortuous channel. The same principle was adopted by the writer with success in controlling and fixing the meanderings of a gravelly river, which is subject to very sudden and heavy freshes.

The want of sufficient funds occasions a great national loss in the construction of our harbours. The history of a large majority of those ports which have been erected by private or local enterprise, presents but a record of the building of piers at one period when the funds were small, and of taking them down at another when the trade had increased and more room and accommodation were required. Want of funds often prevents the original works from being carried within deep water, and in consequence the most expensive part of the protecting breakwater is often put down just in the very place which has afterwards to be converted, at great expense, into a deep water access or berthage. Sometimes, indeed, a whole line of pier is, from motives of economy, placed in such a manner as to interfere most materially with what might have been by far the best and safest berths for shipping, so that in the further extension of the works a great part of the old harbour has to be demolished. Want of a proper marine survey has also often led to very serious errors in the position of the piers.

To such an extent has this system prevailed, that were an engineer called on to value many of our works as they exist at present, his estimate, however fairly and fully made out, would fall lamentably short of the actual cost. This estimate would proceed on a measurement of what he sees, while the actual cost would include the building of piers and jetties which had long since ceased to exist. For these reasons we conceive there could hardly be a more advisable expenditure of the public money than by a system of grants for supplementing the local funds on a liberal scale. With such aid the authorities on the spot would be enabled to protect and improve the existing physical advantages which the shores possess, by preventing the construction of proposed improvements on too narrow a scale. But a comparatively slight increase of the means would, in instances of which the writer is aware, have inclosed a great extra area, and secured a deeper access with superior internal tranquility, the want of which now cripples the trade; and is the subject of lasting regret to all frequenting the harbours.

Reference may be made to *Brit. Assoc. Rep.* 1150 (Scoresby); *Min. Inst. Civ. Eng.* 1848 (Rankine); Ditto 1847 (Scott Russell); Ditto 1844 (Bremner); Smeaton's *Reports, passim. Rep. Com. on Waves by Brit. Assoc.*, J. S. Russell, Lond., 1848. *Researches on Hydrodynamics*, J. S. Russell.—*Trans. Roy. Soc. Edin.*, vol. xiv. 1837. *Account of Experiments on Force of Waves of Atlantic and German Oceans*, Thomas Stevenson,—*Trans. Roy. Soc. Edin.*, vol. xvi. 1845. *On Reduction of Height of Waves after passing into Harbours*, T. Stevenson,—*Edin. New Phil. Journ.* 1852. *Account of the Plymouth Breakwater*, by Sir J. Rennie, London, 1848. Belidor's *Architecture Hydraulique*, Paris. Semple's *Treatise on Building in Water*, Dublin, 1776. *Royal Tidal Harbour Commissions Reports* (Captain Washington), London 1845–6. The Article on Tides and Waves in the *Encyclopædia Metropolitana*, by G. B. Airey, Astronomer Royal. *Report by Commissioners of Harbours of Refuge*, with the *Protest*, by Sir Howard Douglas.

Mr. John Newton has been appointed Surveyor to the Preston Board of Health. There were 67 candidates.

It has been determined, by the Government, in consequence of the successful experiments at Leicester and other places, in reference to utilizing the sewage of towns for the purposes of manure, to appoint a scientific commission to enquire into the whole subject, and make a report as soon as possible. Should the report of the commission be to the effect that sewage can be deodorized and advantageously employed, an Act of Parliament may be expected prohibiting all towns from polluting streams which are used for domestic and drinking purposes.

PRESTAGE'S IMPROVEMENTS IN LOCOMOTIVE ENGINES.

(*With an Engraving, Plate* III.)

We feel satisfied that the locomotive which forms the subject of the Engraving will prove of great interest, and will convincingly show that amid the multitude of minor changes and modifications which have been made in the construction of the locomotive engine, others of a much more important character, embodied in the invention now under notice, have been passed over with comparative neglect.

It will be seen, on reference to the Plate, that the driving shaft and working parts of the engine, instead of being placed below, are *above* the boiler, by which arrangement the space beneath is rendered available for the construction of a tank to contain an ample supply of water for the journey. This tank is continued so as to form the sides of the smoke-box, by means of which the water becomes heated, and thus not only provides a supply, at a high temperature, for the boiler, but also converts the tank and its contents into a most effectual covering for the prevention of loss of heat from the bottom and sides of the boiler. The foot-board is sufficiently extended to carry a corresponding amount of coke. Another and very marked feature of novelty and improvement in this engine is observable in the position of the cylinders, which, with their valves, are encircled by jackets, and placed immediately above the ends of the tubes in the smoke-box. The consequences of this arrangement, in an economical point of view, are most important, inasmuch as the steam, in its passage from the boiler to the cylinders, is led into the jackets before mentioned, and there, becoming superheated, has its elasticity increased to an extent which would apparently justify us in anticipating a saving of at least one half in the consumption of fuel and water. Thus, steam, the pressure of which in its normal condition in the boiler is 120 lb. to the square inch, has a temperature of 343° Fahr., while that of the jackets through which it must pass before entering the cylinders is equal to 600°. But admitting that the temperature of the steam in passing through the jackets becomes raised to only 400°, its pressure will be increased to something like 240 lb. to the square inch. It will at once be seen that as by this arrangement the steam is conducted from the boiler to a chambar of a much higher temperature, and there heated. The only conditions suggested by the Franklin Institute of New York, as being necessary for the economical working of superheated steam, have been most successfully obtained,—the committee's report being, that there would be great economy in using superheated steam, or "stame," if it could be brought into operation where the temperature of colder bodies would not interfere to abstract the heat before it could be profitably employed.

The enormous power of superheated steam is more than sufficiently demonstrated by the awful boiler explosions we but too often have to record; yet, tremendous as are its effects when uncontrolled, there is no mechanical difficulty to prevent its subjection and employment to our advantage in the manner proposed by Mr. Prestage.

Economy in the consumption of fuel is evidently a consideration of paramount importance; but at the same time railway shareholders have also had, amongst other causes, to suffer most seriously from the great cost of renewal and maintenance of way. This has been in a great measure owing to the excessive weight of the engines hitherto employed,—an evil entailed by the large amount of heating surface required to obtain sufficient evaporative power to meet the lavish expenditure (not to say waste), of steam which has taken place to a great extent in all, but more particularly in engines with outside cylinders, where the loss by condensation has in some cases amounted to 33 per cent.

It will be evident on reflection, that in consequence of the reduced size of boiler, Mr. Prestage's engines will be of greatly diminished weight—a fact sufficient in itself to bring them into general use. This will be clearly understood when it is considered that an engine of moderate boiler space, and heating surface superheating its steam, will be equal in efficiency to one of much greater heating surface in connection with which the steam is not superheated. The diminished size of boiler also tells favourably in giving the inventor the option of constructing his engines either with driving-wheels of large or of moderate size. It is impossible to deny, that for fast traffic the former are desirable, not only on account of the increased speed obtainable by their use, but also on account of the diminution of wear and tear consequent on the number of reciprocations of the engine being reduced, and by reason of the more effective and economical manner in which the steam is worked. There is a farther advantage arising from the reduction of the back pressure, to the effect of which, in the present engines, is in some measure attributed the great cost of working at high velocities, from the fact of its increasing greatly in proportion to the speed.

It is, however, to be remarked, that as in the invention before us the patentee, by bringing the boiler down, is enabled to lengthen the funnel, there will be more natural draft, attended by a corresponding diminution of the blast required and of its attendant back pressure.

We would also lay particular stress upon the fact, that in addition to the directly economical advantages attendant upon this construction of engine, in point of safety it presents features of an equally important character. Thus, it is undeniable, that as the centre of gravity is brought nearer to the base of a machine, so its stability is increased. In this instance, not only is the centre of gravity brought considerably nearer to the base and point of resistance than in ordinary locomotives, but is at the same time situated nearly in the direction of the line of traction, and consequently in a highly desirable position for ensuring steadiness, and thus at once giving increased safety, accompanied by a reduction of the wear and tear of engines, road, and rolling stock. In our opinion, numerous accidents have taken place, the chances of which, if not altogether done away with, would at least have been considerably reduced by the use of Mr. Prestage's engines. We might mention many which have occurred in consequence of engines leaving the rails: two in particular have happened lately, in which the leading wheels mounted the rails in traversing curves; and instances have been known in which they have literally leaped from the rails. That casualties of this class would be considerably reduced, must be apparent; and it may afford some satisfaction to the public to know that the construction of engines may be such as to afford increased chances of their keeping the rails, thus in some degree compensating for the anything but improving condition of the permanent ways of several railways we could name. We may further observe, that in working these engines, the driver has a full view and easy access to the working parts, which may be readily lubricated while running. They are, moreover, screened, and placed above the action of the ballast-dust, &c., which otherwise tells most seriously on their wear and tear; and, from their position, can be repaired with greater ease and at less cost than in ordinary locomotives. Finally, from the large size of the fire-box of these engines, they are particularly adapted for the combustion of coal, which is daily getting into more general use as a fuel for locomotives.

REGISTER OF NEW PATENTS.

STEAM BOILERS.

Edwin Heywood, Sutton, York, *Patentee*, April 14, 1856.

This invention relates to a mode of fixing vessels or boilers used for generating steam where two or more fires or furnaces are used, and consists of arranging the furnaces so that when one furnace is opened to supply the fire with fresh fuel, a damper or valve will be opened in an adjoining fire or furnace flue, thus forming a communication between the flue and the chimney, and at the same time closing a damper or valve in the flue of that fire or furnace which is being supplied with fresh fuel, and also closing the door of the fire or furnace belonging to the flue made to communicate with the chimney. As each fire is being supplied with fresh fuel the smoke is caused to pass or be drawn down through its own fire to the ash-pit, and through tubes, openings, or apertures to the adjoining ash-pit, and up through the adjoining fire, causing the smoke or combustible matter to be consumed. In supplying fresh fuel to the last-named fire, the damper or valve above named will be reversed, and the direction of the draught changed to the contrary flue, the smoke passing downward, as before described, through one fire and up through the other, changing the direction of draught alternately as each fire is re-supplied with fuel. The grate bars are hollow, and connected at each end with other hollow bars or pipes, forming a compact hollow framework for fire-bed, and connected to the vessel or boiler, so as to be readily taken out for repairs or other purposes. The water circulates freely through the said hollow framework, by which the generation of steam is accelerated, and the fuel greatly economized.

The furnace doors are suspended one at each end of a beam, capable of sliding up and down, so that when one is raised the other is lowered. A damper is suspended by pulleys, and capable of being traversed upon rails, alternately from one flue to the other. To fix the hollow grate bars in the other hollow side bars or tubes, a thread is put on one end of every cross-bar, and each alternate one is passed through one of the side tubes, so that it will screw into the other or opposite side tube. The aperture thus made in the side tube is closed by a screw-plug. By every alternate cross-bar being thus screwed into one or other of the side tubes, a compact framework is formed, screwed together instead of plugged or rivetted in the usual manner. When the door is open to supply fresh fuel to that furnace the damper of which is in position to cut off the communication of that fire with the flue or chimney, at the same time the door is closed, and the damper of that fire removed, opening a communication with the flue, consequently the smoke of the first-named fire, or that which is newly fed, will pass down through its own fire and grating to the ash pit, and thence through the tubes to the other ash pit, and up through the other grating and fire to the chimney; and when it is desirable to feed the other fire, the doors and damper are changed in position, and the draught is thereby reversed to the contrary direction. By this arrangement of the furnaces, the smoke or combustible matter will have to pass through both its own fire and the adjoining fire, whereby it will be consumed and fuel economised.

Claims.—1. The method of fixing the grate bars described.

2. The general arrangement of furnace or apparatus applied to boilers or vessels for producing steam, boiling water, &c., whereby the smoke is caused to pass down through one fire and up through the other.

STEAM BOILERS.

W. and J. Galloway, Manchester, *Patentee*, May 22, 1856.

According to this invention, boilers are constructed with one or more fires or furnaces, from whence the products of combustion pass upwards or downwards through conical pipes, surrounded by water, and placed with their smaller ends upwards. The products of combustion afterwards pass through horizontal or inclined tubes surrounded by water. A large amount of heating surface is thus obtained, and a power of generating steam in proportion to the heating surface and peculiar form, character, and position of such cones.

To each boiler are two furnaces, inclosed in two cylindrical tubes or flues, placed side by side, and connected by one common chamber at their back ends beyond the fires. This chamber is separated from another chamber placed above it, by a horizontal water space, which is traversed by an assemblage of conical fire tubes or flues, placed vertically with their smaller ends upwards. From the chamber the products of combustion pass through a series of horizontal cylindrical return tubes to a smoke-box at the front end of the boiler, from which they pass up a flue into the chimney. The chambers are stayed and strengthened by conical water tubes, placed with their larger ends upwards, or by cylindrical water tubes. The conical fire tubes are omitted at those places in which they would interfere with the water tubes. By making the fire tubes of conical form, and placing them with their smaller ends upwards, the ascent of the steam from their outer surfaces is facilitated. It is advisable to make these conical fire-tubes of larger diameter than the horizontal cylindrical tubes, so that the flame may not be cooled and extinguished before the gases are completely burned. By constructing the boiler in this manner, the deposit of soot is in a great degree avoided.

Claims.—1. Constructing steam boilers with an assemblage of vertical conical fire-tubes, in combination with an assemblage of horizontal cylindrical fire-tubes.

2. Constructing steam boilers with an assemblage of vertical conical fire-tubes, in combination with vertical water-tubes, and an assemblage of horizontal cylindrical fire-tubes.

PAVING.

C. J. LE M. DE LA HAICHOIS, Finsbury, *Patentee*, March 31, 1856.

This invention consists in the employment of lime, sand, asphalte, caoutchouc, gutta percha, marine glue, and wood, for the purpose of forming an even and durable pavement. A layer composed of lime and sand is laid down to the thickness of about 5 inches on the part to be paved, then a layer of asphalte mixed with stones to the thickness of about 2 inches, after which a layer of asphalte, either alone or mixed with sand to the depth of about 1 inch, is laid down, in which are embedded, at equal distances, strips of vulcanised caoutchouc or gutta percha. In the last application, a layer of asphalte, of about half-an-inch in depth, is laid down, and then the strips of vulcanised caoutchouc or gutta-percha, of about half-an-inch in thickness, and from a half to three-quarters of an inch in breadth, so as to form squares or lozenges. The strips are placed from 6 to 10 inches apart, and are secured together by iron hooks or ties, at a distance of 3 to 5 inches from each other, which hooks pass through them. Instead of using hooks, the strips may be bevelled at the edges, so as to be firmly embedded in and secured by the asphalte. When the strips are laid down, a second layer of asphalte is applied, so as to be on a level with the strips of caoutchouc.

The paving may be constructed by first laying down on a bed or layer of asphalte, mixed with small stones, small cross pieces of wood of about 1 to 2 inches in breadth, and half-an-inch in thickness, injected, according to Dr. Boucherie's process. Upon these cross pieces are placed the strips or bands of vulcanised india-rubber or gutta-percha, prepared as hereinbefore described.

As asphalte does not naturally adhere to caoutchouc, it is necessary to apply a thin coat of marine glue or other similar substance to those parts to be placed in contact with the asphalte before being laid down; the asphalte being hot causes the marine glue to melt and adhere to it strongly. The strips of caoutchouc should be embedded in and secured to the asphalte during the cooling of the latter.

Claim.—The method of constructing pavement in the manner described.

SUBMARINE EXPLORING APPARATUS.

W. E. NEWTON, Chancery-lane, *Patentee*, March 26, 1856.

This invention consists of a novel construction of boat for submarine navigation, and improved appliances for supplying air to divers, and also improved means for raising sunken articles.

The submarine boat is made strong enough to resist the pressure of the water at the depth it is intended to go, being constructed of iron with stout ribs to prevent collapse. It has an egg shape with pointed ends, and is propelled by a screw turned by a crank by persons within, or by a clock spring or electro-magnetic machine. To this boat an ordinary rudder is fitted at the stern, and an up-and-down rudder at the bow. It has two keels, so that it will sit level upon them. Ingress is obtained at a man-hole at top. The boat, which forms an air reservoir, is made large to contain air sufficient for several men to breathe as long as they may require to be under water without opportunity to ventilate it.

The boat being constructed air and water tight, with the windows and ventilating apertures, is ready for use. The crew enter it with ballast nearly sufficient to sink the boat, and by means of a stop-cock they admit a quantity of water, and the boat sinks. By the action of a force-pump a portion of this water is ejected, until the boat is of such a specific gravity as will permit of its rising or sinking with equal facility. The boat is then propelled in the direction required, and is governed by the two rudders. Within the boat is placed a lamp, or Drummond light, shining through the windows, and the pilot can see through the bow lights his direction, and the objects he encounters. When the air requires renewal, a little water is pumped out, and the boat rises to the surface, two pipes are then thrust up about 6 feet above the water; their valves are opened, and the air at the top part of the interior is pumped out, and its place supplied by that which naturally flows in. Or, the air may be purified in some degree by a small fountain of lime water issuing in many jets, to absorb carbonic acid gas, and the issue from a meter of a small quantity of oxygen gas. There may be a heavy ballast beneath the bottom or under the shelves at the sides, which could be liberated from the inside at a moment's notice. If the weight be under the bottom, it could be liberated by turning back a screw. If at the sides, the weights may be held by hooks, the turning of which from within would liberate the ballast, and let the boat rise suddenly to the surface. When divers accompany the boat, they sit upon shelves outside, and draw their breath from within by means of pipes and a suction-blower, the pipes being long enough to admit of their operating at a distance from the boat. When desirable, the boat can be supplied with ventilating pipes reaching above the surface, the circulation of the air being kept up or quickened when required by means of a suction-blower within the boat or above the water. The boat can be drawn by a tow line by a steamer, or dragged by the outside divers to any spot required. Instead of using this novel construction of boat, the inventor proposes in some cases to employ an air reservoir for receiving and distributing air to a group of divers.

The diver should have defensive armour to resist the pressure of the water at great depths, and in all cases he must have a head-piece, with which the two ventilating pipes are brought into connection. One of them, the exhaust pipe, is connected with a blower or an air pump, by which the air is constantly drawn out. The other is the supply-pipe, and conducts to the diver the fresh air which naturally flows down to supply the partial vacuum caused by the exhaust-pipe. When the defensive armour admits of the pipes being contained within the casing which is round the body, the exhaust-pipe should have a branch extending downwards to abstract the carbonic acid gas.

In deep water, a lamp is often necessary. A globe containing the lamp has an exhaust-pipe and a supply-pipe, and the supply and exhaust air effected in the same manner as for a diver. A lamp of suitable shape is also attached to the breast or head-piece of the diver, the air pipes of which are branches of his own breathing pipes.

The breathing pipes must be made flexible, and strong enough not to break by tension, and with rings or coils of wire within to resist collapse. At the junction of the pipes with the diving dress, there must be in each of them a valve, so arranged that if the pipe should break and admit water, the valve would close and protect the diver. In case of accident to the dress, so that it admits the water, the supply-pipe must be so situated that the diver can take it in his mouth, and make sure of breath until he can rise to the surface and open a stop-cock, which will communicate air to his mouth from above the water.

Gas bags are employed to recover submerged property when found in deep water, such as a ship. Each one of them is calculated to float to the surface a weight equal to about ten tons. Such a bag would be in cylindrical form, about 12 ft. 6 in. long, and 6 feet in diameter when inflated. The bag must be made air tight, and strong enough to contain the gas. It has a valve held closed by a spring and by the outside pressure, which will allow the gas to escape whenever the pressure within is greater than is deemed safe. The bags are connected to the sunken vessel by chains, and then inflated.

The gas to inflate the bags may be generated from chemical substances of various kinds. In the drawer at the bottom of the bag, and which shuts water-tight, a quantity of alkali may be put dissolved in water or magnesia in a granulated state. Amid this lies a bottle of acid;—beside this, is an iron shaft having a cam upon it, and a crank outside. When it is desired to inflate the bag, the diver turns the crank, and the cam is thrust against the bottle and breaks it; the acid is diffused in the alkali, and a gas is evolved which distends the bag, and gives it a lifting power. Or iron filings may be put in the drawer of the box, or zinc; and in the bottle dilute sulphuric acid to evolve hydrogen gas, or the vessel may be inflated by burning in it a slow gunpowder.

The inventor remarks, that it is not in all cases necessary to have an artificial draught in the breathing pipes. If they are made thick and non-conducting, the warmth of the body of the diver, and the heat given off by the lamp which he carries, will make a natural draught.

Claims.—1. The arrangement of submarine vessel, as described, which is capable of carrying the divers from place to place, and of supplying them with air.

2. The arrangement above described for creating a circulation of air through the diver's helmet at or near the usual pressure of the atmosphere.

3. The construction of collapsible vessel, whereby the pressure of the gas generated therein may be regulated as required.

METROPOLITAN STREET WASHING.

The committee appointed to superintend the new system of street washing adopted in Marylebone during the last autumn, have reported that the experiments had been carried out in Oxford-street and the Edgeware-road, to the great satisfaction of the inhabitants. The facilities for carrying out the experiments became so increased that at last the entire of Oxford-street was effectually washed by a small gang of men in two consecutive mornings. An experiment upon macadamised roads was also made, but although at an unfavorable period, by carefully securing the gully holes free from the descent of heavy matter, very little passed into them, and the experiment was satisfactory, the surface of the road being well bound, damp, and clean for many days after. A new arrangement was subsequently carried out with regard to gullies, by which all solid matter was brought in a reservoir or pit placed under the grating, so that nothing, even fluid, could pass into the sewer until it had ascended to a dip-stone or trap, which also prevented the ascent of gases from the sewer. On testing these pits, no deposit of heavy matter was found therein, and only 4½ inches of mud or sand was deposited there. In a sanitary point of view this plan will diminish the exhalations from decomposed animal and vegetable matters, and on the score of cleanliness and comfort in the avoidance of mud, dust, &c., the public would be greatly benefited. The relative cost between this and the old system was 50*l*. the old system being 917*l*. and the new system 967*l*. The report was adopted.

THE SUNKEN RUSSIAN FLEET.

Of all the 70 vessels that were scuttled or sunk in the harbour of Sebastopol between September 1854 and Feb. 1855, there have been only one steamer, the Chersonese, and a few transposts raised. The result of the examination to which the others have been subjected by divers shows them not to be worth much expense being bestowed upon them. The ships of the line which were sunk at the entrance of the harbour had already been ten years afloat, and have now been embedded in the sand there for two winters, so that they certainly cannot be worth much. The liners, Paris, Grossfürst, Constantine, Maria, and Tschesma are lying on their beam-ends, and have been much injured by the lurching over of the guns, the ballast, and other ponderous articles; the Chrabry, Kullewtschy, and the steamers Vladimir, Bessarabia, Gromonessetz, Odessa, Krimea, and Turok are described as standing upright on their keels, and it is proposed to lift these by means of the Chersonese and the transports. As regards those steamers which were among the vessels that were last sunk, considerable hopes are entertained that they may be brought into service again. The parties who have undertaken the recovery of these wrecks from the bottom of the harbour are to be paid for their trouble and outlay with one-half the estimated value of all objects recovered, a remuneration that is thought to be in all probability very inadequate to the expenses. The method proposed is to fasten on to the sides of the vessel to be raised sacks made air-tight with tar or gutta percha; in the case of a ship of the line it is calculated that 2000 of these sacks must be used, containing 50,000 cubic feet of air. Whether the scuttled vessels can ever be used or not it seems to be decided that they must be lifted, and not blown to pieces, inasmuch as by the latter process the roads would be encumbered with a vast number of chains, guns, anchors, and other heavy bodies, which would for ever after obstruct the anchorage very much.

A communication from Mr. James Coey was read at a recent meeting of the Liverpool Dock Committee, describing a plan by him for improved approaches to the pier. He proposes to erect a bridge across the Mersey, of 6 spans of 521 feet each, and at a level above the pierhead of 125 feet, to connect the London and North-Western Railway with the Chester and Birkenhead Railway; th rail on the Liverpool side of the river to be carried on to the top of a pile of granaries ending at Roscoe-street, where a tunnel could be formed to Edge-hill. It is stated that the commiteee have also under consideration a plan prepared by the Dock Surveyor, Mr. Hartley, for a large graving-dock at the north-east end of Prince's Dock basin, as the entrance will be through the north-east corner of Prince's Dock. The length of the dock will be 700 feet, large nough to accommodate three ships of 2000 tons burden.

WROUGHT IRON BEAMS.*

By Thomas Davies, F.A.I.S.

The material first used in the construction of beams was doubtless timber, and although it has many properties peculiarly fitting it for this purpose, yet, on account of its flexibility, and the difficulty of getting it of sufficient size and strength for long spans, its tendency to decay, and its destructibility by fire, it is in many cases unsuited for the purpose required.

When the manufacture of cast metal became more general, and the means were obtained of making large castings, the applicability of this material to the formation of beams could not fail to suggest itself. This material has decided advantages—in its rigidity, in its capability of being made of almost any required shape and strength, in its non-liability to decay, and in its incombustibility; and consequently, it has come to be very extensively used for the purpose referred to.

There has, however, been a general want of confidence in beams of this material, arising from different causes. One objection is, that when a beam gives way, it does so without any previous warning. Another objection is, that although we have innumerable experiments on the strength of cast-metal, by which we are enabled to calculate the amount which any particular beam of this material ought to carry, it does not follow that it will bear that amount. In a large casting there may be some inequality in the metal used; again, if there is much difference in the thickness of the parts, the cooling of one part before another produces, to some extent, a tendency to fracture, especially if subjected to any sharp concussion; or the casting may be clean and apparently sound, and yet there may be a flaw, of which nothing can be known until it is revealed by a fracture. No doubt, to guard against these defects, we have the system of testing; but this is not always to be depended upon, as it has been considered, that in some cases beams have been tested so nearly to the limits of their strength, that, though passing the ordeal, they have been permanently injured thereby. This suggests another objection, that though a beam be in every way sound, yet, if it is occasionally subjected to great strains, it will ultimately be so much weakened, as to break with a load much less than the original breaking weight.

The result of the want of confidence above mentioned has been, that cast-metal beams are generally made much stronger than, judging from experiment, they require to be, necessitating heavy castings and increase of cost, with the additional drawback of great weight and difficulty of handling.

Malleable iron beams unite, to some extent, the advantages of both timber and cast-metal. They possess the advantage of timber, inasmuch as they are comparatively light, and therefore easily handled, and when overloaded, they show this by yielding considerably before breaking. They possess the advantage of cast-metal in their incombustibility, in their being capable of being conveniently made of any required strength, and even to some considerable extent, in their rigidity; for although malleable iron is comparatively flexible, yet this quality is in a great measure counteracted by the mode of constructing the beams.

Messrs. Stephenson and Fairbairn, in their investigations and experiments relative to tubular bridges, were the first to call general attention to the use of malleable iron in the construction of beams. After many experiments on various sections of tubes, they arrived at the rectangular tube, or box beam, as the best; and it was a simple step, by dividing it in two by a vertical line, to come to the double flange or plate beam, which is the most convenient shape for general use.

Mr. Fairbairn, in his valuable book on cast and wrought-iron, shows the superiority, in many respects, of malleable over cast-iron for beams. He shows, moreover, that, contrary to what takes place in cast metal, the upper flange requires to be larger than the under one, in the portion of 2 : 1, and gives formulæ for calculating the strength of beams. There is, however, this drawback, that while his book contains the details of many experiments on various sections of cast-metal and malleable iron box beams, there is almost a complete want of experiments on malleable iron plate beams. There is given, in fact, the result of only one experiment on one kind of plate beam, and this experiment was not altogether satisfactory.

This circumstance, there is little doubt, has tended to deter many from adopting this of beam. Having made several experi-

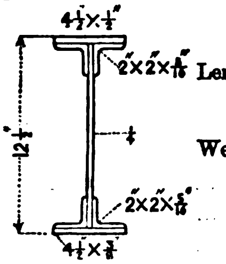
* Read at a Meeting of the Architectural Institute, held in Edinburgh on Feb. 18, 1856.

ments on the kind of beam referred to, I considered, under the circumstances, that the results of some of these might be acceptable to this Institute, and might tend to the more general use of a beam which has decided advantages for many purposes.

Having had my attention drawn to the applicability of malleable iron for beams, and having long shared in the general want of confidence in cast-metal already alluded to, I determined to take the first opportunity of making a trial of them. An opportunity having afforded itself of using them, I consulted Mr. Tod, engineer, Leith Walk, and had the benefit of his experience; and I was so satisfied with the result of the trial, that since then I have not used cast-metal for beams of any importance.

The beams in my first experiments, I am sorry to say, were tested by a Bramah Press, which I afterwards discovered to be very inaccurate. The results of the experiments, however, which are to be laid before this meeting, are only those which have been obtained by the application of *dead weight*, so that there may be nothing to create want of confidence in the statements now laid before you. These experiments were made at various times in Mr. Tod's yard. None of the beams were tested till they broke, as all were intended for use; but, as most of them were tested to a deflection greater than that to which it would be advisable to have them permanently loaded, they give data for guidance in fixing the dimensions of other beams.

Experiment I.



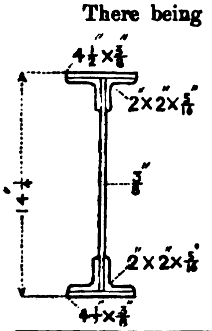
Length of Beam .. ... 12 ft. 0 in.
„ Bearing ... ... 11 „ 8 „
Weight of Beam ... ... 4 cwt. 1 qr.

The Load rested on 20 inches in the middle of the Beam.

Divisions of Load.	Load.	Deflection Loading.	Deflection Unloading.
Cwt. Qrs. lb.	Cwt. Qrs. lb.	Ins. 16ths.	Ins. 16ths.
0 0 0	0 0 0	0 0	0 0
33 0 21	33 0 21	0 2	0 3
42 2 14	75 3 7	0 3	0 4
65 2 14	141 1 21	0 4	0 5 nearly
38 3 0	180 0 21	0 5	
27 0 7	207 1 0	0 6	0 6 full
28 3 20	236 0 20	0 7	0 7

Load ... ... 11¾ tons.
Deflection ... ... $\frac{7}{16}$th inch.
There being no apparent permanent deflection.

Experiment II.



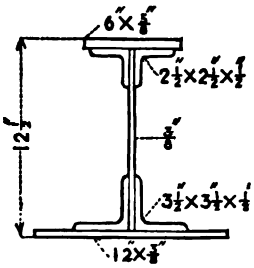
Length of Beam ... ... 17 ft. 2 in.
„ Bearing ... 16 „ 6 „
Weight of Beam... ... 6 cwt. 2 qr.

The Load rested on 21 inches in the middle of the Beam.

Divisions of Load.	Load.	Deflection Loading.	Deflection Unloading.
Cwt. Qrs. lb.	Cwt. Qrs. lb.	Ins. 8ths.	Ins. 8ths.
0 0 0	0 0 0	0 0	0 1
37 2 0	37 2 0	0 1	0 2
33 0 24	70 2 24	0 2	0 3 nearly
54 2 16	125 1 12	0 3	0 3 full
52 0 0	177 1 12	0 4	0 4 full
52 0 0	229 1 12	0 5	0 5

Load ... ... 11½ tons.
Deflection ... ... ⅝ths inch.
Permanent deflection ... ... ⅛th inch.

Experiment III.



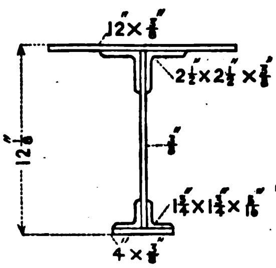
Length of Beam ... 30 ft. 0 in.
„ Bearing ... 28 „ 6 „
Weight of Beam ... 20 cwt. 2 qrs.

The Load rested on 27 inches in the middle of the Beam.

Divisions of Load.	Load.	Deflection Loading.	Deflection Unloading.
Cwt. Qrs. lb.	Cwt. Qrs. lb.	Ins. 8ths.	Ins. 8ths.
0 0 0	0 0 0	0 0	0 3
34 1 4	34 1 4	0 2	0 5
12 3 12	47 0 16	0 3	0 6
9 2 16	56 3 4	0 4	0 7 nearly
13 3 20	70 2 24	0 5	1 0 nearly
12 3 12	83 2 8	0 6	1 0 full
16 0 8	99 2 16	0 7	1 1 full
13 0 0	112 2 16	1 0	1 2
13 0 0	125 2 16	1 1	1 3
13 0 0	138 2 16	1 2	1 4 nearly
13 0 0	151 2 16	1 3	1 4 full
13 0 0	164 2 16	1 4	1 5
13 0 0	177 2 16	1 5	1 6
13 0 0	190 2 16	1 6	1 7
13 0 0	203 2 16	1 7	
13 0 0	216 2 16	2 0	2 0

Load ... ... 10¾ tons.
Deflection ... ... 2 inches.
Permanent deflection ... ... ⅜ inch.

Experiment IV.



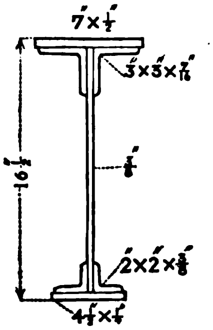
Length of Beam ... 29 ft. 6 in.
„ Bearing... 28 „ 6 „
Weight of Beam ... 14 cwt. 3 qrs.

The Load rested on 22 inches in the middle of the Beam.

Loading.			Unloading.		
Divisions of Load.	Load.	Deflection.	Divisions of Load.	Load.	Deflection.
Cwt. Qr. lb.	Cwt. Qr. lb.	Ins. 8ths.*	Cwt. Qr. lb.	Cwt. Qr. lb.	Ins. 8ths.*
0 0 0	0 0 0	0 0	0 0 0	0 0 0	0 3¼
... ...	... ...	... ...	5 3 8	5 3 8	0 4
17 1 24	17 1 24	0 1	8 2 26	14 2 6	0 5
11 2 16	29 0 12	0 2	11 2 16	26 0 22	0 6
11 2 16	40 3 0	0 3	11 2 16	37 3 10	0 7
11 2 16	52 1 16	0 4	11 2 16	49 1 26	1 0
8 2 26	61 0 14	0 5 nearly	11 2 16	61 0 14	1 1
11 2 16	72 3 2	0 6	11 2 16	72 3 2	1 2
11 2 16	84 1 8	0 7 full	11 2 16	84 1 18	1 3
8 2 26	93 0 16	1 0	11 2 16	96 0 6	1 4
8 2 26	101 3 14	1 1	11 2 16	107 2 22	1 5
11 2 16	113 2 2	1 2 full			
8 2 26	122 1 0	1 3	11 2 16	119 1 10	1 6
8 2 26	130 3 26	1 4	11 2 16	130 3 26	1 7
8 3 22	139 3 20	1 5	15 0 22	146 0 20	2 0
9 1 14	149 1 6	1 6 full			
6 1 0	155 2 6	1 7	12 2 0	158 2 20	2 1
6 1 0	161 3 6	2 0			
6 1 0	168 0 6	2 1 full			
3 0 14	171 0 20	2 2	12 2 0	171 0 20	2 2

Load... ... ... 8½ tons.
Deflection ... ... 2¼ inches.
Permanent deflection ... ... $\frac{1}{16}$ inch.

* The deflections were observed to 16ths of an inch, but the 8ths only are here given.



Experiment V.

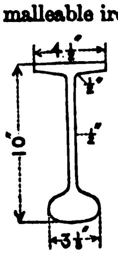
Length of Beam	...	23 ft. 6 in.
„ Bearing	...	22 „ 6 „
Weight of Beam	...	13 cwt. 2½ qr

The Load rested on 21 inches in the middle of the Beam.

LOADING.			UNLOADING.		
Divisions of Load.	Load.	Deflection.	Divisions of Load.	Load.	Deflection.
Cwt. Qr. lb.	Cwt. Qr. lb.	Ins. 16ths.	Cwt. Qr. lb.	Cwt. Qr. lb.	Ins. 16ths.
0 0 0	0 0 0	0 0	0 0 0	0 0 0	0 2
... ...	... ...	... ...	17 1 24	17 1 24	0 3
34 3 20	34 3 20	0 1	20 1 14	37 3 10	0 4
20 1 14	55 1 6	0 2	23 1 4	61 0 14	0 5
26 0 22	81 2 0	0 3	23 1 4	84 1 18	0 6
23 1 4	104 3 4	0 4	23 1 4	107 2 22	0 7
20 1 14	125 0 18	0 5	23 1 4	130 3 26	0 8
18 1 8	143 1 26	0 6	25 0 0	155 3 26	0 9
18 3 0	162 0 26	0 7			
18 3 0	180 3 26	0 8	25 0 0	180 3 26	0 10
18 3 0	199 2 26	0 9	25 0 0	205 3 26	0 11
15 2 14	215 1 12	0 10			
15 2 14	230 3 26	0 11	25 0 0	230 3 26	0 12
12 2 0	243 1 26	0 12	21 3 14	252 3 12	0 13
12 2 0	255 3 26	0 13			
13 1 12	269 1 10	0 14	16 1 26	269 1 10	0 14

Load	...	...	...	...	13½ tons.
Deflection ...	...	...	...	...	⅞ths inch.
Permanent deflection			...	...	⅛th inch.

I have as yet had only one opportunity of testing a rolled malleable iron Beam, of which the following is the result:—



Experiment VI.

Length of Beam...	...	10 ft. 9 in.
„ Bearing	...	10 „ 3 „
Weight of Beam...	...	3 cwt. 21 lb.

The Load rested on 8 inches in the middle of the Beam.

On account of some circumstances, the testing was not quite so satisfactory as could have been desired, so that the observed intermediate deflections are not given. The total load, however, was (204½ cwt.=) 10¼ tons. The deflection was ⅝ths of an inch, or perhaps 7/16ths of an inch. The permanent deflection, after the removal of the load, was ⅛th of an inch.

It ought to be noticed, that the loads by which the beams in the foregoing experiments were tested, consisted for the most part of railway bars, requiring two men at each end to lift them, and that in loading there was a considerable amount of concussion and vibration, so that the test was considerably more severe than that due to the mere application of the load stated.

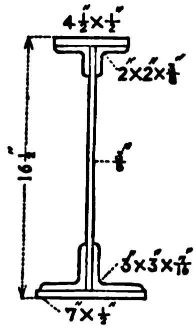
The foregoing are the details of all the experiments I have to bring before the meeting. I do not attempt from so few cases to generalise; but in the meantime I leave them before the Institute for their consideration. I may mention, that I am inclined to doubt the accuracy of the proportions of the upper and under flange for plate beams, as given by Mr. Fairbairn; but I am not at present in a position to speak definitely on this subject. (See Appendix.)

There is one remark, however, which I beg to make, before concluding this part of the paper. The flexibility of malleable iron beams, is no doubt greater than that of cast-metal beams, but it is not so great as to prevent them being used for most purposes. For instance, it might be supposed that such beams were, from this cause, inapplicable to the support of walls already built, where the lower part has to be removed, as in the case of the alterations in shop fronts, which are continually being made in this city; but I may give the result of an experiment made in an alteration in Princes-street, as a case in point.

A pair of beams were used, similar to that referred to in Experiment II. except that they were 2 inches deeper, the length being 14 inches greater, and the actual bearing, when put in their place, being 16 ft. 8 in. After the masonry above the beams had been keyed up, and the supports to the walls removed, so as to throw the whole weight of the wall above upon them, the deflection was only 1/10th of an inch. I do not mean to say, that this was all the beams had yielded; but the keying up, before the supports were removed, had taken up whatever additional yielding there had been, although this must have been very little, as there was no appearance, so far as the eye could detect, of any deflection in the beams.

Appendix.

As already stated in the body of the paper, I was inclined to doubt the accuracy of the proportions of the upper and under flanges, as stated by Mr. Fairbairn. Since then I have made another experiment upon the beam used in Experiment V. but reversed; that is, with the large flange undermost, the results of which are given in the annexed table—



Experiment VII.

(Same Beam as tested in Experiment V. the larger flange being undermost.)

Length of Beam	...	23 ft. 6 in.
, Bearing	...	22 „ 6 „
Weight of Beam	...	13 cwt. 2½ qr.

The Load rested on 21 inches in the middle of the Beam.

LOADING.			UNLOADING.		
Divisions of Load.	Load.	Deflection.	Divisions of Load.	Load.	Deflection.
Cwt. Qr. lb.	Cwt. Qr. lb.	Ins. 16ths.	Cwt. Qr. lb.	Cwt. Qr. lb.	Ins. 16ths.
0 0 0	0 0 0	0 0	0 0 0	0 0 0	0 3
24 2 1	24 2 1	0 1	19 0 7	19 0 7	0 4
17 1 3	41 3 4	0 2	19 2 21	38 3 0	0 5
18 0 24	60 0 0	0 3	21 1 0	60 0 0	0 6
18 0 24	78 0 24	0 4	27 1 8	87 1 8	0 7
14 3 16	93 0 12	0 5 bare			
17 1 12	110 1 24	0 6	34 2 24	122 0 4	0 8
20 1 0	130 2 24	0 7			
20 1 0	150 3 24	0 8	34 2 24	156 3 0	0 9
23 0 16	174 0 12	0 9	31 3 8	188 2 8	0 10
20 1 1	194 1 13	0 10			
27 1 18	211 3 3	0 11	23 0 23	211 3 3	0 11
15 0 20	226 3 23	0 12	15 0 20	226 3 23	0 12
15 0 20	242 0 15	0 13	15 0 20	242 0 15	0 13
15 3 6	257 3 21	0 14	15 3 6	257 3 21	0 14
12 0 16	270 0 9	0 15	12 0 16	270 0 9	0 15

Load	...	...	...	...	13½ tons.
Deflection ...	...	...	...	...	15/16ths inch.
Permanent deflection			...	...	3/16ths inch.

The circumstance of this being the same beam which was tested in Experiment V. and which received a set of ⅛th of an inch in the opposite direction from that in which it was strained in the present instance, accounts for the apparent anomalies in the above experiment, as compared with the results of the former, Thus, at the commencement of the second testing, the beam falls more quickly than on the former occasion, while as the experiment proceeds, it seems to recover strength, and there is little difference in the ultimate strength in both cases. Again, in unloading, the beam in the second testing springs up more quickly than in the first, which is inconsistent with the idea of its being weaker, as the observed deflections imply.

An allowance ought therefore to be made for the previous set of ⅛th of an inch, and the following table is probably near what ought to be substituted for that just given.

Experiment VII. (as corrected.)

Loading.			Unloading.		
Divisions of Load.	Load.	Deflection.	Divisions of Load.	Load.	Deflection.
Cwt. Qr. lb.	Cwt. Qr. lb.	Ins. 16ths.	Cwt. Qr. lb.	Cwt. Qr. lb.	Ins. 16ths.
0 0 0	0 0 0	0 0	0 0 0	0 0 0	0 1
... ...	... ...	... ...	19 0 7	19 0 7	0 2
35 0 0	35 0 0	0 1	19 2 21	38 3 0	0 3
23 0 0	58 0 0	0 2	21 1 0	60 0 0	0 4
27 0 0	85 0 0	0 3	27 1 8	87 1 8	0 5
25 1 24	110 1 24	0 4	34 2 24	122 0 4	0 6
20 1 0	130 2 24	0 5			
20 1 0	150 3 24	0 6			
23 0 16	174 0 12	0 7	34 2 24	156 3 0	0 7
20 1 1	194 1 13	0 8	31 3 8	188 2 8	0 8
17 1 18	211 3 3	0 9	23 0 23	211 3 3	0 9
15 0 20	226 3 23	0 10	15 0 20	226 3 23	0 10
15 0 20	242 0 15	0 11	15 0 20	242 0 15	0 11
15 3 6	257 3 21	0 12	15 3 6	257 3 21	0 12
12 0 16	270 0 9	0 13	12 0 16	270 0 9	0 13

Load... ... ... 13½ tons.
Deflection ... ... $\frac{12}{16}$ths inch.
Permanent deflection ... ... $\frac{1}{16}$th inch.

It would have been desirable, in order to have obtained the strength of the beam, as above, without requiring to have recourse to allowances, to have used a beam which had not been previously strained by testing. This was intended in making the above experiment; but through a mistake, the same beam was used over again, and there was not an opportunity of making another experiment before the beams were sent away.

It would be very unadvisable to attempt to draw particular conclusions as to the exact proportions of the upper and under flanges, from these two experiments merely, but the results seem to warrant us in coming to the general conclusion, that for this kind of beam the flanges ought to be nearly equal, the under flange being rather larger than the upper.

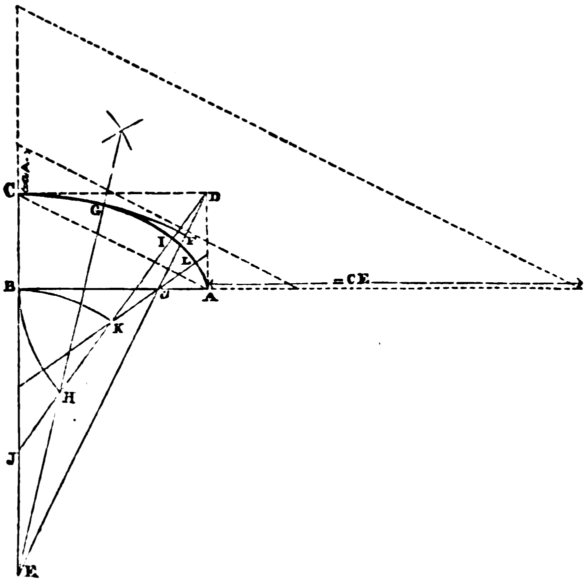
Since making this last experiment, and coming to the above general conclusion, and while preparing this paper for the press, I have seen a new work by Mr. Fairbairn, entitled, 'Useful Information for Engineers.' In it he inserts some of the mathematical investigations of Mr. Tate on the subject, which quite agree with the statements here made. Mr. Tate concludes his remarks by saying—"The difference in the value of these constants is so small, as to lead us to infer, that the beam in Experiment 12 approaches to that of maximum strength with a given quantity of material. The sectional area of the top and bottom flanges are to each other as 14 : 15, which is very nearly a ratio of equality."

FRICTION OF MACHINES.

Bourne, in his work on the Steam-Engine, says:—"The friction of iron sliding upon iron has generally been taken at about one-tenth of the pressure, when the surfaces are oiled and then wiped again, so that no film of oil is interposed. The friction of iron rubbing upon brass has generally been taken at about one-eleventh of the pressure, under the same circumstances; but in machines in actual operation, where a film of some lubricating material is interposed between the rubbing surfaces, it is not more than one-third of this amount, or 1-33rd of the weight. While this, however, is the average result, the friction is a good deal less in some cases. The fact appears to be that the amount of the resistance denominated friction depends, in a great measure, upon the nature of the unguent employed, and in certain cases the viscidity of the unguent may occasion a greater retardation than the resistance caused by the attrition. In watchwork, therefore and other fine mechanism, it is necessary both to keep the bearing surfaces small, and to employ a thin and limpid oil for the purpose of lubrication, for the resistance caused by the viscidity of the unguent increases with the amount of surface, and the amount of surface is relatively greater in the smaller class of works."

PROBLEM:

TO FIND SEVEN TRUE CENTRES TO STRIKE AN ELLIPSE.



Either by calculation, or geometrically, as in dotted lines in figure, or Euclid, Prop. II., Book VI., find the 4th proportionals to the conjugate and transverse radii, and set the larger on C B extended to E.

Form the rectangle A B C D and join D E.

Then A B : C D : : C D : A *a*

And C B : B A : : B A : C E

Now strike the curve C F, and bisect the angle joining E G. From *a* as a centre, with distance *a* B, cut E G in H; the point H is the centre for curve G I. Unite D H and extend to J, and from J with distance J B cut J D in K; join K *a* and extend to L.

The points E, H, K, and *a*, are the true centres for the portions of curve C G, G I, I L, and L A.

Barcelona, Nov. 9th, 1856. William Moon.

NOTES OF THE MONTH.

Mr. R. Raywood, Penistone. York, proposes an improvement in the rails used in the permanent way of railways, by forming them of two parts each having a T-shaped head or edge formed upon it, so that when they are placed together the two will constitute a continuous rail, having a section corresponding to those now in general use; by this means the necessity of what is usually termed the "fish joint" will be obviated. One arrangement, found to answer, is as follows:—suppose two bars of any convenient length, and suitable in width, &c., each having, as before mentioned, a T-shaped head or edge; these bars have also grooves or slots formed in such a manner, that when they are placed side by side, one edge of one will take into the groove of the other, by this means securing them so as to form the rail, as mentioned. If necessary, the two parts, formed as above, may be united by bolts or other suitable apparatus.

Mr. Duff, of the Oakbank Engine Works, Glasgow, has effected an improvement in the construction of the high-pressure non-condensing engine. It consists of two cylinders, instead of one, as in the ordinary form of construction. The steam from the smaller of the two cylinders, before passing into the atmosphere, exhausts itself into the second cylinder, which is three times the capacity of the first. The effect is that the steam gives three-fourths additional power as contrasted with the same volume of steam acting through the former or single cylinder engine, in proof of which the improved engine, with a cylinder of only eight inches diameter, is doing the work with greater facility than the single cylinder engine, which has one of 10 inches diameter, the length of stroke and pressure of steam in both being the same. But there is in addition this material distinction, that the improved or double-cylinder engine effects a saving in fuel of about 40 per cent. The engine is now in daily operation at Mr. Duff's works.

The annual general meeting and *conversazione* of the Architectural Institute of Scotland was held on the 1st ult. in Edinburgh. The attendance of members and guests was large. The collection of photographs and architectural engravings was extensive. The photographs which attracted particular attention were the largest hitherto attempted in Scotland, by Mr. Kibble, of Glasgow. The Lord Provost was called to the chair, and Lord Neaves delivered the introductory address of the session.

The first annual exhibition of the association recently established in Scotland to encourage the application of art to objects of ornament and utility, was opened at Edinburgh on the 13th ult. by a brilliant and well-attended *conversazione*. The exhibition is to be an annual one.

It is stated, that Mr. Charles Manby, who has, after 17 years' service, resigned the post of secretary to the Institution of Civil Engineers, has succeeded the late Mr. Starbuck, as the representative in London and on the Continent of the extensive engine manufacturing firm of Robert Stephenson and Co., of Newcastle-on-Tyne. Mr. Manby is succeeded as secretary by Mr. James Forrest, who has been connected with the Institution for the last 14 years.

Wimborne Minster is about to undergo complete restoration. The chancel and its aisles having recently been repaired, under the superintendence of Mr. Wyatt, at a cost of 5000*l.* raised on the tithes, the necessity of restoring the remainder of the minster has become more apparent. It is fully expected the work of restoring this fine specimen of Norman and Early English styles of architecture will rapidly progress. The general features of the minster are of the Norman period, especially the eastern tower, triforium, the chancel, and the arches of the nave.

A bridge of novel construction is now being made in this country for the East Indian Railway. It is intended to cross the river Soane, one of the tributaries of the Ganges, and when completed will be nearly a mile in length. There will be 29 piers, and the span from pier to pier will be 150 feet, being about 26 feet more than the span of the arches of the High-level Bridge at Newcastle-upon-Tyne. Like that structure, it will consist of two roadways, the upper one for the railway, and the lower one for foot-passengers and palanquin-bearers, the height from the lower to the upper way being 26 feet. The peculiarity of the construction is that the two roadways are fastened together and supported by latticework of wrought-iron, combining great strength with a light and elegant appearance. The bars are of channel iron, and cross each other diagonally, being firmly riveted together at each crossing One complete arch has just been constructed at the Elswick Engine Works, Newcastle, by way of experiment, and the result is most satisfactory. The entire weight is 120 tons. It was made with a slight curve, 2 inches higher than a dead level, and when tested with a weight of 362 tons it only went down 2 inches below the level, or 4 inches altogether at the centre. The separate lengths or arches will rest at each end on five rollers of cast iron, to allow of expansion and contraction, according to the variation of the temperature. The engineer engaged in the construction of this bridge is Mr. George Rendel, of London. As soon as the bridge is completed it will be taken to pieces in order to be shipped, and will be reconstructed in India.

The Grand Trunk Railway of Canada is now open throughout from the St. Lawrence where the great Victoria tubular bridge is in progress to the western terminus at Lake Ontario, near Toronto, a length of 850 miles. A single line only has as yet been laid down. The whole route is level. The Victoria bridge will not be finished till 1860. The cost of this structure was originally estimated at 1,455,000*l.*, but this sum has since been reduced, and the present calculation of its probable cost is about 1,250,000*l.* It is supposed that in its erection 250,000 tons of stone and 7500 tons of iron have been used; the iron superstructure is supported on 24 piers and 2 abutments, the centre span being 330 feet; there are 12 spans on each side of the centre, 242 feet each—the extreme length including abutments is 7000 feet. The height above summer water level in the centre opening is 60 feet, descending to either end at the rate of 1 in 130. The contents of the masonry will be three nillions of cubic feet; the weight of iron in the tubes 8000 tons. The following are the dimensions of tube through which the trains pass in the middle span, viz.: 22 feet high, 16 feet wide; at the extreme ends 19 feet high, 16 feet wide. The total length from river-bank to river-bank will be 10,284 feet, or about 50 yards less than two English miles. On an average there is a station on this line to every 6 miles, 2 men to every 3 miles, and a locomotive to every 4 miles.

The Lords of the Treasury have granted to Mr. Inman, the late chief surveyor of the Office of Works, a pension of 533*l.* per annum.

The Queen has conferred the honour of knighthood upon Mr. Rowland Macdonald Stephenson, of Gloucester-terrace, Hyde park, and late of Calcutta, Civil Engineer.

Mr. J. Jay has undertaken to complete the Carmarthen and Cardigan railway from the Myrtle-hill station of the South Wales railway to Llandissil for 135,000*l.*

The Secretary of the Treasury, United States of America, has awarded a contract to E. Harmon and Co, for the erection of an iron building for a Marine Hospital at New Orleans. This model fire and heat-proof structure is destined to initiate the use of iron in the construction of the public architecture of the country. It is regarded as the most important measure for the interests of iron manufactures ever adopted by the national government.

At the conclusion of the inquest on the bodies of the men killed at Southampton by the explosion on board the steamer *Parana*, the verdict was a very elaborate one, the substance of which was, that the deceased met their deaths by the accidental bursting of the starboard forward boiler on board the *Parana*, during the trial of an experiment as to the superfluous heat in the up-take; that by a great amount of caution the accident might have been prevented; that the evidence proves that one safety-valve applied to one boiler is not a sufficient protection to life and property; that it is questionable whether safety-valves are constructed on sound and effective principles; that the safety-valve of the boiler which caused the accident was insufficient in dimensions, and defective in principle; and, lastly, the jury declare, their conviction that the Royal Mail Company and their officers had displayed great anxiety to obtain perfection in their machinery and to guard against accidents, in having their boilers and engines in good ordor.

Experiments have recently been made at Woolwich, to test the power of resistance of timber lined with 4-inch iron plates—the combined materials being of the same thickness as the floating batteries constructed during the late war; and also to test the durability and quality of iron plates manufactured by rolling, as compared with iron turned out by the hammer. The target was an immense construction of timber, lined with 4-inch plates of iron of both descriptions, the total weight was 30 tons. Twenty-four rounds of 68 pounders were fired at this target with the following results:—the first 14 rounds were fired at a distance of 600 yards, and after the first few rounds the timberwork gave way in several directions. The last 10 rounds were fired at a distance of 400 yards, and the work of destruction consummated; the timberwork of the target was completely broken and splintered, and the plates of iron made by the rolling process were cut up and split, having apparently but little adhesion. The iron plates which had been made by the old process resisted the solid wrought-iron shot much more successfully, and it was apparent that these plates possessed more adhesive power than the rolled plates. By the force of the cannonade the immense target was forced by the concussion several feet from the foundation or box on which it was placed. The last shot fired went completely through the target, timberwork, and iron included. It was the subject of remark by several practical men, that the principle of combining timber with iron plates, was, no doubt, the best that could be at present adopted; but it was evident from these experiments that such plates must be improved upon before they could resist the concussion of repeated discharges of heavy shot.

Messenger's Triangular Tubular Boiler, recently patented, consists in surrounding the fire with tubes, which form water spaces extending from front to back, and secured at each end to sockets cast on inner plates, with sides, and ends, and flanges, to which are secured front and back plates. A water space is thus formed between inner and outer plates which communicate with the tubes. Water admitted at the lower tubes becomes heated, circulates through all the tubes and water spaces; and rises to an outlet at the upper part of the boiler, from whence it is conveyed to whatever place is required to be heated. The patentee describes its advantages as: 1st. The amount of surface which is by this arrangement exposed to the fire, reduces the quantity of fuel required very considerably; 2nd. Tubes being used for fire-bars, all burning of the iron is prevented; 3rd. Should any tube become injured, it can be replaced without in the least disturbing the other part of the boiler. To convert it into a steam-boiler, the patentee proposes to add a steam-chest, communicating with the water-spaces.

OBITUARY.

Recently, Mr. Nash, one of the oldest members of the Society of Painters in Water Colours. He devoted his attention in early life to making drawings of ecclesiastical and other ancient buildings for the illustration of topographical works, and continued afterwards to paint similar subjects.

Lately, Mr. R. R. M'Ian, Artist, an Associate of the Scotch Academy.

On the 24th ult., Dr. Paris, Physician. He was born at Cambridge on the 7th of August, 1785, and at 22 years of age he was elected physician to the Westminster Hospital. He was for a short time in practice at Penzance, and while there founded the Royal Geological Society of Cornwall. When at Penzance he gave to the miners the great boon of the "tamping bar," the instrument by which they are enabled to pursue their business amid inflammable gases without the fear of striking fire from the rock. He was elected President of the College of Physicians in the year 1844, and this office he held until the hour of his death. Dr. Paris possessed rare literary talent, and was the author of several sterling works. His "Life of Sir Humphry Davy" will ever remain one of the classical biographies of the English language.

COMPETITIONS.

Designs and estimates are required for building a master and mistress's residence, and a school room to accommodate 100 children, with a boundary wall and approaches, and all the necessary fittings for the school, in the parish of Peterchurch, Herefordshire. The plans to be accompanied by the name of a builder who will complete the works for a sum under 1000*l*. Plans to be sent to Mr. Thomas Lewis, Hay, South Wales, by the 20th inst.

Design and specification are invited for a building to be erected in the town of Llanelly in commemmoration of the late Mr. Richard Nevill. Particulars may be had of Mr. Frederick L. Brown, Secretary, Llanelly. Designs to be sent in by the 31st inst.

The Burial Board for the Parish of Sunderland, near the Sea, Durham, require plans and specifications for enclosing and laying out ten acres of land, for the purpose of a Burial-ground with Two Chapels, and Cottages. A plan of the ground may be seen at the offices of the Burial Board. Each chapel to accommodate 100 persons, and not exceed 600*l*. including the fittings. The two cottages, with store-room, not to exceed 450*l*. The Board will give 20*l*. for the plan and specification approved by them. Plans to be delivered at the office of the Board, No. 5, Church-street, Sunderland, by the 2nd of February.

The Committee appointed by the Town Council of Bristol, to superintend the erection of a New Pauper Lunatic Asylum, offer premiums of 100*l*., 50*l*., and 25*l*. for the three best designs for the same. Plans to be accompanied with specifications and estimates. The building to receive 200 patients, with requisite offices, and accommodation for resident officers. The amount to be expended on the building to be between 15,000*l*., and not exceeding 20,000*l*. The building material found on the intended site to be used as much as possible. The elevation to be of a simple but cheerful character. The "Suggestions and Instructions" for building Lunatic Asylums, published by the Commissioners in Lunacy, to be, as far as practicable, complied with. The plans to be deposited at the Town Clerk's office, Council-house, Bristol, by the 14th February. A lithographed plan of the intended site, and copies of the "Suggestions," may be obtained upon application to the Town Clerk's office.

The Commissioners of Her Majesty's Works and Public Buildings invte architects of all countries to furnish them with designs for Offices for the Secretary of State for Foreign Affairs, for the Secretary of State for War, and for laying out the ground between the Thames and St. James's-park, adjoining Great George-street. The drawings to be made to a scale of 16 feet to the inch. General specifications of the materials proposed to be used in the buildings must accompany each design. A block-plan showing how the site may be so appropriated that the two buildings proposed to be erected may form part of a large and comprehensive scheme for concentrating the principal public offices, and for the improvement of the leading thoroughfares, including Westminster-bridge, whether as regards its present or any other site. Seven premiums for the best designs for the War Office of 800*l*., 500*l*., 300*l*., 200*l*., 100*l*., 100*l*., and 100*l*. Seven premiums for the best designs for the Foreign Office, of 800*l*., 500*l*., 300*l*, 200*l*., 100*l*., 100*l*., and 100*l*. For the best design for a block plan, three premiums of 500*l*., 200*l*., 100*l*. Plans of the ground, and other particulars will be forwarded on application to Mr. Alfred Austin, Office of Works, Whitehall. Designs to be sent in by the 20th of March.

Designs are invited from artists of all countries for a Monument to be erected in St. Paul's Cathedral, to the memory of the late Duke of Wellington. The cost, with all expenses, not to exceed 20,000*l*. Premiums of 700*l*, 500*l*., 300*l*., 200*l*., and five of 100*l*. A ground-plan of the cathedral, and the site of the proposed monument, &c., will be forwarded, on application to Mr. Alfred Austin, Office of Works, Whitehall. Designs from artists residing in the United Kingdom to June 1st, 1857; from artists residing abroad to the 25th of the same month.

Designs are wanted for a New Town-hall, to be erected in St. Andrew's—the cost of erection not to exceed 3500*l*. Particulars may be had of Messrs. Grace and Yoole, Town-clerks, St. Andrew's, Scotland.

Designs for a church to be erected at Berne are invited from architects of all countries by members of the "Catholic parish of the city of Berne." The cost not to exceed 6000*l*. The first prize is 60*l*.; four medals, gold and silver, are also offered.

The Burial Board of Gloucester Cemetery have selected the design of Messrs. Medland and Maberly, for the new cemetery, from sixteen that were submitted by various architects.

The Norwich Board of Guardians have selected the design of Messrs. Medland and Maberly for the Workhouse, awarding to them the first premium of 100*l*. The second premium was obtained by Mr. C. B. Nichols, of West Bromwich. The estimated cost is 20,000*l*.

The plans of Mr. T. L. Evans, of Abingdon-street, Westminster, for the drainage of the Borough of Linkfield, Reigate, Surrey, have been selected, and the first premium awarded to them.

The Design of Mr. Barry, of the firm of Banks and Barry, has been selected for the New Industrial School for Middlesex.

The Building Committee have selected the design by Mr. Lindley, of Ashton-under-Lyne, for the New Offices of the Independent Order of Odd Fellows, Manchester.

INSTITUTION OF CIVIL ENGINEERS OF IRELAND.

A general meeting of the members of this body was recently held in Dublin, G. W. Hemans, Esq., the recently elected President, in the chair.

The President, in his inaugural address (in which, after some remarks expressing the respect and gratitude felt by the institution towards the past presidents, General Sir J. Burgoyne, General Sir H. Jones, and Dr. Griffith, for their originally forming, and subsequent support of the institution), proceeded to represent the great influence such a society might have, if properly supported, in elevating and establishing the profession of civil engineers. He considered that some test of a public nature was wanting to establish a right to confidence when men seek to be entrusted with works of the utmost importance to society. At present many unqualified persons assumed the title of civil engineer. As there was no law to prevent this, it should be the object of the institution to endeavour, by taking such a scientific standing as would command public respect, to distinguish its own members as recognised civil engineers, who could not without adequate merit have been admitted into their society. For this object it was necessary to make exertions to elevate the society itself, and to keep up its public interest by more frequent communications from the members, descriptive of public works. A paper ought to be required from every new candidate for admission in order to test his ability. The public works of Ireland were then alluded to, and some statistics given of outlay on, and results of Irish railways. The capital expended was up to the present time about 15,000,000*l*., and the number of miles about 1000, giving an average of 15,000*l*. per mile, about half of the whole length being single lines. In England the average outlay was about 39,000*l*. per mile. In Ireland the working expenses were 41 per cent. of gross receipts—in England, 48 per cent.; but this included taxes, from which Ireland was exempt. The receipts per mile in England were over 50*l*. per week, in Ireland only 20*l*. per mile per week; but the dividends in Ireland averaged 4·03 per cent.; in England only 3·85 per cent. After mentioning the railway bridges over the Boyne and the Shannon, and the Cork tunnel, the President then passed in review some other Irish works, such as the new docks at the end of the North Wall, Dublin—the Kingstown Harbour Works—the arterial drainages, &c., and regretted that accounts of these had not been brought forward, so as to enable him to notice them now in detail. He then stated that some highly interesting, practical, scientific problems awaited solution in the coming year. The General Transatlantic Telegraph Cable, of which details were given as to the proposed method of making and laying, and explaining that the whole cost would only be 350,000*l*., for which messages would, it was expected, be sent from America to Ireland at the rate of ten words per minute, or 14,000 per day. The *Great Eastern* steamship, of 22,500 tons burthen, was then described as a novel feature in navigation, destined to be one of the wonders of British enterprise. She is to be ready for sailing in the ensuing year. The method by which she is to be launched was explained. A very interesting machine for boring tunnels through rocks in one operation was then described. It had been adopted by some eminent contractors and engineers on trial, and having succeeded in a tunnel of 5 feet diameter, was now going to be applied to much larger dimensions. Its rate of progress would far exceed ordinary tunnelling. The invention was due to Captain Peurice, of the Royal Engineers. If ultimately successful, it would cause great changes in tunnel practice. The Roquefavour Aqueduct in France; Mr. Brunel's great bridge at Saltash, the centre pier of which is about 200 feet high, and built in an iron cylinder to a depth of 90 feet below high water mark; the Niagara Suspension Railway Bridge, 800 feet span; Messrs. Gordon and Liddell's Crumlin Viaduct; Mr. Stephenson's Victoria Bridge, &c., were then briefly described as constructions worthy of careful study; and the President concluded by expressing his sense of the honour done to him by his elevation to the chair, and his hope that all their meetings would be conducted in good feeling and harmony, and that they would be well supported in a professional point of view.

On its conclusion, Dr. Griffith rose to express the pleasure and gratification with which he, and he was sure all present, had listened to the important and elaborate address the President had favoured them with. He begged to move that the marked thanks of the institution be given to Mr. Hemans for it.

NEW PATENTS.

PROVISIONAL PROTECTIONS GRANTED UNDER THE PATENT LAWS AMENDMENT ACT.

Dated August 30.

2018. F. Long, Paris—Improvements in life-boats

Dated September 8.

2092. B. Sabatier, Paris—Improvements in photography

Dated September 18.

2142. E. Green, Wakefield—Improvements in scrapers employed to cleanse boiler tubes and flues for economising fuel

Dated September 19.

2195. W. J. Bisseker, Ludgate-hill, Birmingham—Improvements in strings or wires used in or on musical instruments

Dated September 24.

2238. J. B. Howell, Sheffield, and N. Harvey, Haymarket—Improvements in steam and other boilers

Dated October 8.

2358. D. Joy and W. Holt, Leeds—Improvements in hydraulic motive power engines, and the application thereof to certain useful purposes

Dated October 15.

2406. G. Guillaume, Southampton—An apparatus for obtaining motive power by means of water or other fluid

Dated October 21.

2476. W. E. Newton, Chancery-lane—Improved machinery for rolling and forging iron or steel. (Communication)

Dated October 25.

2512. H. Hochstaetter, Darmstadt—Improvements in obtaining instantaneous light

Dated October 27.

2518. J. Fordred, Islington—Improvements in lamps and apparatuses connected therewith, and in manufacturing certain liquids for the production of light. (Communication)

2520. J. Fenton, Low Moor, near Bradford—An improved method of and signal apparatus for preventing accidents on railways

Dated October 31.

2558. B. Goodfellow, Hyde, Chester—Improvements in the construction of steam-boilers, and in the mode of supporting steam-boilers in their seatings

2559. D. E. E. A. de Chavanon, Essex-street, Strand—Improvements in cleaning all sorts of cloth fabrics and skins, by the application of a substance so called carburine.

Dated November 7.

2624. A. Holt and J. Bentley, Cardigan Mill, East Ardsley, near Wakefield—Improvements in machinery for weaving stuff and other goods

Dated November 8.

2630. W. Gossage, Widnes, Lancaster—Improvements in the manufacture of carbonates of zinc, of iron, and of manganese, and in the useful application of such carbonates

Dated November 12.

2658. J. Patterson, Beverley, York—Improvements in apparatus for churning, which apparatus is also applicable to the washing of roots and other substances

2660. G. I. Bache, Glasgow—Improvements in lamps and apparatus for affording or supplying artificial light

2662. J. Eccles, Blackburn—Improvements in machinery for making bricks, tiles, pipes, and other articles made of plastic materials

2664. W. H. Balmain and T. Colby, Saint Helen's, Lancaster—Improved means of grinding various substances

2666. J. Apperly, and W. Clissold, Dudbridge, Gloucester—Improved apparatus for condensing wool, cotton, and other fibrous substances

2668. R. A. Brooman, Fleet-street—Improvements in the preparation of fibres for spinning, and in machinery employed therein. (Communication from H. Hofer)

2670. F. J. W. Packman, Puckeridge, Herts, and C. F. Pike, Oxford-street—An armed glove or covering for the thumb and fingers

Dated November 13.

2672. J. H. Johnson, Lincoln's-inn-fields—Improvements in machinery or apparatus for cutting and folding paper. (Communication from C. Chambers, United States)

2674. C. W. Dixey, New Bond-street—Improvements in double opera glasses, and other glasses of a similar nature

2676. T. S. Holt, Manchester, E. Earnshaw and J. Barlow, Rochdale—Improvements in certain parts of steam-engines, steam-boilers, and apparatus connected therewith

2678. T. Earp, Newark-on-Trent—A tap for measuring liquids

2680. J. Kinniburgh, Renfrew—Improvements in moulding or shaping metals

2681. W. E. Cochrane, Osnaburg-terrace, Regent's-park—Improvements in the permanent way of railways

Dated November 14.

2682. P. A. le Comte de Fontainemoreau, South-street, Finsbury—An improved method of forming letters and other devices on metalic surfaces. (Communication)

2683. J. Hacking, Bury, Lancaster—Improvements in machinery for dressing, polishing, and finishing threads and yarns

2684. T. B. Sharp and J. Anthony Collet, Manchester—Improvements in locomotive steam-engines

2685. A. E. Huart, Southampton—An improved toy for the use of children

2686. R. Emery, King-street, St. James's-square—Improvements in springs for carriages and other vehicles

2687. R. Emery, King-street, St. James's-square—Improvements in the construction of axles and boxes of carriages for common roads

2688. J. R. Day and T. Rutter, Birmingham—A new or improved metallic tile for roofing or covering buildings

2689. E. Money, St. James's-square—An improved artificial manure

2690. J. B. Heu, Rue St. Lazare, Paris—Improvements in preserving animal and vegetable substances suitable for food. (Communication from C. L. Marle)

2691. J. Sutherland, Paddington—An improved railway break

2692. H. C. Ash, Park-place South, Chelsea—Improvements in railway signals

2693. D. Saul and P. Williams, Swinton, Lancaster—Improvements in machinery or apparatus for spinning and doubling cotton and other fibrous materials

2694. A. Symington, Kettle, Fife—Improvements in apparatus for drying yarns and woven fabrics

2695. C. Binks, London—Improvements in converting iron into steel, and in giving a coating of steel to iron

2696. A. Reid, Sidmouth-street, Regent-square, and C. O'Neil, Golden-square—Improvements in treating metallic ores to obtain copper

2697. J. Crawley, Wood-street, Cheapside—Improved machinery for stitching fabrics

2698. J. Greaves, Gerrard-street, Soho—An improved construction of ladies' side saddle. (Communication from H. Adams, New York)

2699. J. Aitken, Islington—Improvements in the furnaces employed in the manufacture of iron or other metals

Dated November 15.

2700. N. P. J. Leseure, South-street, Finsbury—An improved embroidering machine

2701. H. H. Fox, College-hill—Improvements in manufacturing brushes

2702. D. J. Hoare, Mortimer-street, Cavendish-square—Improvements in the manufacture of iron

2703. R. Mushet, Coleford, Gloucester—Improvements in the manufacture of iron

2704. A. Barclay, Kilmarnock—Improvements in the manufacture of iron

2705. G. Davies, Serle-street, Lincoln's-inn—An improved paper suitable for the filtration of liquids, the dressing of wounds, and for the manufacture of envelopes, bags, bands, and for other similar purposes. (Communication from J. A. Pichot, and P. P. Malapert, Poitiers, France)

2706. J. Billing, Abingdon-street, Westminster—Improvements in chimneys

2707. G. Pye, Ipswich—An improvement in treating and bleaching cotton

2708. H. Blackburn, Butterworth-hall, near Rochdale—Improvements in billies and mules for slubbing and spinning wool, cotton, or other fibrous materials

2709. J. Drew, Back-hill, Middlesex—Improvements in library tables or desks

2710. N. Robinson, J. Lister, and H. Stevenson, Bradford, York—Improvements in looms for weaving

2711. C. Binks, London—Improvements in the manufacture of iron and steel

Dated November 17.

2712. T. Cope, Liverpool—Improvements in tobacco-cutting machines

2713. A. M. J. Eeckman, Lille, France—A mechanical bakery and cookery

2714. J. Worthington, Manchester—An improved mode of signalling from the guard to the engine driver on railway trains

2715. C. Michel, Lyons, and I. A. Maret, Paris—Making atmospherical observations

2716. W. Hawkes, Birmingham—A new or improved machinery for applying steam-power to the ploughing of land and other agricultural operations

2717. E. Blanchon, Blois, France—Machinery and apparatus for marking and boring leather and other similar substances, for making and cutting screwed pins, and for uniting leather and other similar materials. (Communication)

2718. G. Jones and J. R. Jones, Liverpool—An improved life boat

Dated November 18.

2719. J. Wilson, West Bromwich, Stafford—Improvements in springs for railway and other carriages

2721. S. C. Lister, Manningham, near Bradford—Improvements in spinning

2722. F. A. Magnay, Taverham Mills, Norwich—Improvements in damping paper for printing

2723. R. Butterworth. Chelsea—Improvements in the means of securing the ends of rails for railways

2724. S. Dyer, Bristol—Improved mechanism, applicable to propelling ships and vessels, applicable also as power machinery for ships' purposes

2725. J. Grieve, Bank-park, Tranent, Haddington—Improvements in chimney cans

2726. H. Bessemer, Queen-street-place, New Cannon-street—Improvements in the manufacture of iron

Dated November 19.

2727. W. Brindley, Moorgate-street—Improvements in the treatment and application of papier mache for covering floors, roofs, and other like useful purposes

2728. T. Gillman, Creed-lane, Ludgate-hill—Improvements in boxes or packing cases

2729. H. J. Distin, Cranbourn-street, Leicester-square—Improvements in cornets and other wind musical instruments. (Communication)

2730. W. S. Churchill and J. Bradshaw, Stalybridge, Chester—Improvements in machinery or apparatus for drying yarns or fabrics, applicable to machines for sizing or dressing yarns or threads to prepare them to be woven

2731. J. Jones, Middlesborough-on-Tees, and E. Jones, Liverpool—Improvements in the manufacture or production and treatment of metal castings

2732. J. Lord, Rochdale—An improved admixture or compound to be employed as a substitute for oil in the treatment of animal wool, preparatory to "carding."

2733. James, Earl of Caithness, Barrogill Castle, Caithness—Improvements in driving belts, straps, or bands for machinery, and in the application and use thereof

2734. W. E. Newton, Chancery-lane—An improvement in centrifugal pumps. (Communication)

2736. G. Watson, Manchester, and C. Satterthwaite, Preston—Improvements in the manufacture of fire lighters

2737. J. Yearsley. Saville-row, St. James's—An improved method of and instrument for applying artificial tympanums

2738. A. Watson and A. H. Williams, Cornhill—An improved cap or top for scent bottles

2739. S. Fox, Deepcar, Sheffield—Improvements in machinery for drawing wire and tubes

2740. L. A. de Milly, Paris—Improvements in the manufacture of fatty acids

2741. S. Fox, Deepcar, Sheffield—Improvements in heating steel wire and tubes, also ribs and stretchers of umbrellas and parasols for hardening, and in apparatus for straightening wire and tubes

Dated November 20.

2742. E. Salt, Bolton-le-Moors—An improved paper-cutting machine

2743. J. M. Gilbert, Manchester—Improvements in certain machines for etching or engraving

2744. W. Erlam and J. Phillips, Newton-heath, Manchester—Improvements in working railway signals or alarums

2745. P. A. le Comte de Fontainemoreau, South-street, Finsbury—Improved apparatus for preparing carbonic acid gas and impregnating liquids therewith. (Communication)

2746. C. F. J. Fonrobert, Berlin—Improvements in the manufacture of boots and shoes. (Partly a Communication)

2747. C. F. J. Fonrobert, Berlin—Improvements in the manufacture of insulated wires for electric telegraphs. (Partly a communication)

2748. T. F. Joyce, Birmingham—Improvements in joining, supporting, and strengthening the rails of railways

2749. W. Morgan, Gloucester-terrace, Hyde-park—An improvement in heating parts of cylinders and other hollow bodies of iron to a welding heat

Dated November 21.

2750. R. B. Benson, New York—Improvements in reefing sails

2752. R. Eaton, Sussex-terrace, New-road, Battersea—Improvements in apparatus for buffing on railways, and for other purposes

2753. L. Dartois, South-street, Finsbury—An improved machine for the cleansing of textile and fibrous substances

2754. A. M. M. de Bergevin, Sermon-lane—A method or methods of purifying coal without decarbonisation

2755. J. Norman, Liverpool—Improvements in propelling navigable vessels

2757. J. W. Clare, White-street, Surrey—Improvements in preventing, removing, consuming, and condensing smoke and noxious vapours, and in apparatus for those purposes

2758. C. Tooth, Burton-upon-Trent—Improvements in charging or filling and filling up casks or other vessels for containing fermenting liquids

2759. F. Ludewig, Paris—An improved leaven

2760. S. Rothenheim, London—An improved walking-stick pipe

2761. W. E. Newton, Chancery-lane—Improvements in machinery for spinning or twisting fibrous substances. (Communication)

2763. J. Barrans, New Cross, Surrey—Improvements in apparatus for applying oil or lubricating fluid to the axles of railway carriages and locomotive engines

2764. S. Russell, Darnley-terrace, Gravesend—Improvements in the construction of scissors and shears
2765. R. A. Brooman, Fleet-street—A method of and preparation for rendering textile and other like fabrics sanitary and disinfecting agents. (Communication from J. Ledoyen and J. Beanlavon)
2766. C. Garton and J. St. John G. Parsons, Bristol—A method of treating cane sugar, in order to fit it to be employed in brewing and distilling
2767. T. Roberts and J. Dale, Manchester, and J. D. Pritchard, Warrington—Improvements in obtaining and purifying oxalate of soda, which improvements are also applicable to the manufacture of oxalic acid

Dated November 22.

2769. W. T. Henley, St. John-street-road, Clerkenwell—Improvements in electric telegraphs, and apparatus connected therewith
2770. G. B. Galloway, Basinghall-street—Improvements in furnaces for steam boilers and other uses
2771. A. R. Terry, Great George-street, Westminster—Improvements in sawing, splitting, cutting, and binding kindling wood
2772. W. K. Hall, London—Improvements in machinery for cutting, punching, and shaping metals
2773. R. Tucker, Belfast—Improvements in preparing and drying glue and gelatinous matter
2774. J. Wheeler, Wootton-under-Edge, Gloucester—A method of converting rotary into reciprocating motion, especially applicable to machinery for forcing plastic substances through moulds and dies
2775. R. A. Brooman, Fleet-street—Improvements in the manufacture of artificial wines, or beverages to be substituted for wines, and in apparatus for aiding fermentation. (Communication)
2776. J. S. Wright, Birmingham—Improvements in the manufacture of paper or papier-mâché and metal buttons
2777. W. E. Laycock, Sheffield—Improvements in looms for weaving
2778. D. Chadwick, Salford, and H. Frost, Manchester—Improvements in apparatus for measuring water and other fluids and gas
2779. W. E. Newton, Chancery-lane—Improvements in railway carriages. (Communication)

Dated November 24.

2780. E. Hunt, Glasgow—Improvements in looms for weaving ornamental fabrics
2781. G. Salt, Saltaire, York—Improvements in weaving carpets and other piled fabrics
2782. J. Broadley, Saltaire, York—Improvements in weaving
2783. J. K. Martin, Dundee—Improvements in hoisting or purchase apparatus for ships and other vessels
2784. M. J. Cooke, Dean-street, Newcastle-on-Tyne—Improvements in washing, wringing, and mangling machines
2785. C. J. Lewsey, Albion-terrace, Commercial-road-east—Improvements in sugar-cane mills
2786. W. H. Aston and S. Hopkinson, Zetland Mills, Huddersfield—Improvements in steam-boiler furnaces and apparatus employed for supplying water to steam boilers
2787. H. Brickley, Stratton, near Cirencester—Improvements in mills for grinding
2788. C. E. Heinke, Great Portland-street—Improved apparatus for illuminating objects beneath the surface of water, or for giving light in mines and other places where combustible or explosive gases exist
2789. J. Orr, Glasgow—Improvements in the manufacture of pile fabrics
2790. G. Sharp and W. Elder, Jarrow, Durham—Improvements in steam hammers and machinery for forging iron and other substances

Dated November 25.

2791. J. Bond, Barnley, Lancaster—Improvements in machinery for counting and indicating the number of revolutions performed by rollers and shafts
2792. H. Bragg, jun., Belfast—Improvements in drying or extracting moisture from air and in machinery or apparatus for starching, clearing, drying, stretching and finishing fabrics
2793. H. Bougleux, Leghorn—Improvements in the construction of steam boilers
2794. R. A. Brooman, Fleet-street—Improvements in machinery for embroidering. (Communication from E. Lebée, St. Quentin)
2795. J. Palmer, Stockton-on-Tees, Durham—Improved means for separating different kinds or qualities of seed or grain from each other
2796. J. L. Elkin, Jeffreys-square, St. Mary Axe—An improved process applicable to the manufacture of zinc. (Communication)
2797. J. Marshall, jun., Selby—An improvement in the purifying of oils and fatty matters
2798. A. V. Newton, Chancery-lane—Improved machinery for forging iron. (Communication)

Dated November 26.

2799. J. Musgrave, jun., Globe Iron-works, Bolton-le-Moors, Lancaster—Improvements in the construction of cloth beams for beetles
2800. J. Brown, Bolton-le-Moors, Lancaster, and J. Adin, Manchester—Improvements in Jacquard machines
2801. L. G. Riant, South-street, Finsbury—An improved mode of preparing whalebone, gutta percha, and other elastic bands employed in the manufacture of wearing apparel
2803. M. Henderson, Glasgow—Improvements in cutting, sawing, or shaping and polishing stone
2805. A. V. Newton, Chancery-lane—An improvement in the process of coating iron bolts, bars, sheets, spikes, nails, and other articles of iron, with metallic alloys, for the preventing of rusting or oxidation. (Communication from J. Poleux, New York)
2806. H. E. Palmer, Stonehouse, Devon—Improvements in photographic apparatus

Dated November 27.

2807. A. Lees and D. Schofield, Oldham—Improvements in self-acting mules for spinning and doubling
2808. P. A. le Comte de Fontainemoreau, South-street, Finsbury—Improved weighing apparatus. (Communication)
2809. W. A. Gilbee, South-street, Finsbury—An improved mode of reefing and reducing topsails. (Communication from I. Boss, New York)
2810. W. Woofe, Weston Birt, Gloucester—An implement for paring land, applicable also to the removing of turf
2811. P. R. Hodge, Albion-grove, Barnsbury-park—Improvements in the manufacture of felted cloth
2812. H. Hedgeley, New-road, Brighton—Improvements in spirit lamps

Dated November 28.

2813. R. Griffiths, Mornington-road, Regent's-park—Improvements in vessels and engines for propelling vessels
2814. P. Walker, Warrington—Improvements in brewing, and in the machinery or apparatus employed therein
2815. J. Higgin, Manchester—Improvements in treating certain vegetable dye-stuffs, or preparations therefrom, so as to obtain a colouring substance of increased purity
2816. C. A. Tissot, South-street, Finsbury—Improvements in the production of motive power, and in the apparatus connected therewith
2817. A. Cellier, South-street, Finsbury—Improved mucilage, applicable to the sizing and printing of textile materials
2818. J. M. Saunders, Menloe Rathgar, Dublin—Improvements in cooking ranges
2819. H. T. Sourbuts, Hyde, Chester—Improvements in taps or valves, parts of which are applicable to lubricators for steam engines, and other purposes
2820. H. Waller, Lickhill, near Calne, Wilts—Improvements applicable to vessels used in the manufacture of cheese
2821. A. Turner, Leicester—Improvements in the manufacture of elastic fabrics
2822. M. Allen, Cavendish-grove, Wandsworth-road—Improvements in the slide valves of steam-engines

Dated November 29.

2823. J. G. Taylor, Glasgow—Improvements in pencil-cases
2824. C. Siemens, John-street, Adelphi—Improvements in fluid meters
2825. J. Dryden, Dundee—Improvements in weaving
2826. W. Johnson, Lincoln's-inn-fields—Improvements in projectiles. (Communication from N. Scholfield, Norwich, Connecticut)
2827. L. W. Wright, Sydenham—Improvements in mahinery for bending plates for the formation of pipes and tubes
2828. L. Stuart, New York—Improvements in machinery for reducing fibres to pulp (Communication from J. Kingsland, jun.)
2829. J. Brown, Liverpool—Improvements in the construction of the lower masts of ships
2830. E. S. Atkinson, Knottingley, York—An apparatus for condensing vapours, fumes, gases, and smoke arising from chemical and smelt works
2831. J. L. Clark, Adelaide-road, Haverstock-hill, Hampstead—Improvements in electric telegraphs. (Partly a communication)
2832. R. Harmer, Princes-street, Spitalfields—Improvements in stereoscopic pictures

Dated December 1.

2833. J. Worthington, Manchester—Improvements in telegraphing and communicating on railway trains
2834. C. Gilks, Union-row, Tower-hill—Improved stand for umbrellas for railway and other carriages
2835. J. C. Jones, Poland-street, Oxford-street—The improvement of the common pin wooden leg and crutch
2836. J. Gedge, Wellington-street South, Strand—Improvements in lubricating the journals of the axles of railway vehicles or other moving parts of machinery. (Communication from A. Macpherson, Brussels)
2837. J. Gedge, Wellington-street-south, Strand—Improvements in gas meters. (Communication from A. Macpherson, Brussels)
2838. J. Hadden, Cannon-row, Westminster—Improvements in pianofortes
2839. J. Gibson, Paddington—Improvements in buffing and drawing apparatus
2840. G. Collier, Halifax, and J. W. Crossley, Brighouse, York—Improvements in apparatus used in hotpressing, and in the means of manufacturing parts of apparatus used for such purpose
2841. E. J. Emmons, Massachusetts, United States—A new or improved nursery chair. (Communication from J. Stevens, Massachusetts)
2842. G. Vertue, Northam, Southampton—Improvement in deodorising sewage waters and sewage matter, when lime is used
2843. F. Peabody, late of the United States, now residing in St. James's-street—Improved apparatus for obtaining motive power by the action of the wind
2844. J. Ramsden, Bradford—Improvements in apparatus or the mechanism of looms for weaving a certain class of plaids, checks, and fancy woven fabrics
2845. H. N. D. Bardot, Paris—Improvements in treating or preparing colours for printing
2846. N. Monnier, Paris—Improvements in bridles and bits for stopping horses

Dated December 2.

2847. E. Dwyer, Woolwich—Improvements in the manufacture of children's chairs
2848. F. Cornwall, Birmingham—Improvements in the construction of fire-places applicable for general purposes, whereby combustion is rendered more perfect and capable of regulation or control, smoke thoroughly consumed, and the draught in open fire-places much increased
2849. J. Longbottom, Leeds—Improvements in apparatus for drying, roasting, carbonising, and calcining vegetable, mineral, and animal substances
2850. R. A. Brooman, Fleet-street—Improvements in pumps and in pumping. (Communication)
2851. R. A. Brooman, Fleet-street—Improvements in bleaching. (Communication from H. Bouchet)
2852. R. A. Brooman, Fleet-street—A chemical composition or agent to be employed in the dyeing of wools and woollens. (Communication from M. Lipman)
2853. R. A. Brooman, Fleet-street—Improvements in pumping engines and in pumps. (Communication)
2854. L. D. Girard, Paris—Improvements in hydraulic turbines
2855. J. Fowler, jun., Havering, Essex—An improvement in the manufacture of wire ropes
2856. J. Apperly, Dudbridge, Gloucester—Improved fabric applicable to the manufacture of feed cloth or aprons
2857. R. Dryden, Kinaston-street, Lambeth, and S. Miles, South-terrace, Willow-walk, Bermondsey—An improvement in the construction of cylinder printing presses
2858. M. Townsend, Leicester—Improvements in machinery for the manufacture of knitted fabrics
2859. A. Bower, Liverpool—Improvements in or applicable to the keels of navigable vessels
2860. J. H. B. Thwaites, Bristol—An improved screw bolt, or fastenings, for ship building and other purposes
2861. F. Siemens, John-street, Adelphi—Improved arrangement of furnaces, which improvements are applicable in all cases where great heat is required

Dated December 3.

2862. J. Mizen, Deptford—Improvements in apparatus for making gas, partly applicable to culinary or other domestic purposes
2863. P. Kürten, Cologne—Improvements in the manufacture of mottled soap and yellow soap
2864. F. A. Gatty, Accrington, Lancaster—Improvements in the construction of filters or drainers
2865. E. Rider, Cannon-street, City—"Improvements in the manufacture or treatment of gutta-percha, being improvements upon the invention secured to me by Letters Patent, dated the 20th day of July, 1852"
2867. A. Bullough and W. Bullough, Blackburn—Improvements in looms
2868. H. Genhart, Liège, Belgium—Improvements in fire-arms and ordnance and of the cartridges or projectiles to be used therewith
2869. J. Denis, Queenhithe—Improvements in apparatus for corking and uncorking bottles without leaving any air between the liquid and cork. (Communication)
2870. J. Deeley, Mile-end-road—Improvements in furnaces for smelting and melting
2871. J. K. Cheetham, Rochdale—Improvements in the application of photographic pictures to metal and other surfaces, and in rendering the same applicable as printing surfaces
2872. W. E. Newton, Chancery-lane—Improved processes for ornamenting metallic surfaces in intaglio, or in relief, for printing purposes. (Communication from C. Nègre, Paris)

Dated December 4.

2873. A. Lecocq, France—Improvements in hydraulic engines
2874. J. Apperly and W. Clissold, Dudbridge, Gloucester—Improved machinery for preparing fibrous substances for spinning
2875. L. Bayer, Soho—An improved stuffing to be used in place of hair or other substances in which such articles are commonly employed
2876. I. Livermore, Shrubland Grove East, Queen's-road, Dalston—An improvement in waterproofing paper
2877. L. C. Stuart, New York—Improvements in drying sized paper
2879. D. Barnard and D. Lichtenstadt, High-street, Whitechapel—Improvements in tanning
2880. J. S. Holland, Woolwich—Improvements in the manufacture of iron, part of which is applicable to other purposes
2881. W. Henson, Buckingham-street, Caledonian-road, Islington, and H. Palmer, Newman-street, Oxford-street—Improvements in sewing or stitching machines
2882. A. E. L. Bellford, Bedford-street, Strand—Improvements in drying, burning, and cooling bricks, tiles, and other ceramic substances. (Communication)
2883. L. J. F. Margueritte, Paris—Improvements in treating or preparing materials to be used in manufacturing retorts, crucibles, bricks, and other kinds of earthenware
2884. D. Crawford, Glasgow—Improvements in washing, cleansing, and preparing textile fabrics and materials

Dated December 5.

2885. R. Davison and J. Crowther, Limerick—Improvements in machinery for winding yarns or thread on bobbins or pirns fixed on spindles driven by gear or cogged wheels, and for winding weft, for either hand or power looms
2886. H. Moore, New Windsor—A boot and shoe stud
2887. W. Kloen, Birmingham, and D. Jones, Liverpool—An improvement or improvements in photography
2888. T. Earp, Newark, Nottingham—An improved cutting apparatus for reaping and mowing machines
2889. A. Grant, Clement's-court—Improvements in shirts. (Communication)
2890. L. P. Kerdyk, Manchester—Improvements in machinery or apparatus for extracting colouring matters to be employed for the purposes of dyeing, or for other similar processes
2891. W. Clyburn, Lombard-street—Improved machinery for making butter
2892. H. Ogden and H. Hibbert, Salford—Improvements applicable to colliery and locomotive engines for the purpose of arresting or retarding their motion at required intervals, and of indicating the amount of work done in relation to such intervals

Dated December 6.

2893. W. Hooper and J. Fry, Mitcham, and G. Nasmyth, Bucklersbury—Improvements in springs for railway carriages, and for other purposes
2894. W. H. Bowers, Gorton, Manchester—Improvements in apparatus to be used for the purposes of distillation
2895. W. S. Clark, High Holborn—Improvements in combined caldron and furnace for agricultural and other purposes. (Communication from H. Newsham, Baltimore, United States)
2896. C. Schiele, Oldham, Lancaster—Improvements in machinery or apparatus for cutting nuts, screws, or bolts, and toothed wheels
2897. J. Perry, Ballymoney, Antrim—Improvements in the treatment, application, and use of mineral tar for the production of oleaginous and lubricating matter and fuel
2898. J. Longbottom, Leeds—Improvements in generating, surcharging, or superheating steam
2899. J. H. Taylor, Bunhill-row, and P. Marcus, Well-street—An improvement in irons for ironing
2900. H. T. Elliston, Leamington—A new or improved method of hanging and closing doors
2901. S R. Smith, Bristol—Improvements in anchors
2902. J. Leslie, Conduit-street, Regent-street—An improvement in stoves and fireplaces

Dated December 8.

2904. G. Collier, Halifax, and E. Heywood, Sutton Crosshills, near Leeds—Improvements in steam boilers and steam generators
2905. R. Eaton, Sussex-terrace, New-road, Battersea—An improvement in the manufacture of springs when india-rubber is used
2906. J. Aston and J. Brant, Birmingham—An improvement in the manufacture of covered buttons and covered ornaments
2907. J. Bertram, Edinburgh—Improvements in steam engines
2908. J. Blain, Belfast—Improvements in Jacquard apparatus for weaving
2909. B. Carless, Birmingham—An improved bird cage
2910. R. F. Miller, Hammersmith—A mode of printing tables of fares, advertisements, notices, tablets, ornamental designs, figures, and other like announcements on painted or other surfaces to supersede writing
2911. E. Burwell, Gainsborough—An improvement in roasters for coffee, cocoa, chicory, and similar substances

Dated December 9.

2912. J. Harris, Frodsham—A pneumatic signal apparatus, and mode of working the same
2913. J. Lilie, Manchester, and A. Dobson, Belfast—Improvements in machinery or apparatus to be used in the processes of drying animal, mineral, and vegetable substances
2914. J. Browning, Minories—Improvements in stereoscopes.
2915. T. Vicars, sen., T. Vicars, jun., T. Ashmore, and J. Smith, Liverpool—Improvements in the manufacture of biscuits, lozenges, and other like articles of confectionery
2917. J. Rawson, Bury—Improvements in lubricators
2919. J. R. Scartliff, Wolverhampton—Improvements in apparatus to be employed as an alarm and detector in cases of burglary
2920. J. Walton, Styal, near Wilmslow—Improvements in tables
2921. W. S. Carr, New York—Improvements in water-closets
2922. E. K. Muspratt, Liverpool, and B. W. Gerland, Hesse Cassel—Improvements in treating waste liquors produced in the manufacture of chlorine, and in separating nickel, cobalt, and copper from liquids containing them in combination with manganese and iron
2923. H. Mollet, Newlay, near Leeds—An improvement in fulling woven woollen fabrics
2924. F. O. Ward, Cork-street, and F. Wynants, Rue de la Paix, Brabant, Belgium—Improvements in the manufacture of manures
2925. J. Thornett, jun., New North-road—Improvements in gas-burners

Dated December 10.

2926. W. Storey and T. Storey, Lancaster—Improvements in forming ornamental devices on the surface of paper and certain prepared woven fabrics
2927. A. Macarthur, Dalsholm Paper Works, Dumbarton—Improvements in boiling, bleaching, washing, or cleansing fibrous materials
2928. W. E. Newton, Chancery-lane—Improved apparatus for supplying steam boilers with water. (Communication)
2929. T. Smith, West Smithfield—An improved joint for folding handles or sticks of umbrellas and parasols
2930. J. Cornes, Swan-lane—Improvements in chaff-cutting machines

Dated December 11.

2931. J. Green. Philadelphia—Improvements in the mode of manufacturing glass lights for street vaults, ships, buildings, and friction boxes, and the apparatus for ladling or conveying the molten glass from one furnace to another
2934. M. Burke, Liverpool—Improvements in mariners' compasses to counteract local attraction
2935. M. Burke, Liverpool—Improvements in the construction of anchors
2936. T. Wheatley and W. Wheatley, Openshaw—Improvements in fog-signals and in the means of working the same
2937. W. W. Reay, Birmingham—An improvement or improvements in shoes for horses and other animals
2938. V. Delperdange, Rue Verte, Schaerbeeck, near Brussels—Improvements in metallic and elastic packing
2939. R. Emery, King-street, St. James's-square—Improvements in the construction of certain kinds of agricultural implements (for breaking clogs of earth and levelling the soil), called harrows
2940. W. Lund, Fleet-street—An improved spring clip, for holding or retaining loose papers, or other loose articles
2941. G. Collier, Halifax—Improvements in machinery or apparatus for the manufacture of piled fabrics
2942. F. W. Anderton and J. Beanland, Bradford, York—Improvements in apparatus or means in connecting with furnaces to facilitate the consumption of smoke
2943. W. C. T. Schaeffer, Great Winchester-street—Improvements in distilling fatty and oily matters
2944. W. P. Miles, Patent Lock Factory, Forest Hill Station, Brighton Railway—Improvements in locks and fastenings. (Communication from Mons. Motheau, Paris)
2945. C. Humfrey, The Terrace, Camberwell—The application and use of paraffine in the manufacture of hair-oils, ointments, and plaisters for medical purposes
2946. H. King, Frome, Somerset—Improvements in machinery for thrashing and dressing wheat and other grain
2947. W. C. Cambridge, Bristol—An improved construction of portable railway
2948. L. J. F. Margueritte, Paris—Improvements in purifying rock and sea-salt

Dated December 12.

2949. P. A. le Comte le Fontainemoreau, South-street, Finsbury—Improved railway signal apparatus. (Communication)
2950. J. T. Wright and E. P. Wright, Birmingham—A new or improved manufacture of ropes, cords, lines, twines, and mill bandings
2951. R. L. Giandonati, St. Paul's Churchyard—Improvements in over shoes. (Communication)
2952. E. Panton and C. F. Walsh, Perth—Improvements in apparatus for charging and capping the nipples of fire-arms
2953. W. Foster, Black Dike Mills, Bradford—Improvements in petticoats
2955. J. Cawood, J. Beeson, W. Smith, and R. Henchley, Derby—Improvements in the valves of steam-engines
2956. J. Headley, Walpole, Haldimand, Canada,—An improved mode of manufacturing artificial granite in various forms, and plating or veneering the same with marble, so as to present an exterior of marble and an interior of stone or granite
2957. H. Pease, Pierremont, near Darlington, and T. Richardson, Newcastle-on-Tyne—Improvements in the manufacture of compounds of alumina
2958. S. Newington, Ticehurst, Sussex—Improvements in hand hoes and cultivators
2959. W. B. Birkby, Upper Rawfold Card Works, Cleckheaton, near Leeds—Improvements in the manufacture of pointed wire fillets used in the preparation of flax, tow, hemp, and other fibrous substances
2960. G. Sherwin, Waterloo-road, Burslem—Improvements in the manufacture of fire bricks, tiles, crucibles, and other articles, when fire-clay is used
2961. G. T. Bousfield, Sussex-place, Loughborough-road, Brixton—Improvements in looms for weaving cut piled fabrics double. (Communication from E. B. Bigelow, Boston, United States)

Dated December 13.

2963. J. Smith, Failsworth, near Manchester—Improvements in Jacquard machines for weaving
2964. L. Braun, Wood-street, City—Improvements in caps and such like articles
2965. J. Metcalf, Newton-heath, near Manchester—Improvements in the manufacture of alum or sulphate of alumina
2966. H. Wickens, Tokenhouse-yard—A throat guard or apparatus for protecting the throat against garotting or other external violence
2967. J. Wadsworth, Haselgrove, near Stockport—Improvements in heating and ventilating apartments, buildings, and ships, and in apparatus applicable to and to be used for such purposes
2968. G. Littlewood, London-wall—Improvements in printing geometric patterns
2969. A. Turner, Leicester—Improvements in the manufacture of elastic fabrics

Dated December 15.

2970. J. Grant, Hyde-park-street—Improvements in heating or cooking by gas, and in apparatus for effecting the same
2971. J. Millner, Charlwood-street, Pimlico—Improvements in chimney cans or caps
2972. L. D. Jackson, Underwood, Nottingham—A pneumatic break or apparatus to be attached to railway carriages or trucks for the purpose of retarding or stopping the same
2973. A. F. des Corats, Rue des Trois Pavillons, Paris—Improvement in lamps
2974. A. V. Newton, Chancery-lane—Improvements in machinery for boring, turning, tapping, and screwing fittings for gas, water, steam, and other pipes, and in vices for holding the same while they are operated upon. (Communication)

Dated December 16.

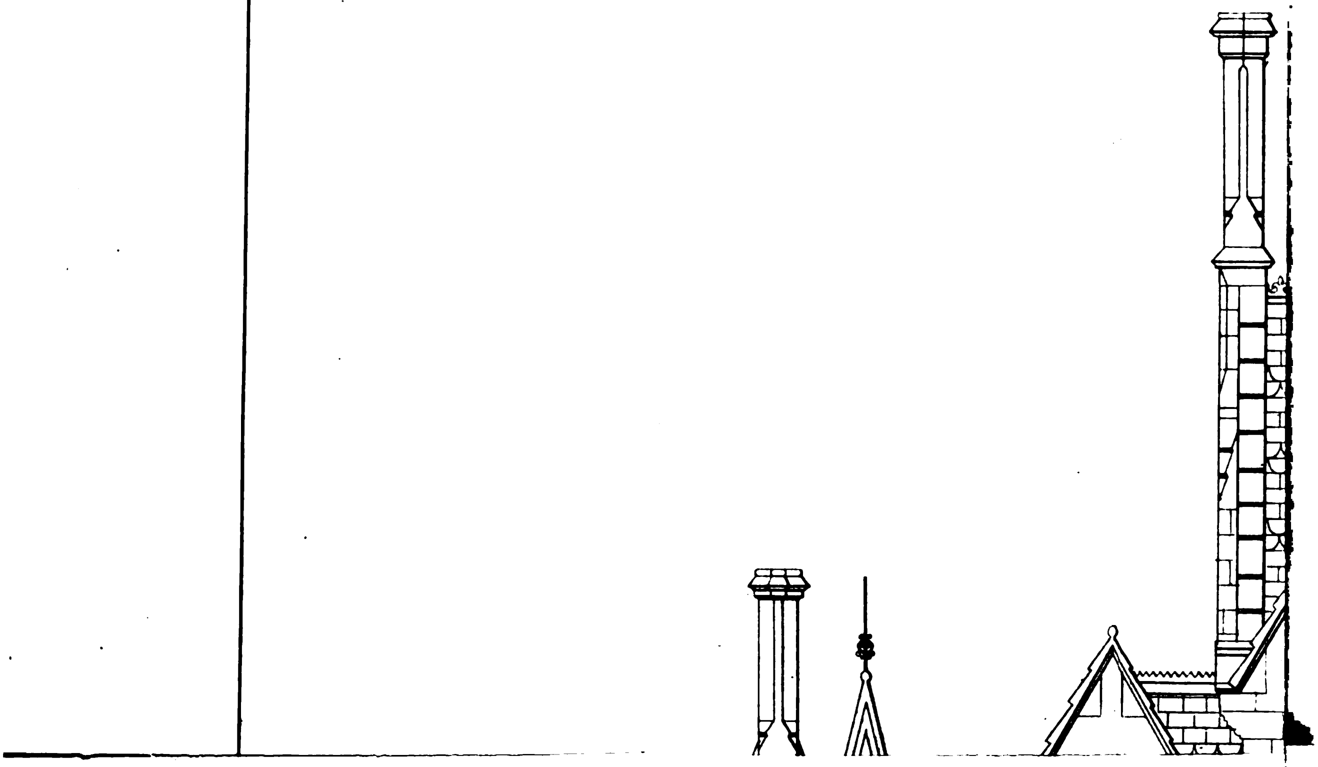
2975. W. Austin, Upper Portland-place, Wandsworth-road—Improvements in pipes or tubes, and in the method of joining and laying the same
2977. E. Heywood, Sutton Crosshills, near Leeds—Improvements in machinery or apparatus used in weaving
2979. W. Carwood, Back Church-lane—An improvement in steam-engines
2981. J. Stobo, Leven Bank Works, Dumbarton—Improvements in lifting or forcing corrosive or chemical liquids
2983. W. E. Newton, Chancery-lane—Improved process or processes of treating feldspar so that it may be used as a manure, or for obtaining potash or soda therefrom. (Communication)

Dated December 17.

2989. W. E. Newton, Chancery-lane—Improvement in the manufacture of table knives. (Communication)
2991. J. H. B. Thwaites, Bristol—New or improved machine or apparatus for holding postage or receipt stamps, and applicable wholly or in part to other similar purposes

PATENTS APPLIED FOR WITH COMPLETE SPECIFICATION.

2878. E. D. Draper and G. Draper, Massachusetts—New and useful improvements in oil feeders, vessels, or cans for oiling machinery.—December 4.
2933. L. Vignat, Paris—A new slide beater with one or more shuttles applicable to any loom whatever for weaving all kinds of tissue—December 11
3027. D. West, Egremont-place, New-road—Improvement in presses constructed to operate by a combination of iron levers, which presses are employed to compress bales of cotton, hemp, wool, and other articles of merchandise—December 22.



BRISTOL WESLEYAN DAY SCHOOLS.

(*With an Engraving, Plate* IV.)

The Bristol Wesleyan Day Schools are to be erected near North-street, and are intended to contain accommodation for upwards of 500 children of the poorer classes on the Glasgow training system. The plans have been submitted to, and received the sanction of, the Committee of Council on Education and of the Wesleyan Educational Committee.

The walls are intended to be of pennant stone with freestone dressings, and the roof will be covered with ornamental tiles. The height of the ground story is 14 feet, and the upper story is 16 feet high to the wall plate and 28 feet high to the ceiling joints, the room being ceiled at the level of the collar beam. The whole of the extensive walls are plastered. An extensive play-ground in front of the schools will be provided with swings, &c., and covered play sheds will be erected at either end for boys and girls respectively.

The cost of the building, exclusive of boundaries, play sheds, &c., will be about £2500. The architects are Messrs. Foster and Wood, of Bristol.

CONSTRUCTION OF ARTILLERY.

SIR,—I claim permission to reply to some remarks in the reviews which have appeared in the October and November numbers of your *Journal*, of my work, "On the Physical Conditions involved in the Construction of Artillery."

(1.) Your reviewer starts with affirming, that "though by the title of this work it would appear to treat solely of the strength and construction of cannon," yet "Mr. Mallett's principal object was to advocate a system of his own for the construction of guns." That is, I am charged with advocating a hobby of my own, under a false title to my book. I deny the accusation, and appeal to the book itself for my vindication. A fair reviewer usually lets an author himself state his "principal object." I have done so thus in my preface: "It became evident that progress and improvement (*i. e.* '*in the existing method* of construction of ordnance') must come, in the first instance, not from questions as to methods of operation, but by the establishment of principles; that *a science of gun founding* yet required to be formed and systematised, and that this must commence with a more searching and exact discussion of the properties of the constructive materials for ordnance—in strict reference to their purpose and application—than had yet been given by any one;" and so far from the particular construction which I have suggested for wrought-iron guns, and those only constituting the principal object of my work, it is no more than incidentally arrived at as a method by which the otherwise insuperable difficulties of constructing wrought-iron cannon of large calibre in one mass or forging, may be met. Yet, apparently for no better reason than because this occurs near the end of the work, it is thus gratuitously and falsely affirmed to be the principal object of a book which, well or ill, embraces the whole range and subject of artillery construction, and impartially discusses every known method.

(2.) Upon the mathematics employed in this particular fragment of the work your reviewer has spent most of his critical thunder —at least one-half the first review is occupied with a flourish of symbols, ending in an equation identical with one in the work; the remainder, so far as the theoretic question of elasticity in relation to "built-up guns" is discussed, might be safely left to the reply of my friend, Dr. Hart, in page 389, &c., of your November number.

(3.) Those who are mathematicians, and acquainted with the subject, will not be misled by the references made to experimental data which have no existence. Your reviewer, when challenged by Dr. Hart to name his experimental authority upon which he affirmed that "when the cubical extension is introduced, the additional tension is approximately in a constant ratio (E) to the cubical extension"—and to give a value for the coefficient E, experimentally obtained, for any of the most ordinary constructive materials—is only able to reply, that "in reality, *analogous* experiments have been made," and that "some account of the literature of the subject may be found" in Mr. Maxwell's Paper, Vol. xx. Edin. Trans., and Mr. Rankine's, No. xxv. Camb. and Dub. Math. Jour.

The former most valuable memoir I have more than once referred to in my work, and I affirm that neither in that paper (which is almost purely theoretic, and not experimental,) nor in the published works of any physicist up to this day, is a single experiment to be found from which any value (much less a reliable one) for the coefficient E, for wrought-iron, can be obtained; but this is the only experimental datum we are here concerned with.

Now admitting, *argumenti gratia*, that the reviewer's calculations were in all other respects unobjectionable, the whole force of his objections to the proposed construction of built-up wrought-iron guns is based upon the assumption that the value of the coefficient E is such, for rolled wrought-iron, as practically to affect the results, as indicated by Dr. Hart's formula adopted by me;—in other words, that the normal compressions are actually sufficient in amount practically to affect the tangential strains, and therefore may not safely be neglected. I believe there is no engineer, nor any physicist, acquainted with such experimental data as we *do* possess upon the extension and compression of wrought-iron, but will at once admit that its cubical bears so small a ratio to its lineal compression or extension as not sensibly to affect the result in the case under consideration. No one knows what the exact cubical compression or extension of wrought-iron is—it can only be rudely guessed at.

(3.) But again—assuming for a moment that your reviewer is quite right. Upon his own assumption and calculation, a built-up wrought-iron gun, of a given calibre, must be, for equal strength, one-third thicker than a common gun (*i. e.* of one piece) of the same calibre. Now, the entire aim and object in view in adopting built-up guns is here ignored: that object is to escape thus the difficulties due to forging in one mass, the chief of which is the want of uniform disposition of the fibre of the iron in a large forged gun, in directions all either lengthwise, or wrapping around the circumference of the gun; instead of which we obtain a confusedly crystallised mass, like cast-iron. Hence the rolled wrought-iron bars or hoops of the built-up gun are practically (nay, actually) a different material in respect to strength, from the forged gun, taking equal sections.

(4.) In page 113 of my work, you will find that this difference in strength is something like *seven to one* in favour of the rolled iron constituting the material of the built-up gun. If, therefore, according to your reviewer, the thickness of the common to that of the built-up gun, must be for equal strength, and of the *same material*,

$$\text{as } 2 : 3,$$

from the greater tenacity in the right directions of the material of the built-up gun, the thicknesses will be

$$\text{as } 2 : \tfrac{3}{7}, \text{ or as } 2 : 0{\cdot}43.$$

So that even upon his own showing (if he will keep in mind the condition upon which the built-up gun is proposed), it will have equal strength with a common gun of the same calibre, at *less than one half the thickness*. A good sample this of what mathematics are worth when applied without attention to essential conditions.

(5.) Time and your space would not admit of my following all the paragraphs of your reviewer in which there is other ground for objection.

If, for example, "it is demonstrable that the explosive force p can never be so great as the tension of ultimate rupture," how is it that any gun ever bursts?

With a rather pedantic supercilium, the reviewer accuses me of not knowing the difference between *vis viva* and *momentum*. Thus he says, P and P′ being the weight of the shot and gun, my expression, $\frac{P}{g}v^2 = \frac{P'}{g}v'^2$, "is clearly wrong, and should be the momentum of the shot = that of the gun. Both are true; and it may comfort your reviewer to hear that my expression in this instance is identical with the quotations given by Generals Piobert and Morin, who always use those for *vis viva*, and not for *momentum*, in treating questions of recoil; and that for reasons so obvious, that it is surprising they should escape so precise a mathematician.

(6.) Again, at page 134, I do *not* say that Mv^2, "the *vis viva* of recoil is transferred as a pressure against the interior of the breech," but that "the latter," namely, the recoil itself, is so transferred.

Charges of schoolboy errors ought not to be made upon readings so grossly careless and incorrect. It is not worth while, however, to pursue these remarks further. A critical fills a high office;—he is as a trustee between author and public: but he mistakes his office and abandons his trust, when, in place of regarding the main design of his author or its degree of fulfilment, he is occupied in showing the glitter of his own weapons, or in trying to pick holes in some miserable fragment disjointed from the entire.

(7.) Allow me to add a few words upon a part of your second notice of my work, p. 367 of your November number.

The difficulty that you have raised as to my views of the law of crystalline aggregation of cast-iron, is all based on the assumption that in dense coherent cast masses the integrant crystals are octohedrons. You say I state them to be so in page 21. Refer to the page, Sir, and you will find this again is a mistake and misquotation on your part. The passage refers to the *loose* crystals often *lining the cavities* in castings, and to none other. The sense in which I use the term, "principal axis of the crystal, is, I believe, clear, from paragraph 16, page 9, of my work; and even from that of the note, p. 213, which you print, in which there is no *petitio principii*. If correctly read, what it affirms is embraced in two propositions:

1. That the symmetric axis of the integrant crystals is coincident with the direction of emergence of the heat wave.

2. That this direction is also that of least pressure within the contracting and cooling mass.

Iron, whether cast or wrought, never is found crystallised in mass in octohedrons—albeit that such may be one of its primary forms;—it is dimorphous.

I shall not attempt to enter further here upon any discussion of my views of crystalline aggregation in mass, as unsuited to the brevity with which such a subject must be treated in your pages. I believe they will be done full justice to, and accepted by those who will take the trouble to master them; and that their practical importance will be increasingly recognised, not only as applicable to the construction of artillery, but in every structure, civil or otherwise, into which crystallised bodies enter as materials.

I am, &c.,

ROBERT MALLET.

*** In the number of this *Journal* for November was published a letter from Dr. Hart, of Trinity College, Dublin, replying to our strictures on his investigation in the appendix to Mr. Mallet's 'Treatise on the Construction of Artillery.' Knowing Dr. Hart's scientific attainments, we premised to our answer in the following number of the *Journal*, that we felt "none of that reluctance in engaging in controversy with him which we should feel if arguing with an opponent who substituted crude physical conceptions for an exact knowledge of mechanical science." These words were dictated in the hope—too sanguine as it now appears—that Mr. Mallet had left the defence of his cause in Dr. Hart's hands.

(1.) We print the letter which we have received from Mr. Mallet, without alteration except that we have ventured to prefix numbers to the paragraphs of his letter, referred to in the corresponding paragraphs of this reply. In the paragraph numbered (1), we are accused of mis-stating in our review the "principal object" of Mr. Mallet's work. On turning to that review it will be found that we expressly acknowledged that, though, "by the title of this work, it would appear to treat solely of the strength and construction of cannons, the investigations into which the author enters relate to subjects of the highest importance to the civil engineer and student of the general theory of the strength of materials;" and we added that the subjects "of which this volume treats are subjects of very general interest."

We cannot therefore have greatly wronged Mr. Mallet, even if we have erred, as he says, in stating that the principal object of his work is to advocate a system of his own for the construction of guns. As far as we are aware, he has nowhere in his work stated explicitly the principal object of it, unless it be in the first page, in which is a dedication in large type to the "Prime Minister," in these words:

"My Lord,—By your kindly-expressed permission, I adorn this volume with your name; in remembrance of my owing the approaching trial of a project for the improvement of ordnance to the attentive and intelligent consideration of its design by your Lordship, and in homage to a long career of able and faithful service as a statesman of the British Crown. The investigations in these pages were partly made in preparation of my designs before you, and their upshot might perhaps be epitomised in the motto of your Lordship's house—'*Flecti non Frangi*.'—I have, &c."

It appears, then, that the "upshot" of Mr. Mallet's investigations is epitomised by the words, "to be bent—not broken," which clearly refer to the use of wrought-iron, and the project mentioned in the first sentence of this dedication. It might be reasonably inferred, we think, that Mr. Mallet's principal object was the advocacy of the project in question. However, he must know his own motives better than any one else, and he has now had the opportunity of setting himself right with our readers on this momentous topic.

(2.) Mr. Mallet does not appear to have read—at least he does not notice—our answer to Dr. Hart, in the December number of this *Journal*. That answer showed that Dr. Hart had arrived at his main conclusion (as to the possibility of constructing guns of uniform tension) by a *petitio principii*, *i. e.* by assuming a quantity to be constant which he intended to demonstrate to be so. The accidental slip in his reasoning was one of those to which the most practical mathematicians are, notwithstanding the utmost care, occasionally liable.

(3.) Mr. Mallet asserts, with quite as much confidence as discretion, that the whole force of our "objections to the proposed construction of built-up wrought-iron guns is based upon the assumption that the value of the coefficient E is such, for rolled wrought-iron, as practically to affect the results, as indicated by Dr. Hart's formula adopted by me." It seems sufficient to reply to this by the following quotation from Dr. Hart's letter to us (*ante* Vol. XIX. p. 389): "Since by your subsequent hypotheses you eliminate E, I suppose we may conclude that the result would continue to hold if $E = 0$." Our results, as Dr. Hart remarks, do not in the least depend on particular values of E, the coefficient of cubic compressibility. Moreover, we have given in our reply to Dr. Hart, what we believe to be a rigorous demonstration, on the hypothesis that E is negligible, of the impossibility of constructing a gun so that it shall have uniform tension when subject to explosive force. We consider it therefore demonstrated, on both assumptions as to the law of elasticity (*i. e.* the common one adopted by Mr. Mallet, which neglects E, and the more accurate one which takes E into account), that his "project" is a physical impossibility.

(3.) Mr. Mallet says, "the entire aim and object in view in adopting built-up guns" are "to escape thus the difficulties due to forging in one mass." We thought that one of his objects was increase of strength. The practical advantages of forging in several parts we readily admit to be considerable, if they can be obtained without loss of strength; and it was to the latter subject alone that we explicitly confined our investigations.

(4.) At page 113 of Mr. Mallet's work, he refers to the relative tensile strength of wrought-iron in the direction of its fibre and across it. He then draws a conclusion as to the increase of strength of guns, in which the explosive strains are all resisted by wrought-iron in the line of fibre. Even supposing he has correctly estimated this increase, it will not follow that it is due to the peculiar method of construction advocated by him. The peculiarity of his method is, we believe, the superposition of rings successively "shrunk on" at different temperatures. It was to the value of that novelty that we confined our attention. The use of guns which resist the explosive strains by tension of iron in the direction of its fibre, is no novelty. Of the construction of wrought-iron hooped guns there are innumerable examples, ancient and modern.

(5.) The quantity p, to which Mr. Mallet refers, is used throughout our investigations to denote an explosive force which a cannon may bear without rupture. Anything more than the most superficial knowledge of the theory of the tension of vessels would have prevented him from combating the proposition to which he here objects.

(5.) Mr. Mallet says that the equation

$$\frac{P}{g} v^2 = \frac{P'}{g} v'^2,$$

and the proposition that the momentum of the shot = that of the gun, are both true. The latter proposition gives

$$P v = P' v',$$

whence, comparing with the former equation, it follows that

$$v = v',$$

or the velocity of the ball's projection is equal to that of the cannon's recoil! We really ought to apologise to our readers for taking up space by exposing blunders so gross. No references are given to passages of the works of Piobert and Morin by Mr. Mallet, but it is clear enough that he must have misapprehended those authors.

(6.) Mr. Mallet says we have mis-stated his meaning at page 134 of his work, and that it is not the *vis viva* of recoil, but the recoil itself, which is transferred as a pressure against the breech. Both expressions are alike incorrect. To say that either the velocity of recoil, or the *vis viva* of that velocity, is a pressure is to confound the measure of finite force with measures of dynamical effects, dependent on another element besides force—namely, time. Mr. Mallet takes no notice of the other blunders which we exposed in this passage of his book—unless the remark, about "trying to pick holes in some miserable fragment disjointed from the entire," refers to them. Surely we should abandon the trust of which he speaks so loftily, if, discerning errors which show an utter confusion of the elementary principles of dynamics, we failed to apprise our readers of them.

(7.) Mr. Mallet says that our objection to his "law of crystalline aggregation of cast-iron" is all based on the assumption, that in dense coherent cast masses the integrant crystals are octohedrons," and that iron is not "found crystallised in mass in octohedrons, albeit that such may be one of its primary forms—it is dimorphous"—(*i. e.* has two forms.) What is the second form? All the crystals of iron certainly belong to the cubical or octohedral system, and therefore have *three* rectangular equal axes. These are axes of symmetry; and the difficulty arose from the circumstance of Mr. Mallet speaking of the axis of the crystal as *one*, whereas it has three axes. If symmetric axes of cubical or octohedral crystals be *coincident* "with the direction of emergence of the heat wave," as is here stated, they have also axes *perpendicular* to the direction of that wave; so that the law, as so announced, gives no information as to the position of the "planes of weakness," which that law was intended by Mr. Mallet to define.

NEW SOURCE OF POWER.

The many attempts that have been made to apply electricity as a motive power, and as a means of illumination, have hitherto failed, chiefly from the want of some cheaper means of exciting that force; for the cost of the voltaic batteries employed to produce a given effect, has greatly exceeded the cost of steam or of gas. A cheaper mode of exciting electricity is all that is required to render it extremely serviceable in many departments of the arts, and numerous attempts have consequently been made to attain that object. Considering the many sources from which it is known that electricity can be obtained, any day may bring to light some means of rendering the power practically available. It is well known that a locomotive engine generates, at every yard of its progress on a railway, an amount of electricity enough to kill all the passengers in its train. During the burning of a candle, also, chemical actions come into play sufficient to produce an abundant supply of electricity, if the means could be discovered of developing the power which is thus imperceptibly generated. The movement of bodies in close proximity to magnets has been made to develope torrents of electricity; and Professor Faraday has shown that the immersion into acidulated water of minute lengths of zinc and copper wire, generates, in less than a minute, as much electric force as is developed during a powerful thunderstorm. With these and other known means at command, it, therefore, seems very probable, that ere long the sought-for supplies of power and of light may be obtained at a rate more economical than either steam or gas; and when that is accomplished, social changes as great as those produced by steam locomotion, or by gas lighting, would shortly be the consequences.

Among the means of accumulating cheap stores of electricity that at present give most promise of practically useful results, is the extraordinary development of power in the induction-coil invented by M. Ruhmkorff, of Paris. The common medical-coil machine is a miniature representative of that apparatus, and the effects have been so much increased by recent improvements effected by Mr. Hearder, of Plymouth, as to place the improved apparatus nearly as much above M. Ruhmkorff's, as the latter is superior in power to the medical induction-coil.

The operation of this class of apparatus depends upon bringing into action the secondary current, which is always induced when contact is made and broken with a voltaic battery. As the apparatus has been hitherto constructed, even with Mr. Hearder's improvements, no direct use is made of the current of electricity primarily excited by the voltaic battery, the effect being entirely produced by the induced current transmitted through the second wire, which is coiled round the one that conducts the electricity of the battery. The power thus manifested seems, therefore, to be a clear addition to that of the direct action of the voltaic battery; and the effects it produces, by the action of a small number of zinc and copper plates, greatly exceed in intensity any that can be otherwise obtained from the most powerful voltaic combinations, or from the largest electrical machines.

In the construction of the improved induction-coil, the thick wire through which the voltaic current is transmitted is wound round a wooden hollow core, about 10 inches long, and over that is placed a gutta-percha tube, on to which there is wound about three miles of fine copper wire, about the thickness of sewing silk, well insulated by silk and varnish. To this apparatus is applied a spring armature, that automatically breaks and makes contact upwards of a thousand times in a second; and at each break of contact through the primary wire, a current of electricity is induced in the long coil of thin wire. Mr. Hearder has ascertained that the electricity excited by this apparatus when actuated by a voltaic battery of twelve cells, exceeds that excited by 800 plate electrical machines, each 2 feet in diameter, and kept in brisk action. Metals were melted with great facility, and torrents of brilliant sparks, 3 inches long, passed between the terminals of the secondary wire.

These effects are, in addition to the electricity, due to the direct action of the battery, and the force is thus exhibited in a form infinitely more intense than when transmitted through the wires connected with a voltaic battery in the ordinary manner, however large or numerous the series of plates may be. It is a peculiarity, also, of these secondary currents, that they may be developed either in a form of great intensity so as to give powerful shocks, or in large quantity so as to fuse metals, by proportioning the thickness and length of the wire to the effects required. The excitement of electricity by secondary currents was discovered by Professor Faraday not many years ago. We have seen him wrapt in admiration at the phenomena discovered by himself, as exhibited in Ruhmkorff's induction-coil. These phenomena have been much exceeded by the improved apparatus of Mr. Hearder, and the principle seems capable of being further applied so as to become practically useful.

STREET PAVING.

In addition to the subterraneous drainage which has occupied the public attention so much of late, we are happy to find that an effectual remedy seems to have been at length provided for the evils of mud, dust, noise, and danger to horses, so complained of in the thoroughfares of the metropolis. This remedy is proposed to be effected by what is termed a composite paving, patented by Sir John Scott Lillie.

The component parts of this paving are wood and granite, in alternate rows, formed into blocks of about 2 feet in length by 1 foot in width, and 8 or 9 inches deep, cemented with asphalte. The materials are rendered impervious to water by bituminous cement, which gives them the advantages of freedom from dust, mud, noise, and danger to horses; and by being formed into blocks of about 2 feet square, facilities are afforded for removal and re-laying, when access to gas or water mains is rendered necessary. The durability of the materials appear, moreover, to be very considerably increased, if we may judge from specimens that have undergone severe tests by heavy wagons in coal-merchants' yards for the last three years, without any apparent injury; and from a specimen laid down at the commencement of last year at the Holborn end of Southampton-street, Bloomsbury, which has been subjected to heavy traffic leading to the Euston-square railway station, and to the whole of the traffic of Holborn, which was diverted into that street while Holborn was being repaired during the commencement of last summer.

When the surfaces of our streets are thus relieved from the evils adverted to, and our subterraneous drainage carried off to the sea, as contemplated by our Metropolitan Commissioners, and the polluted waters of the Thames also purified, the inhabitants of this great emporium of traffic will have reason to be grateful.

MODE OF TIMBERING SHAFTS.

A lecture was lately delivered by Mr. Warington Smyth at the Government School of Mines. The difference between the various modes of timbering shafts in the several localities in the coal districts was pointed out, and instances were shown of the Northern and Somersetshire collieries. A knowledge of the methods of timbering was highly essential to the miner, and as this portion of mining was very expensive, it was requisite that the agent should be perfectly acquainted with the strata, so as to be able to economise with a due regard to safety. In the mines in the Hartz Mountains, and at Schemnitz, the shafts were very large; timber there was plentiful, and could be obtained at a cheap rate, and, consequently, was not so great an object. In some cases, as with sewers, water-works, and military mines, where it was not required the shaft should last for a considerable time, only slight timbering was needed. Diagrams and models of the various modes of temporarily timbering shafts were then shown and described. Mr. Smyth observed that in our metalliferous mines in Cornwall some good examples of timbering could be seen, and the Cornish method was much more secure than that practised in Cumberland and Lancashire. The difference between the two systems was illustrated by diagrams and models, and a well-executed model of a mine in the Ulverstone district, explanatory of the mode of timbering levels and shafts, was on the table, and described. There had been a great difference of opinion as to whether it was better to sink a shaft perpendicularly or on an incline; in some cases the latter was considered preferable where it was on the underline of the lode, but in general it was thought, if properly constructed for the purpose of drawing as well as for other conveniences, that a perpendicular shaft was the most economical; in an inclined shaft the caps have a greater tendency to break. The shaft at Andreasberg, in the Hartz, was 410 fathoms in depth, and it had been found here that the timber had been preserved by occasionally being moistened by cold water. This was considered of so much importance that pipes had been carried down from the surface, and at intermediate places plugs had been drawn, and the timber watered, much in the same manner as if the rose of an engine had been applied. It was found that this mode of irrigating the timber preserved it for a length of time, and in his opinion the preservation and economisation of timber had not received the attention that such an important subject merited; owing to the influence of hot air, and other causes, it was liable to decay.

SELF-INDICATING BALANCE BAROMETER.

M. Secchi, of Rome, has recently invented a new construction of barometer, which possesses the advantages of not being liable to be broken, of giving the readings exact which aneroids and others do not, and of recording those readings by self-acting mechanism. M. Secchi says that all improvements hitherto have been limited to the employment of large tubes to avoid the evils of capillary attraction, and to the obtaining of greater exactitude in the readings. All attempts to make the instrument graphic —that is to say, self-acting to record the different variations, and to make the indications more minute—have not yet been successful. The principles on which the new barometer is constructed will be understood by the following statement:—Suppose the cuvette of a barometer to be placed on a table and the glass tube so arranged as to admit of its being lifted by hand. The force that will be required to lift the tube will be equal to the weight of mercury in the tube, or in other words, to the amount of atmospheric pressure exercised on the mercury of the instrument. We shall therefore be able to really weigh the pressure of the atmosphere by attaching the barometer (the tube only) to one end of a balance, and weights to the other; for it is evident that at every change in atmospheric pressure a corresponding increase or decrease in weight will have to be made at the other end of the balance to maitain equilibrium. To ascertain the value of absolute pressure on a unity of surface, it will be necessary to take into consideration the weight of the tube, and also of the weight of that portion thereof which is immersed in the mercury contained in the cuvette, and especially the internal sectional area. The knowledge of the latter, so far from being an obstacle, is a positive advantage in construction; for, by increasing the sectional area, the force that actuates the instrument will also be increased, and will consequently permit of more exact and more readings. If the sectional area be 10 square centimetres, and the pressure varies by centimetres in height, the weight to be placed at the other end of the balance will be that of 19 cubical centimetres of mercury, or 135 grammes; while, if the sectional area had been equal to one square centimetre only, the weight would have been but 13·5 grammes.

Starting from these observations, M. Secchi adopted the following construction for his barometer, which has been made and used in the observatory at Rome. The barometrical tube is attached to one end of a steelyard or balanced lever, which carries at the other end a counterbalance weight and a pointer, 15 millimetres, or ⅝-inch diameter, which is reflected in a mirror. This mirror also reflects a graduated scale, so that the variation of 1-10th of a line of the pointer is indicated by a movement of six lines on the reflected image. The writer enumerates the following advantages peculiar to his invention:—1. As the atmospheric pressure is weighed, and not indicated by the height of the column of mercury, the tube may be constructed of any non-fragile material, such as iron, which does not amalgamate with the mercury, provided the bore is of equal diameter throughout. 2. By increasing the sectional area of the tube, the additional weight will give sufficient motive power to a pencil attached to the other end of the lever to mark the variations of atmospheric pressure. 3. By the intervention of suitable gearing, the scale of observations may be augmented without inconvenience or danger to the exactness of the instrument. 4. The new construction is independent of the form of the miniscus, of the purity of the mercury, of its specific gravity, and of the temperature and difference of gravity peculiar to different latitudes, for all these qualities exercise influence upon the volume of mercury, and on the height of the column of mercury in the tube, which has to be measured to obtain the weight of atmospheric pressure, whereas, with the new instrument, the weight is given at once. Another advantage of employing iron for barometrical tubes is, that there is no danger to fear from the adhesion of air or moisture, and that the mercury may be boiled without fear of bursting. Iron barometrical tubes will likewise permit of other fluids being employed, and probably advantageously, instead of mercury. The writer further states that he invariably found his new barometer indicate variations of atmospheric pressure before ordinary barometers did so, and that by avoiding loss from friction, most exact instruments may be produced. The perusal of the description of this ingenious invention has suggested its application to some practical purposes, which are submitted to the attention of engineering and scientific men. The suggestion has for its object to construct—

Audible or Danger-Signalising Barometers, which, if placed on board a ship, would tell the captain and the whole crew of the approach of storms; or which, if placed in mines, would warn miners and inspectors of the presence of fire-damp, as well as indicate its precise locality. For this purpose it would be only necessary to employ a weighing barometer, the pointer of which was composed of some suitable conducting material, but insulated from the rest of the instrument. The pointer should be in communication with one of the poles of an electro-magnetic battery. The dial, over the face of which the pointer would have to travel, should be composed of glass, or other suitable non-conducting material, with metallic points inserted at those gradations which indicate dangerous variations of atmospheric pressure. These points would have to be placed in communication with the other pole of the battery. The reader will readily see, by this arrangement, that when the pressure of the atmosphere shows the presence of danger, either at sea from storms or squalls, or in mines from the accumulation of carburetted hydrogen gas, the pointer will come in contact with the metallic danger-point in the face of the dial, and so complete the electric circuit, which would have the effect, by the intervention of the ordinary or well-known apparatus, of sounding an alarum, either by ringing a bell or exploding gunpowder. The arrangements may be varied to suit the particular case, by making the dial of some conducting material, and the danger-points of non-conducting materials, so that it would be the breaking of the electric circuit that would give the alarm. In the case of ships, the barometer might be placed in the captain's cabin, with an alarum there, and another on deck near the wheel. While in mines, a barometer should be placed in every gallery, with an alarum to warn the miners who might be there; and it should also be in communication with an alarum and corresponding dial indicator at the mouth of the pit, so that the overlooker might at all times know the state of the atmosphere in every part of the mine, and be duly warned.

ST. JAMES'S PARK.

St. James's Park at the present time looks almost in a hopeless condition. It seemed at first sight easy enough, after the new sewer was made, to drain the water from the lake and to level it; but no sooner was the work commenced, than an immense number of copious springs were tapped, which being below the level of the outfall, could not be carried off by the ordinary methods. It was found necessary to sink a sumph or a well, at the end of the lake opposite the Horse Guards, to receive the produce of these springs, and to erect a double-action pump, worked by steam, to lift the water into the new sewer. It has also been found requisite to lay down three lines of 12-inch drain pipes along the bed of the lake, to conduct the water to the well, instead of through cuttings, as was originally intended. These pipes are now being covered up with earth to within 5 feet of the surface, which will then be covered over with concrete of a uniform thickness. When the whole of the bed of the lake is thus completed, the well will be filled up with concrete also, and then the outfall into the sewer will be sufficiently high that the water at any time may be drained off by gravitation, so that, if necessary, three or four times a year, with the assistance of some dozen men, the lake may be cleansed in a single day.

The works are now proceeding rapidly, and that portion of the lake between Buckingham Palace and the proposed new bridge is nearly levelled. About a hundred men are at work, and great efforts are being made to complete the works by the end of April. The excavations for the foundation of the new bridge have been sunk, and the basements of the bridge will be immediately finished. The contractors, after digging 5 or 6 feet, came to a bed of solid peat of some 5 feet in thickness, which cut like so much cheese, and below this some powerful springs were tapped; which compelled the erection of double-actioned pumps, that are now in full operation.

PROPOSED NEW SUBWAYS.

On the 16th ult., the Metropolitan Board of Works came to a determination to refer the question of subways under the proposed new streets in Southwark and Westminister to a committee, to advise as to the best course to be adopted. The subject at first sight seems a simple one, but in practice it is found full of difficulties. The French Emperor, in the new streets that have been formed in Paris, has ordered the construction of subways, for the purpose of laying the different pipes for sewage, water, gas, and telegraphic wires; but although these streets are far advanced towards completion, Alderman Cubitt, who lately inspected them, stated that they are far from satisfactory. The question of subways under the streets is comparatively a new one; but its importance can hardly be over-estimated, especially as regards the metropolis. It was first propounded by the late John Martin, the painter. There are seven or eight different gas companies, and as many water companies, who drive their pipes and mains underneath the different thoroughfares. In addition to this, in almost every street there is a main sewer, with the various private capillaries. At present the telegraphic wires run through a few streets, but ere many years elapse we shall find almost every street provided with the means of telegraphic communication. How often these various pipes and sewers require repair every Londoner knows to his cost. No sooner have the workmen made good the thoroughfare, after laying down water-pipes, than the gas companies break it up again; and when they have finished their work, the sewers are found to be insufficient, and new ones are laid down. It is for the purpose of obviating these annoyances that the proposition of a series of subways is suggested. The desire is, that under every street there shall be a sort of tunnel, in which, side by side, the various descriptions of sewers and pipes may run, so that they may at all times be accessible without the necessity of breaking up the roadway, and interfering with the traffic. By this means new sewers or pipes could be easily laid down or repaired at a much less expense, and without inconvenience. To adopt this system throughout the whole metropolis would involve an enormous outlay, which the Metropolitan Board of Works would hesitate to incur, at least for the present; and they, therefore, propose that for the moment experiments be tried in the new streets which they are seeking for powers to construct. In this they are pursuing a judicious course, as, when the streets are being made, the outlay will be comparatively trifling, and should the plan succeed it can afterwards, by degrees, be generally extended, when the main sewers are constructed.

The board have also adopted a wise measure in offering premiums for the best plans, and in calling in the assistance of professional men, independent of the board, to act as judges. It would have been advisable if they had adopted the same course with respect to the main drainage question, as then, in all probability, instead of the government having to provide a proper plan at the cost of great delay, the works might now have been commenced.

Prizes of 100*l.*, 50*l.*, and 20*l.*, are offered for the three best designs, and in order that there may be no imputation of partiality, the officers of the board are prohibited from competing. The judges are to be the chairman and two members of the board, assisted by their engineer and superintending architect, a civil engineer of eminence, a gas engineer, a water engineer, and an architect, who are not in any way to be connected with the board. These gentlemen will inspect the different designs, and advise the board as to the best.

REPORT ON THE WORKS OF THE METROPOLITAN WATER COMPANIES.*

By Henry Austin, William Ranger, and Alfred Dickens, Superintending Inspectors of the General Board of Health—(July 1856.)

EAST LONDON WATER COMPANY.

Works in 1850.

Sources of Supply.—The river Lea, *i. e.* about 87 per cent. of the water supplied by this company was brought to Old Ford from the river Lea (at Lea-bridge), upwards of six miles from its mouth, by an open canal, nearly two miles in length; about 12 per cent. was taken into the reservoir near Lea-bridge; and about one per cent. was taken from a branch of the Lea, called the water-works stream.

Reservoirs.—This company had six open reservoirs, their capacity, including the canal, was about equal to 35,000,000 gallons. They were situated as follows:—Two at Old Ford; two on the eastern side of the river Lea; one at Lea-bridge; and one at Stamford-hill. These reservoirs, for the most part, were lined with Kentish ragstone.

Filtration.—The water was not filtered. It was received into two large reservoirs of deposit, previously to flowing into smaller reservoirs, whence it was pumped into the district supplied by the company.

Engine Power.—The total nominal engine-power was 516·8 horses by steam, 34·5 do. by water-wheels. The total number of steam-engines was five, as follows:

1. Engine,	cylinder 90	inches diameter;	stroke 10 feet.
,,	pumps 44	inches diameter;	stroke 11 feet.
2. Engine,	cylinder 80	inches diameter;	stroke 10 feet.
,,	pumps 41	inches diameter;	stroke 9 feet.
3. Engine,	cylinder 60	inches diameter;	stroke 8 feet.
,,	pumps 27	inches diameter;	stroke 8 feet.
4. Engine,	cylinder 60	inches diameter;	stroke 8 feet.
,,	pumps 27	inches diameter;	stroke 8 feet.
5. Engine,	cylinder 36	inches diameter;	stroke 8 feet.
,,	pumps 17¾	inches diameter;	stroke 8 feet.

The water-power possessed by the company consisted of—The Lea-bridge water-wheel, with two pumps, one having 20¼ inches diameter, stroke seven feet; and the other eleven inches diameter, stroke three feet. The Stratford water-wheel, with two pumps, one having eleven inches diameter, stroke three feet; and the other nine inches diameter, stroke three feet.

Mains, Branches, &c.—The total length of mains was stated to be at least 88 miles, the sizes varying in diameter from 42 inches to 5 inches. These were always charged with water, under pressure. There were besides, 140 miles of service-pipes of 4 and 3 inches diameter, making a total length of pipeage of 228 miles.

Quantity of Water Pumped.—The quantity of water delivered in the year ending Christmas 1849 was 3,222,753,876 gallons. This was a somewhat smaller supply than was pumped in the previous year, the decrease having been due, it was considered, to the introduction of the system of daily instead of alternate supply, and the saving of waste consequent thereon. The average supply to each house, exclusive of large consumers, watering roads, &c., was, for seven days per week, 140 gallons per diem.

Tenements Supplied.—The total number of private houses supplied was 56,673, and 264 large consumers. The highest service afforded was about 120 feet above high-water mark, and the lowest about three feet above the same level. The supply was given six days in the week, or oftener if required, throughout the company's district.

* Report of the General Board of Health on the Metropolis Water Supply.—For first portion of this Report, see *Journal*, Vol. XIX., page 410.

Cost of Works.—The total expenditure upon the works up to Midsummer 1849 amounted to 745,781*l.*

RECENT ALTERATIONS AND ADDITIONS.

Source of Supply.—The river Lea, above Tottenham. For the conveyance of the water from Tottenham to Lea Bridge, a new open channel has been cut of 100 square feet sectional area. From above this new intake, a large and expensive intercepting drain has been executed, four and a half miles in length, which cuts off from the river the refuse of dye-works, and the drainage of neighbouring places, which are stated to have a population of about 35,000 inhabitants, so that the water is now obtained of the same purity as above Chingford Mills.

Filter Beds, Reservoirs, &c.—At Lea Bridge the water is received direct from the river on to 13 new filter beds, which cover an area of 12 acres. These have been constructed in two circles, each with a pure-water well in the centre. There are seven filter beds arranged in one circle and six in the other. The filtering medium is three feet six inches in thickness, composed entirely of sand. From the filter beds the main body of water is conveyed by a four feet iron pipe to the two oval reservoirs at Old Ford, which were formerly subsiding reservoirs. They have now been connected and covered with brick arches, springing from cross arches resting on piers, the surface of the arches being covered with soil. These reservoirs are 2½ acres in extent. The other reservoirs of the company near Old Ford, and that at Stamford Hill are now thrown out of use.

Engine Power.—In addition to the engine-power described in the former return, a new engine, with 100-inch cylinder and 11-feet stroke, has been erected at Lea Bridge for the supply of the upper northern district. There are six boilers to this engine. It is capable of lifting 150 cubic feet of water each stroke. A new Cornish engine, 70-inch cylinder, is also in course of erection at Old Ford. The aggregate nominal engine-power of the company is now 840 horses; equal to 40,000,000 gallons of water per day lifted 100 feet high.

Consumption of Smoke.—Some apparatus has been employed at Old Ford for the prevention of dense smoke from the furnaces, but "smokeless" fuel is now used.

Quantity of Water Pumped.—The quantity of water now pumped is 16 million gallons per day, and the number of tenements supplied is 70,000. The supply is furnished six days per week.

Mains, Branches, &c.—The total length of pipeage laid, up to Christmas, 1855, was 331 miles. The plan of the Company's mains and district mains, required by the Metropolis Water Act, 1852, is complete up to Christmas last. It is drawn to the scale of 12 inches to the mile.

Cost of Works.—The cost of the new works executed since the Acts of 1852, has been 250,000*l.*, making, with the previous outlay, a total expenditure of 995,781*l.* upon the works of this Company.

General Remarks.

The new works of the East London Water Company most worthy of note, are the 100-inch cylinder engine, the filtering arrangements at Lea Bridge, and the intercepting drainage. This engine at Lea Bridge is said to be the largest yet erected for waterworks, although it will be seen that the Southwark and Vauxhall Company have one of still larger dimensions now in course of construction.

The filter beds are the most extensive works of the kind appertaining to the metropolitan supply, and they are admirably arranged. They were commenced in 1852; the first half was completed in June, 1854, and the whole by the 5th November, 1855, when filtered water only was delivered to the Company's district.

The water of the Lea was quite as turbid as that of the Thames at the time of inspection, owing to the recent rains; but, although the filtering medium employed by this Company is of less thickness than that of any other, the filtered water certainly appeared to be the brightest.

The East London Water Company, as stated in the return, employed no means of filtration before the Act of 1852. The large depositing reservoirs upon which they had to rely for clearness of the water have now been abandoned, and all communication between them and the mains has been cut off. The cocks are now used in the main which brings the filtered water from Lea Bridge to the covered reservoirs at Old Ford.

This company has no high-service reservoir for the supply of their tenants; the water is pumped direct into the district for distribution.

The new buildings at Lea Bridge are of brick; they are substantial, and of handsome elevation. The chimney, and stand-pipe for the supply of the northern high-level district, are enclosed in a square tower 148 feet in height. Fifty-two inch cocks are fixed between the pump and stand-pipe, and between the stand-pipe and main.

No expense has been spared in making these works as complete as possible.

THE KENT WATER COMPANY.

THE WORKS IN 1850.

Source of Supply.—The water supplied by this Company was, and is still, taken from the river Ravensbourne, at Deptford.

Reservoirs.—The total capacity of the Company's reservoirs and filter beds amounted to 8,716,754 gallons. Two of these were impounding reservoirs situated at Deptford; the water was conveyed from them to two filter beds, and then pumped to the service reservoirs in Greenwich Park, on Woolwich Common, and near the Marine Barracks at Woolwich. From these reservoirs fire mains were also laid to command the Government establishments at Deptford, Greenwich, and Woolwich.

Filtration.—The sand surface of the two filters employed by the Company was 1½ acre. Upon these the water was admitted and passed through direct to the engine pumps, all the water supplied having been filtered. The filtering medium was clean washed gravel, at the bottom, with a layer of shells on the gravel, and sand on the shells.

Engine Power.—The steam-engines employed consisted of two Boulton and Watt engines, 38 inch cylinders, 8 feet stroke. Pumps, 14½ inches diameter, 6 ft. 3 in. stroke; and one Cornish engine, 70-inch cylinder, 10-feet stroke. Pumps, double acting, 20½ inches diameter, 10 feet stroke.

Mains, Branches, &c.—The total length of mains, branch mains, side services, and services for small streets, was 85 miles, 3 furlongs, and 165 yards, the sizes varying from 24 inches to 1½ inch in diameter.

Quantity of Water Pumped.—The total quantity of water pumped during the year 1849 was 393,948,750 gallons. The average supply to each dwelling house, reckoning seven days per week, was nearly 92 gallons per diem.

Tenements Supplied.—The number of tenements supplied was 9632, and 13 large consumers. The supply was given six days a week to private consumers, and to the Government establishment at Woolwich and to the railways, seven days a week. The highest service afforded by the Company, was 220 feet above high-water mark, and the lowest at high-water mark.

Cost of the Works.—The total expenditure upon the works was not stated, as the Company's books do not contain any account showing this result, but the capital raised amounted to 202,104*l.* 13*s.* 6*d.* The cost of the works was said to have exceeded this sum, as for many years a large proportion of the earnings was laid out in purchase of pipes and other works, properly chargeable to capital.

RECENT ALTERATIONS AND ADDITIONS.

Filter Beds, Reservoirs, &c.—One new filter bed has been added at Deptford, making a total surface for filtration of 12,820 square yards. The filtering medium consists of two feet of gravel, six inches of shells, and two feet of sand. The subsiding reservoirs at Deptford, described in the former return, comprise an area of 25,157 square yards, and are capable of holding 1,358,298 cubic feet of water.

The service reservoir in Greenwich Park covers an area of 3122 square yards, and contains 168,370 cubic feet of water. That on Woolwich Common covers an area of 4378 square yards, and contains 277,890 cubic feet of water.

Engine Power.—One new Cornish engine has been erected at Deptford, 70-inch cylinder, 10-feet stroke, Double acting pump, 18 inches diameter. It is contained in the same building as the similar engine before described. The aggregate nominal engine power of the Company is now 500 horses.

Consumption of Smoke.—No apparatus for consumption of smoke is employed. Welsh coal is always used, and no dense smoke is formed.

Quantity of Water Pumped.—The quantity of water pumped in 1855 was 862,760,566 gallons. The number of tenements to which the supply is now furnished is 16,077. For the high service the water is now raised to a maximum height of 300 feet, and for the low service, 170 feet. The works for the high and low service are quite distinct. The maximum daily supply to the district in 1855 was 3¼ million gallons. The supply is either constant or is given daily to all parts of the district.

Mains, Branches, &c.—The total length of pipeage now laid down is stated to be 124 miles. A plan of the mains and district mains, as required by the Metropolis Water Act, is in a forward state, laid down on the Ordnance engraved outline sheets, five feet to the mile, but it is not yet complete.

Cost of the Works.—The cost of the new works executed since 1852 has been 27,022*l.*, and taking the amount before given as the cost of the previous works, the total expenditure has amounted to 229,126*l.* 13*s.* 6*d.*

General Remarks.

The new works executed by the Kent Water Company since the previous return, call for no particular observation, except that they have been well carried out, and that the engines and buildings are a model of cleanliness and order.

No stand-pipe is used, but a larger air vessel than usual is connected with the main, it being 6 feet in diameter, and 30 feet high.

With double-action pumps, the water being always in motion, no risk is incurred in pumping directly into the mains, either for supply, or for delivery into the high-level reservoirs.

The service reservoirs for the filtered water remain open as before, being situated beyond the limits prescribed by the Act of 1852; but, it should be added that they are chiefly of use as reserves in case of fire, a separate fire-main being carried from each to the Government buildings. The supply to the district is given for the most part direct from the mains, independently of the reservoirs. The lower reservoir, however, near the Marine Barracks at Woolwich, being in an objectionable locality, is now abandoned and disconnected from the works.

THE HAMPSTEAD WATER COMPANY.

Works in 1850.

Sources of Supply.—The sources of supply were described in the return of 1850 as "springs at Hampstead and Ken Wood, two artesian wells, and temporarily the New River." The wells were situated respectively at Hampstead and Kentish Town.

Reservoirs.—The total superficial area of water in the reservoirs, when full, was stated to be about 35 acres; the depths of the reservoirs were said to vary considerably, and the bottoms to be so irregular that no estimate has ever been made of their total capacity that could be depended on.

Filtration.—The water was not filtered.

Engine Power.—The two steam engines amounted to about 72-horses power nominally. They consisted of a Cornish engine, at Kentish Town, 60-horse power, 44-inch cylinder, 10-feet stroke; and a high pressure non-condensing engine at Hampstead, of 12-horse power, cylinder 12 inches, 3 feet stroke.

Mains, Branches, &c.—The total length of the mains, branch mains, side services, and services for small streets, amounted to about 26 miles, 1 furlong, 131 yards, and varied in size from 12 inches to 3 inches internal diameter.

Quantity of Water Pumped.—The quantity of water pumped during six months ending 1st December, 1849, including a temporary supply from the New River Company, was 78,013,000 gallons. The estimated quantity delivered to each house for domestic supply was 86 gallons per diem. The supply was given three days a week throughout the district.

Tenements Supplied.—The total number of houses supplied during the year 1849 was 4490, empty houses inclusive; one large consumer of 500 gallons per diem, for six days a week, and two ditto 1500 gallons per diem, for six days a week. The highest service afforded by the company, was about 215 feet above high-water mark, and the lowest 60 feet above that level.

Cost of the Works.—The total capital invested in the works of this company, as they existed in 1850, was estimated to be 81,231*l.*

Recent Alterations and Additions.

Sources of Supply.—There is no fresh source of supply for this company. The artesian well at Kentish-town from which part of the supply was formerly obtained, has since been continued to a depth of 1302 feet from the surface by a bore hole commencing with 12 inches in diameter, and reduced first to 10 and then to 8 inches. After passing through the chalk in full expectation of obtaining water from the sands supposed to lie beneath it, a stratum of what is considered to be the new red sandstone has been penetrated without tapping the springs.

Reservoirs and Filter Beds.—The reservoirs remain as before. One small filter bed, comprising an area of 6309 square feet, divided in the middle for cleansing purposes, has been constructed within the reservoir at Kentish-town, to filter the water obtained from the Hampstead and Highgate ponds. The filtering medium is 3 ft. 3 in. in depth, and is composed of the following layers: 1 foot large washed pebbles; 6 inches small washed pebbles; 6 inches fine shingle and gravel; 1 ft. 3 in. sand. The filtered water was first supplied at Christmas, 1855.

Consumption of Smoke.—No apparatus has been adopted for this purpose. Welsh coal is used for firing.

Mains, Branches, &c.—The total length of pipeage now laid extends to about 33¼ miles. The mains of this company have been subject to such frequent alterations for the purpose of making connections at different points with the pipes of the New River and West Middlesex Companies, to meet the constantly increasing requirements, that it is said to have been impossible to prepare a satisfactory plan of the underground works as required by the Metropolis Water Act.

Quantity of Water Pumped.—There appear to be no data for determining the gross quantity latterly supplied per day to the tenants of this company, as the charge for the supply in aid by the New River and West Middlesex Companies, has been founded on the amount of the water rents of the houses supplied, and not on the quantity. Assuming, however, the same average quantity per house as in the former return, the gross daily supply would amount to 603,060 gallons, the number of houses supplied being 6348.

Cost of the Works.—The cost of the additional works executed by this company, since the former return, has been 33,224*l.* 5*s.* 3*d.*, making with the previous outlay a total expenditure of 114,455*l.* 5*s.* 3*d.*

General Remarks.

The only new work of this Company strictly consequent upon the Act of 1852, is the small filtering apparatus above described.

The new boring at Kentish Town was commenced in June, 1853, from the bottom of the old well, which had been sunk 540 feet deep. The work was abandoned at the end of 1855, under the circumstances above stated, a depth of 1302 feet having been obtained, and an expenditure of 7500*l.* having been incurred. The result of the undertaking was most unexpected. Considerable discussion has arisen among geologists as to the nature of the strata which have been met with, and much interest attaches to the subject. An entire section of the strata arrived at in the boring is appended. It would be of importance to the cause of science if any means could be found for the continuance of the work.

A very small district is now supplied by this Company. Supplies of water have been obtained in aid for some time from the New River Company; and before the filter bed was ready, the water was also obtained for the supply of part of the district from the West Middlesex Company.

The water from the well at Hampstead, from which about 70 gallons per minute are raised, was found to be clear and bright, and of better colour than the filtered reservoir water.

The means of supply of the Hampstead Company, owing to the sacrifice of their previous well, and the failure and abandonment of the new one, are now less than before. It is understood that terms have been agreed, whereby the affairs of the company will be merged in those of the New River; and the Hampstead Water Company, which originated in the time of Henry VIII., will then cease to exist.

Section of the Boring at Kentish Town.

			ft.	in.	Depth ft.	Depth in.
Tertiary Strata, 324 ft. 6 in.	*London Clay* (236 ft.)	1. Yellow clay	30	6		
		2. Blue clay, with *Septaria*	205	6		
	Woolwich and Reading Series (61 ft. 6 in.)	3. Mottled (red, yellow, and blue) clay	37	6		
		4. White sand, with flint pebbles	0	6		
		5. Black sands; *passing into*	2	0		
		6. Mottled green and red clay	1	0		
		7. Clayey sands	3	0		
		8. Dark-grey sands with seams of clay... ...	9	6		
		9. Quick-sands ash-coloured	6	6		
		10. Flint-pebbles	1	6		
	Thanet Sands (27 ft.)	11. Ash-coloured sands ...	10	0		
		12. Argillaceous sands ...	4	0		
		13. Dark-grey clayey sands...	11	0		
		14. Bed of angular green-coated flints	2	0—	324	6
Chalk, 586 feet.	*Middle Chalk with flints* (244 ft. 6 in.)	15. Chalk with flints ...	119	6		
		16. Hard chalk without flints	8	0		
		17. Chalk, less hard with few flints	31	6		
		18. Nodular chalk, with three beds of tabular flints	13	6		
		19. Chalk, with seams of tabular flint and a few nodular flints... ...	32	6		
		20. Chalk, with a few flints and some patches of sand	9	6		
		21. Very light-grey chalk, with a few flints ...	30	0		
	Lower Chalk without flints (294 ft.)	22. Light-grey chalk, with a few thin beds of chalk-marl subordinate ...	133	0		
		23. Grey chalk-marl, with compact and marly beds and occasional pyrites	161	0		
	Chalk-marl (47 ft. 6 in.)	24. Grey marl	20	0		
		25. Harder grey marl, rather sandy and with occasional iron-pyrites ...	27	0		
		26. Hard rocky marl ...	0	6—	910	6
	Upper Greensand (72 ft. 6 in.)	27. Bluish-grey marl, rather sandy; the lower part more argiliaceous ...	58	9		
		28. Dark-green sand, mixed with grey clay ...	13	9—	983	0
	Gault (130 ft. 6 in.)	29. Bluish-grey micaceous clay, slightly sandy ...	39	0		
		30. Ditto, with two seams of argillaceous green-sand	6	7		
		31. Micaceous blue clay ...	84	11—	1113	6

	ft.	in.	Depth. ft.	in.
32. Red and yellow sands, and sandstone ...	1	0		
33. Compact red clay, with patches of variegated sandstone	4	0		
34. Pure dark red clay	4	7		
35. Red clay, whitish sands, and mottled sandstone	3	0		
36. Hard red conglomerate, with pebbles of syenite, greenstone, trap-rock, quartz, hornstone, red claystone-porphyry, and fossiliferous schist, well rounded, and varying in size from a marble to a cannon-ball...	2	0		
37. Micaceous red clays, mottled in places ...	26	0		
38. Seams of white fissile sandstone and red sand	3	8		
39. Mottled sandstone	0	4		
40. Red sand and sandstone with small pebbles and *Belemnites*, and a few small phosphatic nodules	2	0		
41. Seams of red sandstone and white sands ...	4	0		
42. Pebbly red sands, and fissile sandstone ...	1	0		
43. White and red sandstone	5	0		
44. Fine light-red sands	2	9		
45. Hard fissile sandstone	0	3		
46. Very fine light-red sand	4	0		
47. Pure red clay...	2	0		
48. Red and mottled clayey sands, with some iron-pyrites	1	3		
49. Red sandy micaceous clay with fissile sandstone	2	5		
50. Compact hard greenish sandstone	10	0		
51. Very micaceous red clay	1	0		
52. Grey and red clayey sands	1	1		
53. Light-coloured soft sandstone with fragments of *Ammonites*	2	1		
54. Red sand and sandstone (highly inclined?)	6	2		
55. Greenish sandstone	4	0		
56. White and grey clayey sands, with iron-pyrites	2	0		
57. Reddish argillaceous sands, with seams of sandstone	3	8		
58. Micaceous red clay	18	4		
59. Seam of greenish sandstone...	0	5		
60. Red mottled and micaceous clay, with patches of light-coloured sand and fragments of *Ammonites* and of a *Scaphite* ...	14	6		
61. Red compact micaceous clay, with *Belemnites*	20	0		
62. Red quartzose and micaceous sandstone ...	2	0		
63. Brownish-red clayey sand and sandstone ...	4	0		
64. Very hard micaceous sandstone, with small pebbles of white quartz	4	0		
65. Light red argillaceous sand	10	0		
66. Red sandstone, micaceous and quartzose ...	8	0		
67. Light red clayey sands (with small angular fragments of chert or flint?)	2	0		
68. Whitish and greenish hard sandstone (horizontal?)	6	0	1302	0

186 feet 6 inches.

PLUMSTEAD, WOOLWICH, AND CHARLTON WATER COMPANY.

The works were established for the supply of water to the above-named parishes in 1854, and they have now been in actual operation about two years. They are in competition with the Kent Water Company over a considerable portion of the district supplied.

Source of Supply.—This new Company's supply is derived from a well and deep boring in the chalk, the water from which, when first raised, has always an equal temperature of about 52 degrees Fahrenheit; but the special advantage afforded to the tenants of the Company is that the water is softened by Dr. Clark's process. When first pumped from the well this water has 21¼ degrees of hardness, that is to say 21¼ grains of hardening matter in the gallon, 14¾ of which are derived from carbonate of lime held in solution by an excess of carbonic acid gas. The softening process precipitates 13 grains of this carbonate of lime, and leaves a clear bright water of only 8¼ degrees of hardness.

A short description of the softening process, extracted from Dr. Clark's paper read before the Society of Arts, and also an account of the mode of application to these works by Mr. Homersham, the engineer, *Source of* the process has been very successfully carried out, will be still, taken from the separate observations on this subject.

The water, with the lime added, is raised into three open reservoirs of a collective area of 8549 superficial feet, each reservoir being capable of holding 200,000 gallons. They are constructed or concrete walls lined with brick, and the whole are inclosed within a boundary brick wall. These reservoirs are alternately filled and left to settle. When the precipitation is complete, for which not less than 4 hours should be allowed, the clear softened water is raised into covered service reservoirs, whence it is distributed throughout the district. One of these service reservoirs is situated near Plumstead Common, and commands a service of 157 feet above Trinity high water mark. It covers an area of 10,121 square feet, and will hold 12 feet depth of water. It is constructed in two divisions, and is covered with brick arches resting on girders and columns. The other service reservoir is situated on the side of Shooter's Hill and commands a level of 311 feet above Trinity high water mark. It is 3918 superficial feet, and 13 ft. 3 in. deep. The supply is not yet furnished from this upper reservoir.

Filtration.—The water is not filtered, this operation being wholly unnecessary. The water comes from the well perfectly bright; and no difference in this respect can be detected after it has undergone the softening process. This process, however, possesses the further great advantage of preventing subsequent vegetation, from which the supply would otherwise suffer deterioration if kept in open reservoirs.

Engine Power.—The amount of steam power at present employed by the company is nominally 35 horses; but the engine is said to be capable of working up to 60 indicated horses. It is a double-acting condensing engine, cylinder 29 inches diameter, stroke five feet. It performs 30 double strokes or revolutions per minute. Steam is used at a pressure of 30 lb. on the square inch above the atmosphere. The engine house is constructed for the erection of a duplicate engine.

Consumption of Smoke.—No apparatus is employed for this purpose. The boiler is large; there are two fire-places; and alternate stoking, combined with care, are the means relied upon for the prevention of smoke.

Mains, Branches, &c.—The total length of pipeage already laid by the company is about 16 miles, the mains and services varying in size from 16 inches to 2 inches in diameter. A plan of the mains and district mains, as required by the Metropolis Water Act, 1852, does not appear to have been yet completed. A plan exists at the office, to a scale of 12 inches to the mile, showing the pipes as they were originally proposed to be laid down, but the alterations have not yet been inserted.

Quantity of Water Pumped.—The quantity of water pumped for many weeks in succession has been 550,000 gallons per day for seven days in the week, but the average quantity cannot yet be stated. The supply is given to 3000 houses, so that 183 gallons are furnished per house per day for all purposes. The supply is given daily, or twice a day, if required, but except in a very few instances it is not now constant. In the commencement of their operations the company furnished a constant supply, but the house apparatus and arrangements over which they had no control, are said to have been defective, and to have caused such excessive waste as to compel the company to abandon the system. The engineer apprehends no great difficulty in the constant supply, if proper apparatus is used, and the connections are carefully made to a proper system.

Cost of the Works.—The total expenditure upon the works of this company has been about 50,000*l.*, of which 3700*l.* has been the cost incurred in the adoption of the softening process.

General Remarks.

As it is thought desirable to enter upon the separate consideration of Dr. Clark's softening process as a general question, there is little to observe upon these works, except that they have been well carried out, and that considering that this is the first attempt at the complete and permanent application of that process to waterworks for domestic supply, the arrangements appear to be of a very matured and satisfactory character. They have completely settled the question of the practicability and easy working of the process, and of the great advantages of its adoption in all similar cases.

Owing to the great demand upon the works, there is reason to fear that it has not always been practicable to allow sufficient length of time for the complete precipitation of the chalk, and that the water has at times been delivered to the customers in a somewhat turbid state. A certain amount of deposit in the service reservoir also rather favours this conclusion; but this is a defect which is remediable at any time by extension of the works. The water has been raised to the service reservoirs after 16 hours' rest, but this would not appear to be sufficient time for complete precipitation of the chalk. Twenty-fours should be allowed.

It would be an improvement if there were four reservoirs for precipitation, and if they were covered. In the construction of the settling reservoirs already formed, the engineer has provided for arching them over at any time.

One ton of the burnt lime added to the water is said to produce 3½ tons of precipitate. The company have not yet tried the commercial value of this material.

DR. CLARK'S PROCESS FOR SOFTENING WATERS.

By Henry Austin, William Ranger, and Alfred Dickens, Superintending Inspectors of the General Board of Health.*

Before offering any observations on the applicability of this process to the water supply of the Metropolis, under present circumstances, we think it may be useful to give an explanation of what the process is, in Dr. Clark's own words, which we have extracted from the paper read at a meeting of the Society of Arts on the 14th May last, "On means available to the metropolis and other places for the supply of water free from hardness and from organic impurity." He observes:—

In order to explain how the invention operates, it will be necessary to glance at the chemical composition and some of the chemical properties of chalk; for while chalk makes up the great bulk of the matter to be separated, chalk also contains the ingredient that brings about the separation. The invention is a chemical one for expelling chalk by chalk.

Chalk then consists, for every 1 lb. of 16 oz., of lime 9 oz., and carbonic acid. 7 oz. The 9 oz. of lime may be obtained apart, by burning the chalk, as in a lime kiln. The 9 oz. of burnt lime may be dissolved in any quantity of water, not less than 40 gallons. The solution would be called lime water. During the burning of the chalk to convert it into lime, the 7 oz. of carbonic acid are driven off. This acid when uncombined, is naturally volatile and mild; it is the same substance that forms what has been called soda water, when dissolved in water under pressure.

Now so very sparingly soluble in water is chalk by itself, that probably upwards of 5000 gallons would be necessary to dissolve 1 lb. of 16 oz.; but by combining 1 lb. of chalk in water with 7 oz. additional of carbonic acid (that is to say, as much more carbonic acid as the chalk itself contains), the chalk becomes readily soluble in water, and when so dissolved is called bicarbonate of lime. If the quantity of water containing the 1 lb. of chalk with 7 oz. additional of carbonic acid were 400 gallons, the solution would be a water of the same hardness as well water from the chalk strata, and not sensibly different in other respects.

Thus it appears that 1 lb. of chalk, scarcely soluble at all in water, may be rendered soluble in it by either of two distinct chemical changes—soluble by being deprived entirely of its carbonic acid, when it was capable of changing water into lime water, and soluble by combining with a second dose of carbonic acid, making up bicarbonate of lime.

Now if a solution of the 9 oz. of burnt lime, forming lime water, and another solution of the 1 lb. of chalk and the 7 oz. of carbonic acid, forming bicarbonate of lime, be mixed together, they will so act upon each other as to restore the 2 lb. of chalk, which will, after the mixture, subside, leaving a bright water above. This water will be free from bicarbonate of lime, free from burnt lime, and free from chalk, except a very little which we keep out of account at present for the sake of simplicity in this explanation. The following table will show what occurs when this mutual action takes place:—

Agents.		Products.	
Bicarbonate of lime in 400 gallons...	Chalk......... 16 oz. with	= 16 oz. of chalk.	=2 lb.
	Carbonic acid 7 oz.	= 16 oz. of chalk.	
Burnt lime in 40 gallons of lime water	9 oz.		

But, instead of the whole chalk being separable by the process from the water, only 10-11ths would be separated; so that, with regard to chalk, the accurate result would be expressed, if we suppose 440 gallons of similar water to be operated upon, containing 17¼ oz. of chalk. There would be separated, 16 oz.;—there would remain in solution, 1¼ oz. Or to express the result with reference to a single gallon, each gallon would contain of chalk, if unsoftened, 17¼ grains; if softened, 1¼ grain; and would deposit 16 grains.

Here is a convenient place to explain a mode of expressing hardness, in very general use now, but first invented by me, in connection with certain new chemical tests of water, in order to work out conveniently the softening process that has been described.

Each degree of hardness is as much hardness as a grain of chalk, or the lime, or the calcium, in a grain of chalk, would produce in a gallon of water, by whatever means it may be dissolved.

Thus, our supposed water would be 17¼ degrees of hardness before softening; 1¼ degree after softening. And this would be the real result, supposing there were in the water no other hardening matter but chalk; but in the best quality of chalk water from springs or wells in the chalk strata around the metropolis, there is actually present a small proportion of other hardening matter, such as to prevent the water from being softened lower than 2¼ degrees. A gallon of such water, after being evaporated, was found to have held in solution of solid matter—Before softening, 23 grains; after softening, 7 grains; the difference, 16 grains, was due to chalk removed by the softening process.

These explanations will make it easy to comprehend the successive parts of the softening process.

It will be gathered from our description of the Plumstead, Woolwich, and Charlton Waterworks that this scientific and ingenious process no longer remains in the position of a beautiful theory of the laboratory, of which the practical application is doubtful, it having now been in operation for two years on so large a scale with eminent success and advantage.

We shall now give Mr. Homersham's account, extracted from the proceedings of the meeting before referred to, of the mode in which the process is there applied. He states,—

"The manner of carrying out the softening process at the works was as follows:—The lime used was flare lime, made from the upper chalk. Such lime, fresh burnt, was gradually slacked in small quantities in a tub with water, and was passed through a fine sieve, of about 10 meshes to the inch, into a cast-iron cistern. The cistern, which held about a day's supply when full, remained undisturbed for twelve hours, when a quantity of clean water, found to stand above the lime paste, was drawn off, and the lime paste or cream of lime, as it was called, was stirred up to make it all of a uniform consistency, when it was ready for use. A quart of such cream of lime contained in weight about 1lb., or rather more, of dry unslacked lime. As the water (about 900 gallons a minute) was pumped up from the well, a suitable quantity of this cream of lime was passed, by means of a large cylinder and piston moved by the steam-engine, into the pipe through which the water was conducted from the well. The cream of lime and water were intimately mixed by causing them to pass together through two, what were called, agitators, placed at a little distance apart. Between the two agitators, a well, 6 feet internal diameter, and open at the top, was interposed, so that all the lime and water, after it had passed through the first agitator, went into this well on one side, and passed out of it again on the other side, to the second agitator, on its way to the depositing reservoirs. The object of this well, which was 5 feet deep below the entering pipe, was to allow any gritty matter that by accident might be introduced with the lime into the water to fall to the bottom, and so prevent it passing into the depositing reservoirs. The agitator merely consisted of an enlarged pipe, 21 inches internal diameter, and about 6 feet in length, containing within and around it three plates of wrought-iron, about 2 feet apart having in them about 110 holes, each 1 inch in diameter. As the lime and water passed together through the holes at a speed of about 50 inches a second, they impinged quickly against the water in the body of the pipe, which moved only at the rate of 12 inches a second. The lime and water in this way became intimately mixed, and passed on together into a reservoir prepared to receive them, capable of containing (after leaving room for the chalk deposit at the bottom) 600,000 gallons, or one day's supply.

The reservoir was divided into three compartments, each capable of holding 200,000 gallons, for convenience in emptying and filling. When the reservoir was being filled, the lime, at the commencement of filling, was added in excess to the water, so much so, that when the reservoir was only three-fourths full, the remaining fourth part was filled up with pure water from the well. In practice, the adjustment of the exact proportions of lime and water was very easy; the silver test was used for the final adjustment of each compartment of the reservoir, as described in Dr. Clark's paper. The reservoir being thus filled with lime and water, and adjusted by the silver test, in about sixteen hours afterwards all the chalk or carbonate of lime had fallen to the bottom, the water had become perfectly clear, and it was then pumped up to the service reservoir for the supply of the consumers. When the reservoir was emptied of the softened water down to within about 2 feet of the bottom (so as not to disturb the deposit), it was again filled with lime and water as before, the deposit not being taken out until it was 17 or 18 inches deep; this did not occur more than once in eight or ten weeks. The pipe through which the water passed from the well, after the cream of lime was mixed with it, to the depositing reservoirs, was a closed cast-iron pipe, 14 inches in diameter, and about 75 yards in length. It was found for this length, at Plumstead, that the pipe got very slowly coated with a deposit of furr or crystallised carbonate of lime. The same kind of furring or deposit of chalk also took place in the agitators, but by making proper provision for clearing out the deposit which adhered to those parts, they could very easily be kept clear."

As the operation is thus found to be perfectly practicable, there now only remains for consideration the balance of the advantages of the process with the expense of the operation in any individual case.

In order to a clear understanding of these points,—so much erroneous statement having been put forward on the subject,—it may be well to consider what are the limits of the application of the process, what are the benefits to be derived, and what is the probable cost.

The process is confined in its softening action to these waters of which the hardness is derived from carbonate of lime, or precisely those which are similarly softened by simple boiling of

* Report to the General Board of Health on the Metropolis Water Supply.

the water. The action of boiling disengages or expels the free carbonic acid from the water, just as the caustic lime added by Dr. Clark's process neutralises or takes it up, and the carbonate of lime no longer held by it in solution separates and adheres to the sides and bottom of the vessel.

The advantages of the process may be considered under three heads:—health, comfort, and economy,

1. The comparative wholesomeness of hard and soft water for drinking has been a subject of much discussion of late years, but there does not appear to be any conclusive evidence which would allow of any correct estimate of their comparative effect upon the system. Although there can be little doubt that where waters are impregnated with some 60 or 80 degrees of hardening matter its removal would be beneficial, it is contended by many that chalk, to the extent that it exists in the waters supplied by the London companies, cannot be considered injurious to health. Upon this point we do not pretend to offer an opinion: in speaking of the advantages of the softening process to health, we refer simply to the value which it is said to possess, of removing, *in part*, organic impurity in solution in water, and which ordinary filtration will not disengage. We are not aware that it has been practicable to determine the extent of this property of the process; but that it effectually prevents the rapid vegetation which ensues on the escape of free carbonic acid gas from water derived from the chalk, and allowed to rest, has been most satisfactorily proved at the Woolwich works.

2. The comfort of a soft water for personal ablution and bathing will be admitted by all as no mean consideration in favour of the process.

3. The economy to be derived from the use of the softened water is stated to consist of the saving in tea and other articles of infusion; in soap and in soda; the saving of labour in washing, and of the wear and tear of clothes; the avoiding of incrustations of engine boilers, kettles, and other vessels.

The chief economy will obviously be in tea and in soap, but while admitting that this must be considerable, we must express our opinion that the savings that have been calculated in these articles from the use of softened water have been much overrated.

The Commissioners who reported in 1851 on the chemical quality of the supply of water to the metropolis found that the hardness of London water, *as it is commonly used after boiling*, was about five degrees; while without heating it amounts to 14 degrees. It is probable that the water used for making tea may not usually be boiled sufficiently long to reduce the hardness to this extent, and therefore that a saving of tea somewhat considerable would in such case result from the use of water which had undergone the softening process, but we presume that no such economy can be reckoned upon as would be found from the use of the softened water as compared with another which derived its hardness from other sources than carbonate of lime not reducible by boiling. And in the matter of soap, although every hundred gallons of water derived from the chalk strata are said to be capable of destroying and rendering of no effect 30 ounces of soap more than if it had undergone the softening process, it is obvious that this forms a most erroneous basis of calculation of the actual waste incurred from the use of such water. In all washing operations the soap is effectively used with comparatively a small quantity of the water in the vessel, the bulk of the water in use being in fact employed in rinsing, in getting rid of the soap that has performed its office, the destruction of which is then no longer of any consequence.

Notwithstanding these over-estimates, however, the great advantages of the softened water cannot be questioned, and they are well worthy consideration in all places supplied with water to which the process is applicable.

The softening process is applicable with most advantage not to river waters but to clear spring waters, such as are usually derived from wells in the chalk, or to other waters of which the hardness is derived from carbonate of lime, but which have acquired no tinge or discolouring admixture.

In this case the precipitated pure carbonate of lime is stated to possess considerable commercial value as an excellent material for whiting, which, according to Mr. Homersham's calculations, would nearly pay for the whole working expenses, and interest on the capital expended for establishing the process. The public would, in such case, enjoy all the advantages of the system almost free of cost.

If the process were applied to a water which has taken up any impurity or discolouring matter, as the water of the Thames, for instance, it is admitted that the precipitate would be valueless; but, notwithstanding this, looking at all the comfort and advantages to be derived from the use of a soft and pure water, we believe that there are few cases in which we should hesitate to recommend its adoption.

As regards the Metropolis, if the application of the softening process had formed one of the requirements of the Act of 1852, many of the companies' arrangements would necessarily have differed widely from those which have been carried out, but considerable savings might probably have been effected in them which would in part have compensated for the additional outlay.

Reckoning the cost of the process upon the experience of the works of the Woolwich and Plumstead Company, the expenditure for works executed *de novo* for the whole of the metropolis would have amounted to about half a million sterling, and the working expenses to about 20,000*l*. per annum; but now that the new works and arrangements of the several companies have been completed, it is impossible to say what expense would be involved in its adoption; and independently of any outlay that might be required in addition to the large sums which the companies have been already called upon to expend, it is contended that the process would now be in great part unsuitable for, if not quite incompatible with, those works and arrangements just carried out for the improvement of the supplies.

MR. FAIRBAIRN'S LECTURES FOR ENGINEERS.*

Not a year has elapsed since we reviewed Mr. Fairbairn's Lectures to Working Engineers, and now a second edition presents itself for notice, the sound, solid information which the volume contains having gained for it ready acceptance. This edition follows so closely on the first that there has been little opportunity for alteration or addition, beyond a fresh arrangement of some of the lectures to facilitate reference and to ensure greater continuity of purpose. These alterations are not sufficient to change the opinion we before expressed, that it would have been far better if instead of reprinting lectures delivered at various times, and often under special circumstances, years ago, Mr. Fairbairn had presented the results of his experience in a more consecutive form, and written up altogether to the existing state of knowledge. The addition of recent experiences to old opinions sometimes produces an incongruous patchwork that appears unintelligibly contradictory. Thus, for example, in speaking of the forms of boilers, the cylindrical and hemispherical forms are recommended in the original lectures as the strongest and best; but the experiments afterwards made on the strength of flat surfaces, which contradict that opinion, are added to the former without any explanation of the apparently contradictory statements: Thus we find in pages 142 and 143, the following passages, a portion of which we have marked in italics immediately following each other :—

"As respects form, it has already been proved that the cylindrical and hemispherical forms (or those forms by which nature is governed in all her constructions relative to pressure) are the best; and it will be necessary only to observe what has already been forcibly urged upon your attention, namely, *to avoid, under certain conditions, flat surfaces, and to adopt the spherical or cylindrical forms wherever and under whatever conditions they are admissible.*

"This cannot, however, at all times be accomplished; and that flat surfaces should be made to resist severe pressure, is not unfrequently an essential point in construction. *Now these flat surfaces are not so very objectionable on the score of strength as they appear to be at first sight. On the contrary, they are, when properly stayed, the strongest part of the construction; and this I have proved by direct experiment.*"

We remarked, in noticing the first edition of this work, on the erroneous notion which Mr. Fairbairn appears to entertain that the pent-up force in a steam boiler is increased by increasing the surface. It seems strange that the sound practical sense for which he is distinguished, did not at once detect such a fallacy, which is repeated in the present edition. It would be unnecessary to do more than point out the error if committed by any one of lesser authority, but when it is thus repeated by an engineer of eminence it may be worth while to disprove it, which may be readily done by a simple illustration. The statement occurs in page 44, where,

* "Useful information for Engineers; being a series of Lectures delivered to the working engineers of Yorkshire and Lancashire, together with a series of Appendices." By William Fairbairn, F.R.S., &c. Second Edition. London: Longmans and Co.

after estimating the enormous force pent up in a high-pressure boiler with two centre flues and steam at 450lb. to the square inch, he proceeds to notice tubular boilers, and observes that the amount of force before estimated "is, however, inconsiderable when compared with the locomotive and some marine boilers, which, *from the number of tubes, present a much larger surface to pressure.*" Now it is evident, that if the pent-up force be increased by enlarging the surface, the introduction into a boiler of a greater number of tubes might double or quadruple the force though each tube would displace a corresponding bulk of steam, and thus we should arrive at the absurdity of adding to the power by diminishing its quantity; an absurdity which Mr. Fairbairn cannot fail to perceive as soon as his attention is directed to the subject.

There is an important notice in the present edition of the results of experiments recently conducted at the request of the Royal Society and of the British Association for the Advancement of Science, on the resistance of cylindrical vessels to compression from an external and surrounding force. These experiments, which are still in progress, appear to contradict the opinion generally received by engineers, that a long cylindrical tube when subjected to *an uniform pressure* is equal in its power of resistance to a short length of the same tube. It has been found, however, in the recent experiments, that the flue of a boiler is weakest in the middle of its length, and that by increasing the length the strength is diminished in the ratio of that increase. Such a result seems inexplicable by the known action of uniform pressure, and we shall wait with much interest for the details of the experiments and their final indications, to ascertain whether some error may not lurk under the arrangements adopted for testing the strength of the tubes and the uniformity of the pressure. Assuming the pressure to be uniform, the flue would be equally supported on every side and in every part of its length. It seems reasonable, therefore, to infer that if a tube be marked into lengths equal to its diameter, each length will be equally strong. We cannot help suspecting that some circumstances have been omitted to be taken into consideration during the experiments which have vitiated the results.

Subjoined is the notice of these experiments as given in the Appendix:—

Notice of Experiments on the Collapse of Cylindrical Vessels now in Progress.

When treating of the causes of boiler explosions arising from the collapse of internal flues, our knowledge was at that time so imperfect as to limit the inquiry to a few simple observations relative to collapse from the heating of the plates, or from the formation of a partial vacuum within the boiler when it was forced inwards by atmospheric pressure.

Collapses arising from these causes it was observed at the time "could scarcely be called boiler explosions," but I have since had reason to alter my opinion from the weak and apparently defective state of the internal flues of boilers when exposed to severe strain from the pressure of the surrounding water contained in the boiler. I, in common with other engineers, had acted under the impression that perfectly cylindrical tubes, when subjected to a uniform pressure converging upon their centre, were equal in their powers of resistance irrespective of their length. Doubts, however, having arisen as to the accuracy of this conclusion, from symptoms of weakness in the flues of a boiler, I determined to submit the question to the test of experiment; and having applied for assistance to the Royal Society and British Association for the Advancement of Science, the means were placed at my disposal, and a long series of experiments were undertaken, which I hope will shortly be given to the public in the transactions of those bodies.

In the interval, however, it may be expedient to notice that former opinions were erroneous, and that instead of being of uniform strength throughout, the flues of boilers are weakest in the middle, and that by increasing their length their strength is diminished in the ratio of that increase. Or, which is the same thing, the strengths of tubes are proved to be inversely as their lengths. For example, the internal flue of a boiler 10 feet long will sustain double the pressure of a similar flue of 20 feet long.

This result alone is of such importance as to indicate the necessity of an entirely new mode of construction, and we hope at no distant period to show upon what principle the flues should be designed in order to arrive at uniformity of strength in all parts of the boiler.

ATTRACTIVE FORCES.

Professor Faraday has recently delivered a course of six lectures "On Attraction" at the Royal Institution. Though intended chiefly for a juvenile audience during the Christmas holidays, yet his great power of illustration and his brilliant style of lecturing never fail to give a degree of novelty and interest even to elementary subjects, and he always attracts crowded audiences of all ages. This was especially the case during the course of lectures concluded on the 8th ult., the presence of the Prince of Wales, who came from Windsor each time, attended by his tutors, contributing no doubt to crowd the lecture-room.

The first five lectures were devoted to the separate considerations of the attractions of gravitation, of cohesion, of chemical force, of electricity, and of magnetism, and in the sixth lecture he reviewed generally the phenomena of those forces, and showed their intimate relations to one another; thus leading to the conclusion that, though apparently distinct and different, they are in reality but various modifications of the same force.

He commenced by endeavouring to impart a clear idea of the action of attractive force, and for that purpose he used a powerful electro-magnet, over which was laid a slanting board. A cylinder of iron drawn upwards on the inclined plane, and strongly adhering to the board when over the poles of the magnet, was an illustration of the force of attraction directly evident to the senses; and the rolling down of the cylinder, when contact with the voltaic battery was broken and the electro-magnet became inert, served to illustrate gravitation, which, though equally an exhibition of attractive force, is less cognisable to the senses because it acts equally on all bodies. Professor Faraday was particularly anxious to impress on his audience the fact of the universal action of the attraction of gravitation, and that it exerts the same influence on the lightest as on the heaviest substances. A small piece of platinum was contrasted with a bar of aluminium of equal weight, to show the different specific gravities of the same class of bodies; it being observed that though aluminium is the lightest of all the workable metals, being four times lighter than silver, and eight times lighter than platinum—in many of its properties it is a better metal than the heaviest, since it is more lustrous and conducts heat and electricity better than platinum. Though platinum and aluminium are unequal in weight, yet both are equally acted on by the force of gravitation, as proved by their falling to the ground in the same time. The equal attraction exerted by gravitation on light and heavy bodies was further shown by numerous experiments. To illustrate that the rising of a balloon in the air is caused by the pressure of the atmosphere and not by its specific levity, a large solid ball of iron was made to rise in a glass vessel when surrounded by a heavier liquid medium, mercury. A curious illustration of the different weights of aeriform bodies was afforded by floating a small balloon filled with common air on carbonic acid gas, and that gas was ladled from one vessel into another with a ladle in the same manner as a tangible liquid. In alluding to the attraction of gravitation between the sun and the planetary bodies, Professor Faraday particularly noticed the discovery of the planet Neptune by the disturbance its attraction occasions in the movement of Uranus; the discovery being, as he said, less attributable to the astronomer gazing at the heavens, than to the philosopher calculating in his study—the planet having been "felt out" before it was seen.

In considering the attraction of cohesion, Professor Faraday adverted to the law that the attraction of gravitation is inversely as the squares of the distance; and he rather led it to be inferred than stated directly, that the attraction of cohesion is the same force as that of gravitation, but acting intimately between the particles of bodies. This branch of the subject, however, was not very clearly explained, nor did the illustrations bear so directly on it as is usual with Professor Faraday; but it might be gathered from what he said, that as each particle of matter has its specific centre of gravity, from which points the law of distance begins to operate, the more minute the particles, and consequently the nearer their centres of gravity are brought to each other, the greater is their respective attractions, the force of cohesion being in those cases stronger than when the centres of gravity are farther apart. Among the experiments introduced to illustrate the influence of heat in diminishing the attraction of cohesion, was the application of the flame of a spirit lamp to a wire suspending a heavy weight, and the consequent fracture of the wire.

The lecture on chemical attraction was principally directed to the illustration, by a number of brilliant experiments, of the action of chemical affinities in changing the characters of the bodies on which they operate.

In the lecture on electrical attractions the peculiar characteristics of electric force were pointed out and exemplified, peculiar stress being laid on the temporary nature of that kind of attraction, in which respect it differs from the other attractive forces. As an illustration of the frequent excitement of electricity under circumstances when not thought of, Professor Faraday placed his hand on the top of a gold-leaf electrometer whilst he rubbed his feet on a rug, and on removing his hand the gold leaves diverged by the electricity thus excited.

On commencing the lecture on magnetism, a mass of loadstone was held suspended by a string as an illustration in itself of all the attractive forces. Its weight indicated the attraction of gravitation; its solidity and hardness represented the attraction of cohesion; the combinations of the oxygen and iron in its structure exhibited chemical affinity; a charge of electricity was communicated to the loadstone to make it exemplify electrical attraction; and the peculiar property it possessed of attracting iron and steel showed its magnetic attraction. The induction of magnetism in soft iron on the approach of a magnet without touching was exhibited; and the curious fact that the magnetism of the earth possesses the same power of communicating the force, was shown by the following simple experiment. A magnetised steel bar was delicately balanced, and a kitchen poker, held in the magnetic meridian and inclined to the magnetic dip, was brought near it. When held in that position the poker exhibited the properties of a magnet, one end of it attracting and the other end repelling the magnetised bar; and by reversing the ends of the poker, its poles were changed. A few blows with a hammer when held in that position gave a degree of permanency to the force, which otherwise disappeared the instant that the position of the poker was changed. The remarkable disappearance of magnetic property in a horse-shoe magnet when the two poles are connected by a piece of soft iron, indicates, in Mr. Faraday's opinion, that there is a current of force emitted from each pole of a magnet as from the poles of a voltaic battery; and that when connection is made between them by a good conductor like soft iron, the circuit is completed, and for that reason the magnetic effects are not perceptible beyond it.

The relation of the various attractive forces to each other was exemplified in the last lecture by a variety of experiments showing that chemical affinity, electricity, and magnetism are convertible into one another. Having, for instance, given an illustration of chemical action by the combustion of iron in oxygen gas, by the combustion of zinc foil in the air, and by the solution of copper and its subsequent deposition on steel by dipping a knife into the solution, the influence of the contact of dissimilar metals in changing chemical action was shown, by causing the deposition of copper from its solution on to silver when in contact with steel, though no such deposition takes place on silver when not in contact with a metal more readily oxidizable than itself. The effect thus produced was next shown to be caused by the electricity excited by the contact of dissimilar metals, the action of Zamboni's pile, in which the voltaic action is concentrated by a great number of alternations of metal leaves, serving to indicate that voltaic action and electricity are one and the same. Electricity having thus been eliminated from chemical action, the latter was shown to be governed by electricity. Litmus paper and turmeric paper were placed in the voltaic circuit, and the litmus was turned red by contact with one of the poles of the voltaic battery, and the turmeric turned brown by the action of the other, in the same manner as if the former had been exposed to the action of an acid and the latter to that of an alkali. On reversing the poles of the battery, the blue colour of the litmus, and the yellow colour of the turmeric paper were restored. The conversion of electricity into magnetism by the formation of electro-magnets, and finally the conversion of magnetism into electricity, were exhibited; the original magnetic-electrical machine, invented by Mr. Saxton, being produced as an illustration that electricity may be obtained by magnetism of great intensity and quantity. The convertibility of these forces into one another proves, as Professor Faraday observed, that however different they appear to be, they are but modifications of the same force; and the important problem now remaining to be solved by philosophers is the discovery of the nature of the force that can be thus modified to produce such various effects.

NEW EDUCATIONAL MUSEUM.

The Committee of Privy Council on Education have arranged to open the New Educational Museum at the New Buildings, South Kensington, in the spring. It is hoped the museum will afford great help to all classes of the public in carrying out the work of national education, and especially those engaged in teaching. The museum will exhibit, under a proper classification, all important books, diagrams, illustrations, and apparatus connected with education, already in use or which may be published from time to time, either at home or abroad. The public will be admitted free as a public exhibition on certain days of the week; and on other days, which will be reserved for students, opportunity will be given to examine and consult the objects with the utmost freedom. The objects exhibited at St. Martin's Hall in 1854, which were presented to the Society of Arts, and by that society given to the Education Board in order to found a museum, will form part of the Educational Museum. The producers o apparatus, books, diagrams, maps, &c., used in teaching, will have the privilege—subject to certain regulations—of placing their publications and productions in the museum, and thus making them known to the public; and we understand that a unanimous desire to assist has been expressed by all the great educational societies and publishers. A catalogue will be prepared, which will contain the price lists which exhibitors may furnish for insertion. The books and objects will be grouped under the following divisions:—1. School buildings and fittings, forms, desks, slates, plans, models, &c. 2. General education: including reading, writing, grammar, arithmetic, mathematics, foreign languages, histories. 3. Drawing and the fine arts. 4. Music. 5. Household economy. 6. Geography and astronomy. 7. Natural history. 8. Chemistry. 9. Physics. 10. Mechanics. 11. Apparatus for teaching the blind and the deaf and dumb.

THE NEW SCHOOL OF ART AT SHEFFIELD.

The building has just been completed, and reflects the greatest credit upon all who have had the management of it. The entire cost, with fittings, purchase of land, is 7100*l*.

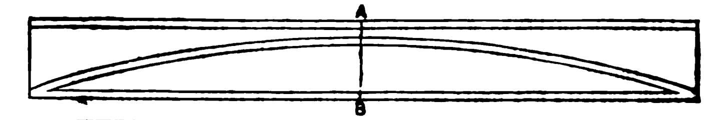
The general form of the building is that of an irregular L, and it is erected on sloping ground, so that the back part of the building is four stories high, and about 70 feet wide, and herein its magnitude consists. The main entrance is in Arundel-street, and opens into the vestibule on the right hand, while on the left is the library and council room. To the right of the passage is the geometrical room, for the study of architecture, engineering, machinery. Proceeding along the lobby, we pass the foot of the grand staircase, and reach the theatre or lecture-room, which will also be used as the life model room. The whole width of the back part of the building on this floor is occupied by the room for the elementary classes, its proportions being about 70 feet by 39 feet, and 21 feet high. A second staircase conducts down to the modelling room, sub-master's room, and cloak room for the students. The ground-floor is appropriated to rooms for casting in clay; fuel, warming and ventilating apparatus. The porter or attendant is housed in premises which can be approached without having to go out of doors. Retracing our steps we ascend the grand staircase and enter the corridor, at one end of which is a most elegant room, occupying the entire front of the building upon this floor, and devoted to the use of the ladies' classes. The head master has accommodation opposite the head of the grand staircase, and over the geometrical room. To the left of the stairs, and over the theatre, is the painting room, lighted by lofty side windows and a skylight, either of which can be used as required. At the end of the corridor, and over the elementary room, and of similar proportions, is the grand cast gallery. This is a beautiful room for the purpose, and one in which the council have acted judiciously in adopting the only alterations of any magnitude needed, or even suggested, in the original design of the building—that is to say, elevating the walls about three feet, and connecting them with the skylight by an elegant cove. Over the front part of the building, facing Arundel-street, are a series of private studios, lighted by skylights, for the advanced students, to use when competing for prizes. All the arrangements for lighting, warming, ventilating, washing, &c., throughout, are of the most complete and effective kind. Great credit is due to Messrs. Manning and Mew, the architects, and to Mr. T. E. Mycock, the contractor.

CAST IRON BEAMS.*

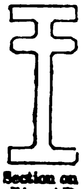
By Thomas Davies, F.A.I.S.

Whatever be the recommendations of wrought iron for Beams, there will always remain many cases in which it will be expedient to use cast metal for the same purpose. It is desirable, therefore, that when the latter is adopted, it should be used with an appreciation of its properties, and of the proportions required for the different parts of the Beam, so as to attain a given strength with the least amount of material.

I do not think there is sufficient attention paid to this, at least in this locality, if we may judge from the sections of the Beams used in this city, in so far as they have come under my observation: For instance, I may refer to a description of Beam which I have noticed several times, and of which the annexed is a sketch—



Elevation.



Section on Line AB

In this case the arched rib is quite useless, occupying the worst position in which the metal composing it could be placed. At the middle of the Beam it occupies as nearly as possible the position of the neutral axis, where there is neither a force of compression nor one of extension acting, and where, consequently, the metal is completely thrown away. Were the Beam cast plain, it would be quite as strong, and would be more easily modelled and moulded, and the casting would more likely be better; whereas, if the metal of the arched rib were thrown into the lower flange, the Beam would be very considerably strengthened.

But leaving this particular instance, I think there is generally very little attempt made to approximate to the strongest section of Beam. There are no doubt many particular cases in which this cannot be followed out, as, for instance, where it is required to have the upper flange broad for the purpose of receiving its load; but still I think, that even in such cases the strongest section might more nearly be approximated to than seems usual.

I do not attribute this to a want of knowledge of what is written on the subject, so much as to a want of confidence in what is written. I believe there is a feeling, that although a certain section may be the strongest for Beams carefully cast, carefully handled, and carefully loaded, yet is doubtful how far it may be the strongest, or at all events the best, for ordinary practical purposes. This feeling, however, may be carried too far, and though we do not go to the extreme of what is shown to be the strongest section by experiment, we ought to approximate to it much more closely than we do, and as far as other considerations will allow.

That which is required to give the strongest section may be stated in a general way to be—to throw as much of the material as possible out of the web into the flanges, and—to make the lower flange considerably larger than the upper.

Mr. Hodgkinson, in a paper in the Memoirs of the Manchester Philosophical Society, gives as the results of his experiments, that the under flange should be to the upper in the proportion of 6 : 1. His experiments having been extensive and carefully made, have ever since been considered the standard of reference, and I do not suppose that his conclusion on this subject has ever been called in question. However, having been led to examine his experiments for the purpose of condensing the results into a general law, or into a few statements that might be carried on the memory, I began to suspect that there was something wrong in the conclusion he had come to. At first I could scarcely bring myself to think that this could be the case, after Mr. Hodgkinson's paper had been so long before the public, and after a considerable portion of it had been incorporated into two of the best works we have on this subject—'Barlow on the Strength of Materials,' and 'Fairbairn on Cast and Wrought Iron,' by the authors of which, the opinions contained in it have thereby been homologated. I have looked, however, over the subject again and again, to see if by any possibility there might be lurking a fallacy in my reasoning, but I can see none. The conclusion then, on this particular point to which I have come, drawn from Mr. Hodgkinson's own experiments is, that the strongest section of Beam is that with flanges from 3½ : 1 to 4 : 1, instead of 6 : 1, as stated by Mr. Hodgkinson.

Before entering on the subject more particularly, I may indicate the nature of the oversight which I consider has been made by Mr. Hodgkinson. He gives the result of nine experiments on Beams, with double flanges of different proportions, from which he comes to the conclusion already stated. In comparing things together, as for instance in the present case, the comparison of the amount of strength due to the different proportions of upper and under flanges, it is necessary to have all other things equal, or that allowance be made for any difference, and Mr. Hodgkinson has accordingly had these Beams made of equal length and depth. He has, however, in his comparison left out of consideration the difference in the thickness of the webs.

Let us take an instance: The Beam No. 19 of Mr. Hodgkinson's experiments,* with flanges 6 : 1, the proportion considered by him the best, has a web containing only one-fifth of the sectional area, the other four-fifths being contained in the flanges which contribute by far the greater amount of strength to the Beam, so much so that Mr. Hodgkinson throws the web out of calculation altogether. The Beam No. 3, with flanges 4 : 1 has however, a web containing one half of the sectional area, so tha there is only the remaining half of the material contained in the flanges.

To compare the strength due to the different proportions of flanges in these two Beams, an allowance ought to be made for this difference. Let us take the material out of the web of the latter Beam, so as to reduce it to the same proportion as that of the former; namely, one-fifth of the sectional area, and let us put this surplus, amounting to 0·3 of the sectional area, into the flanges, where it may contribute its full value to the strength of the Beam. The area of the flanges, as already stated, is 0·5 of the sectional area; if then, we add 0·3 to this, we increase the strength of the Beam by three-fifths (that is, leaving out of consideration, in the meantime, the strength due to the web, which Mr. Hodgkinson neglects), so that this Beam, which broke with a weight of 2737 lb. per square inch of section, would, by this alteration, have its breaking weight increased by three-fifths of this amount, namely (2737 ÷ $\frac{3}{5}$ =) 1642 lb., making in all the breaking weight per square inch of section 4379 lb., while the Beam with flanges 6 : 1, broke with a weight of only 4075 lb. per square inch of section. But this is not all: the metal of which the latter beam was cast, was stronger than that used for the former, as shown by the standard Beam cast along with them for comparison. By supposing the former Beam to be cast of the stronger metal, we will have to allow a further addition to its strength of about 510 lb., so that the comparison will now stand thus:—

	Breaking Weight per sq. in. of Section.
Beam with flanges 6 : 1	4075 lb.
Ditto ditto 4 : 1	4889 „

giving an excess of strength in favour of the beam with flanges, 4 : 1, of about one-sixth.

But to enter on the subject more particularly and in detail—

Table I. shows the result of Mr. Hodgkinson's experiments, referred to in this paper.

Table I.

No. of Experiment.	Proportion of Flanges.	Strength per Square Inch of Section.		No. of Experiment.	Stand. Beam. Strength per Square Inch of Section.
1	1 : 1	2368 lb.			
2	2 : 1	2567 „	compared with	4	2584 lb.
3	4 : 1	2737 „			
9	4½ : 1	3183 „	do.	10	2792 „
11	4½ : 1	3214 „			
12	6 : 1	3346 „	do.	13	2693 „
19	6 : 1	4075 „			
20	6¾ : 1	3576 „	do.	22	2885 „
21	6¾ : 1	3883 „			

Average of Standard Beam ... ... 2738 lb.

* Continual reference requiring to be made to Mr. Hodgkinson's experiments, as recorded in the first part of Mr. Fairbairn's work on Cast and Wrought Iron, it will be necessary to refer to this work as being before us, as it would greatly and unnecessarily enlarge this paper, to incorporate with it all the experiments to be referred to.

* Read at a Meeting of the Architectural Institute, held in Edinburgh on Feb. 18, 1856.

The third column shows the actual load per square inch of section with which the different Beams broke. As these Beams were not all cast at the same time, and as it was impossible to secure, at different castings, metal of exactly the same quality, there was, at each set of experiments, a Beam of the same pattern, cast for the purpose of ascertaining the comparative strength of the metal used in each casting, in order to allow of a comparison between the experiments made at different times. The result of these experiments on the standard Beam are given in the last column.

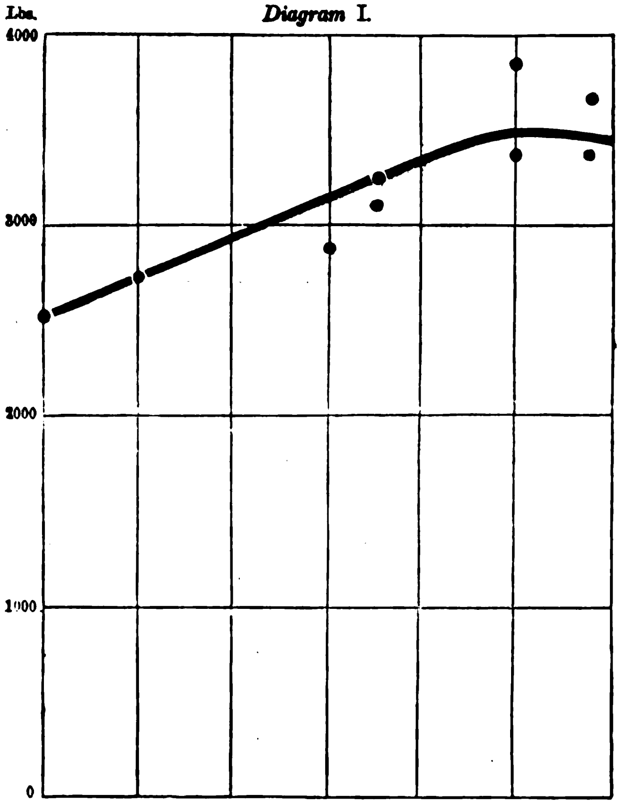
In order to compare the strength of the various Beams, we must reduce them to one standard. Let us take this standard to be the average strength of the standard Beam, which is 2738 lb. per square inch of section; then, by a simple question of proportion, we get Table II. instead of the former.

Table II.

No. of Experiment.	Proportion of Flanges.	Strength per Square Inch reduced to one Standard.
1	1 : 1	2509 lb.
2	2 : 1	2720 ,,
3	4 : 1	2900 ,,
9	4½ : 1	3121 ,,
11	4¼ : 1	3268 ,,
12	6 : 1	3402 ,,
19	6 : 1	3867 ,,
20	6¾ : 1	3394 ,,
21	6¾ : 1	3685 ,,

Diagram I. represents the same at one glance, the Beams, with flanges of different proportions, being marked off horizontally along the base or datum line, according to these proportions, and the various strengths of these Beams being measured by the height of the black dots above this base or datum line. The curved line represents, as nearly as possible, the law of variation of strength for Beams of different proportions of flanges, according to the above experiments.

Diagram I.



The preceding Table and Diagram just referred to, show, that of the Beams experimented on, those with flanges about 6 : 1 were the strongest. But, as already stated, there ought to be an allowance made for the difference in the thickness of the webs of the Beams experimented on, before we can compare the strength due to the different proportions of flanges.

There is some difficulty in making the calculations required for our purpose with exactness, on account of our want of knowledge of the exact proportions of the moduli of elasticity for compression and for extension of cast metal, and whether these are constant or vary in some way, as the pressure—of the amounts to which this material may be extended or compressed, without injury to it—and thus of the position of the neutral axis for different sections of Beams.

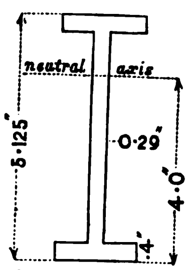
Were we to throw out of calculation the strength due to the web, we would be enabled to dispense with the consideration of the position of the neutral axis, &c., and the calculations required would be greatly simplified; while the difference, though comparatively small, would be still more in favour of Beams with the upper and under flanges of more equal proportions.

Although unable to fix the exact positions of the neutral axis for the various Beams, I have assumed probable positions according to the best of my judgment, considering that the assumptions, though perhaps not quite correct, will make a closer approximation to accuracy than leaving the question altogether out of consideration. I think, from calculations made on different assumptions of the position of the neutral axis, that any error that can arise from this cause will probably be under 3 per cent.

It may be noticed, in corroboration to some extent of the proximate correctness of the law assumed in regulating the position of the neutral axis in the different Beams, that the assumed positions agree very closely with those indicated by the fractures of the Beams in three of the four cases in which that position seemed to be thus indicated, although the law was assumed independently of these observations. Thus, in Beam No. 11, the assumed position is within 0·1 in. of the indicated position, while in Beams No. 19 and 21, the curve of the assumed law follows almost exactly the average between the indicated positions; in the former being 0·4 in. above, and in the latter 0·3 below these indicated positions.

It would be a needless labour, and a wearing out of the patience of this meeting, to attempt to go through all the calculations required to come to the results intended to be laid before you; but your attention is requested to the following, as an example of the process required to be gone through in each case.

In Beam No. 1, the depth of the bottom flange is 0·4 in., and the assumed depth from under edge to neutral axis is 4·0 in.



Suppose the beam below the neutral axis, divided into parts equal to the depth of the thickness of the flange, we will have 10 of these, the web occupying the upper 9, and the flange the 10th. The proportionate amount of strength contributed by each of these parts, is as the square of the distance of the part from the neutral axis. The distance of the centre of the upper part is ½, and the square of this is ¼, and let us call the amount of strength contributed by this upper part ¼. The distance of the centre of the second part 1½, and the square of this is 2¼, so that, in the same proportion, the amount of strength contributed by this part is 2¼; and so on, until we reach the 10th part, or part of the flange immediately under the web, the amount contributed by which in the same proportion is 90¼. If we sum this series, we shall find that the whole strength due to the 10 parts of 4·0 in depth is 332½, 90¼ of which is contributed by the 10th or lowest part, and the other 242¼ by the web.* But we have to take into account the whole flange. The flange being at the same distance from the neutral axis as the lowest or 10th part, it will contribute in the same proportion as that part to the strength of the beam. Now, the breadth of the flange is 1·75 in., or 5·83 times the thickness of the web, so that we have the proportionate strength due to it (5·83×90¼=) 526·16. Add this to the proportion of strength due to the 9 parts of the web, namely 242·25, and we have the proportional strength of the whole Beam, 768·41.†

* We get the same results more simply and more precisely, by taking the cubes of the respective depths from the neutral axis; thus, $10^3 : 9^3 = 1000 : 729 = 332·5 : 242·39$, and 332·5—242·39 = 90·11, as above, very nearly.

† Perhaps it is unnecessary to remind any, that the strain of tension on the part of

The actual strength of this Beam, as reduced to one standard, is, as already seen, 2509 lb. per square inch of section. By dividing this into the proportions above stated we shall get the amount contributed by the web to be $\left(\frac{242}{766}\times 2509=\right)$ 791 lb., and the amount contributed by the flanges to be (2509—791=) 1718 lb.

We have now to consider the alteration on these quantities produced by reducing the thickness of the web, and by adding the metal taken from it to the flanges.

As Beams, Nos. 12, 19, 20 and 21, being those of best section according to Mr. Hodgkinson's experiments, have, on the average, webs of about one-fourth of their sectional area, we shall take this as the quantity to which, for comparison, all the webs are to be reduced. We have then, in Beam No. 1, the area of the cross section, 2·82 in., of which the flanges occupy 1·425 in., and the web 1·395 in. The area of the web will now be one-fourth of 2·82 in., that is, 0·705 in., being a reduction of 0·690 in., which has to be added to the area of the flanges, making it (1·425+0·690=) 2·115 in.

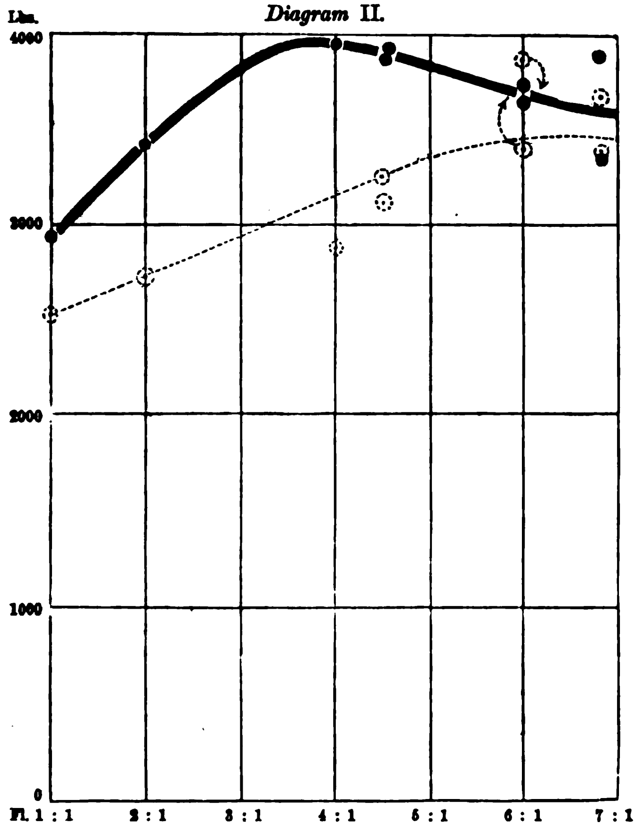
By this alteration in the section, we reduce the amount of strength contributed by the web by $\left(\frac{0\cdot690}{1\cdot395}\times 791=\right)$ 391 lb., while we increase the amount of strength contributed by the flanges by $\left(\frac{0\cdot690}{142\cdot5}\times 1718=\right)$ 832 lb., which gives an increase to the strength of the beam equal to the difference of these two quantities, namely, 441 lb., making the strength of the Beam, No. 1 (altered so as to have the web one-fourth of the sectional area) to be 2950 lb., per square inch of cross section, instead of 2509 lb.

If the same process be gone through with all the Beams, we shall have the results as given in Table III.

Table III.

No. of Beam.	Proportion of Flanges.	Area of Cross Section.	Area of Flanges.	Area of Web.	Proportion of Web to Cross Section.	Strength per Square Inch reduced to one Standard.	Difference on account of thickness of Web.	Strength per Square Inch, when Web reduced to ¼th Cross Section.
		in.	in.	in.		lb.	lb.	lb.
1	1 : 1	2·82	1·425	1·395	0·494 : 1	2509	+ 441	2950
2	2 : 1	2·87	1·43	1·44	0·501 : 1	2720	+ 703	3423
3	4 : 1	3·02	1·52	1·50	0·496 : 1	2900	+ 1050	3950
9	4⅓ : 1	3·37	1·927	1·443	0·427 : 1	3121	+ 760	3881
11	4⅓ : 1	4·50	2·70	1·80	0·400 : 1	3268	+ 642	3910
12	6 : 1	5·00	3·38	1·62	0·324 : 1	3402	+ 343	3745
19	6 : 1	6·40	5·12	1·28	0·200 : 1	3867	— 229	3638
20	6¾ . 1	6·50	4·95	1·55	0·238 : 1	3394	— 47	3347
21	6¾ : 1	5·41	3·808	1·602	0·296 : 1	3685	+ 208	3893

Diagram II.



On Diagram II. the large dots and curved line represent to the eye the same results, and the nature of the law which they follow, while the small points within the dotted circles, and the dotted curve, are the same as those shown on Diagram I. On examination it will be seen, that the result of our investigations, in so far as refers to the strongest section of Beam, is that with the web one-fourth of the sectional area; this is obtained with flanges rather under 4 : 1.

Before proceeding further, we may notice, as a corroboration to some extent of the correctness of these investigations, first, that in the two pairs of experiments, Nos. 9 and 11, and Nos. 12 and 19, the results, after the required corrections are made, approximate very closely, the former so as almost to coincide; and secondly, that all the results (with the exception of the last) arrange themselves so as to allow the curve to follow them almost exactly. In the case of the last pair of Beams, Nos. 20 and 21, the discrepancy is increased by the corrections made; but still it is satisfactory to notice that the curve follows nearly the average of the two. As to this discrepancy, it perhaps arose from some inequality in the castings, or some other of those causes alluded to in the former part of this paper; but the effect has doubtless been increased by the lowness of the neutral axis. This was probably about 1¼ inch from the under edge of the Beam, giving the effective leverage of the flange round the neutral axis as 1½ inch on the average; so that any small difference in the quality of the metal, or any other cause affecting the position of the neutral axis, would give a comparatively greater difference in the strength of the Beam than would have been if the neutral axis had been higher.

These remarks point to another corroboration of the investigations in this paper. In experiment 19 and 21, the fractures indicated the neutral axis to be 1·23 and 1·80 inches from the under edges of their respective Beams. Now this seems to indicate, that by a comparatively small addition to the upper flange, by which the neutral axis would be considerably raised, the strength of the Beams would thereby be increased much more than in the proportion of the amount of metal added.

The foregoing calculations have been made on the assumption of the web being one-fourth of the cross section, as that was about the average of the webs of the Beams of strongest section, according to Mr. Hodgkinson. I have also calculated the strength of the Beams, on the assumption of the web being one-half of the cross section, which is the proportion in the case of Beams, Nos. 1, 2, and 3. The result is given in Table IV. and Diagram III., which indicate that in this case the Beam of strongest section is that with flanges 3½ : 1.

the Beam, below the neutral axis, is equal in amount to the strain of compression on the part above it, and that therefore this latter does not require to be calculated, it being sufficient, in comparing the strength of Beams, to assume the whole strength of the Beam as depending on the resistance to extension.

I have also laid down, on the same diagram, the curve representing the comparative strength of Beams with different proportions of flanges, when web is one-third of the sectional area.

Table IV.

No. of Beam.	Proportion of Flanges.	Strength per Square Inch reduced to one Standard.	Difference on account of thickness of Web.	Strength per Square Inch when Web reduced to ⅓ Cross Section.
1	1 : 1	2509 lb.	— 0 lb.	2509 lb.
2	2 : 1	2720 ...	— 0 ...	2720 ...
3	4 : 1	2900 ...	— 0 ...	2900 ...
9	$4\frac{1}{3}$: 1	3121 ...	— 305 ...	2816 ...
11	$4\frac{1}{2}$: 1	3268 ...	— 428 ...	2840 ...
12	6 : 1	3402 ...	— 816 ...	2586 ...
19	6 : 1	3867 ...	— 1371 ...	2496 ...
20	$6\frac{3}{4}$: 1	3894 ...	— 1098 ...	2296 ...
21	$6\frac{3}{4}$: 1	3685 ...	— 917 ...	2768 ...

Diagram III.

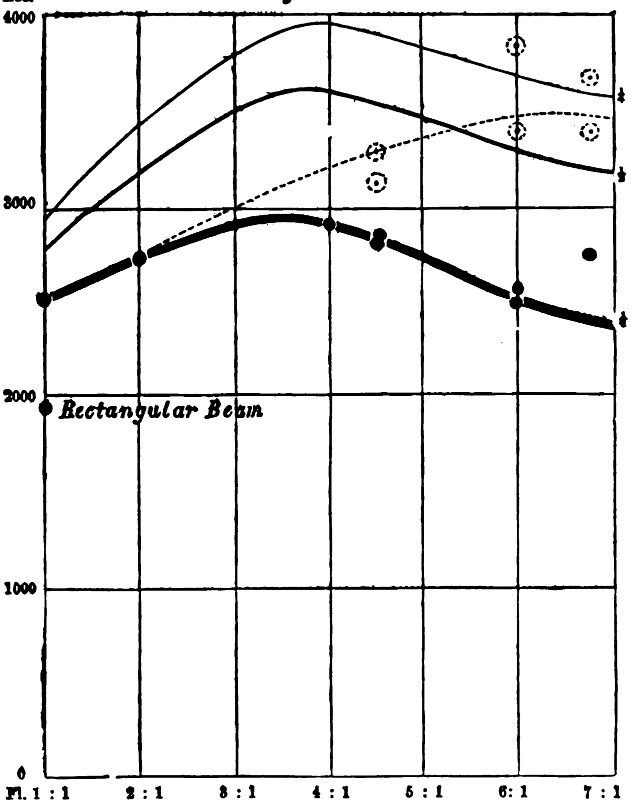


Table V. (Plate V.) is for the purpose of getting the assistance of the eye, in forming a judgment on the comparative eligibility of the various sections of Beams. The depth and area of cross section are the same in all; the upper row has the area of the web one-fourth of the cross section, the second row one-third, and the third row one-half of the cross section—a rectangular Beam of the same area being placed alongside each row, for the sake of comparison. The depth of the Beams is 12 units of any kind: the area of cross section will then be 20. The figures above the Beams give the comparative strength of each, the Beam of strongest section for each particular row being taken as unity. The figures below the Beams give the strength of each, the Beam of strongest section in the upper row (that is, with the web one-fourth of the cross section) being taken as unity. It may be noticed that there were no experiments by which the exact comparative strength of the rectangular Beam could be determined. The strength in the table is therefore given in round numbers, being only approximative, for the purpose of giving some idea of the strength of a Beam without flanges, as compared with those with flanges. The correct strength, however, is probably nearly 5 per cent. less than that stated.

On examination of these respective sections, I think it will be generally considered that the web, one-fourth of the sectional area, is too thin for ordinary practical purposes. On the other hand, the web, one-half of the sectional area, appears to me to be unnecessarily thick; whereas the web one-third of the sectional area seems to be more nearly of a proper proportion. In Beams, where the depth is greater in proportion to the sectional area than that here assumed, it might thin the web too much to retain this proportional area of one-third. In this case it would be necessary to increase the proportion of the web; but probably in no case would it be necessary to do so to a greater proportion than one-half of the sectional area.

On examination of the curves on Diagram III., it will be seen that there is very little difference in the strength of Beams on each side of the maximum. Now, as it is generally desirable, for other reasons, to have the flanges of more equal proportions than those of maximum strength, it will be advisable to consider, in the case of Beams with the web one-half of the sectional area, the strongest section to be that with flanges 3 : 1, instead of $3\frac{1}{2}$: 1, and in the case of Beams with web one-fourth of the sectional area, the strongest section to be that with flanges $3\frac{1}{2}$: 1, instead of about 4 : 1.

From these considerations we come to the conclusion, that for general purposes, THE MOST ELIGIBLE SECTION OF BEAM IS THAT HAVING A WEB FROM ONE-THIRD TO ONE-HALF OF THE SECTIONAL AREA, AND FLANGES FROM $3\frac{1}{2}$: 1 to 3 : 1, according to circumstances.

There are some things, arising out of these investigations, which I felt desirous of laying before this meeting, such as rules for calculating the strength of Beams, taking into account the proportions of both flanges and web, neither of which Mr. Hodgkinson's rule does; but I have been prevented by ill health from entering into these investigations so thoroughly as to be satisfactory; and besides, this paper has probably stretched out to a sufficient length for the present. Perhaps I may have the honour of submitting some further remarks to the Institute on a future occasion.

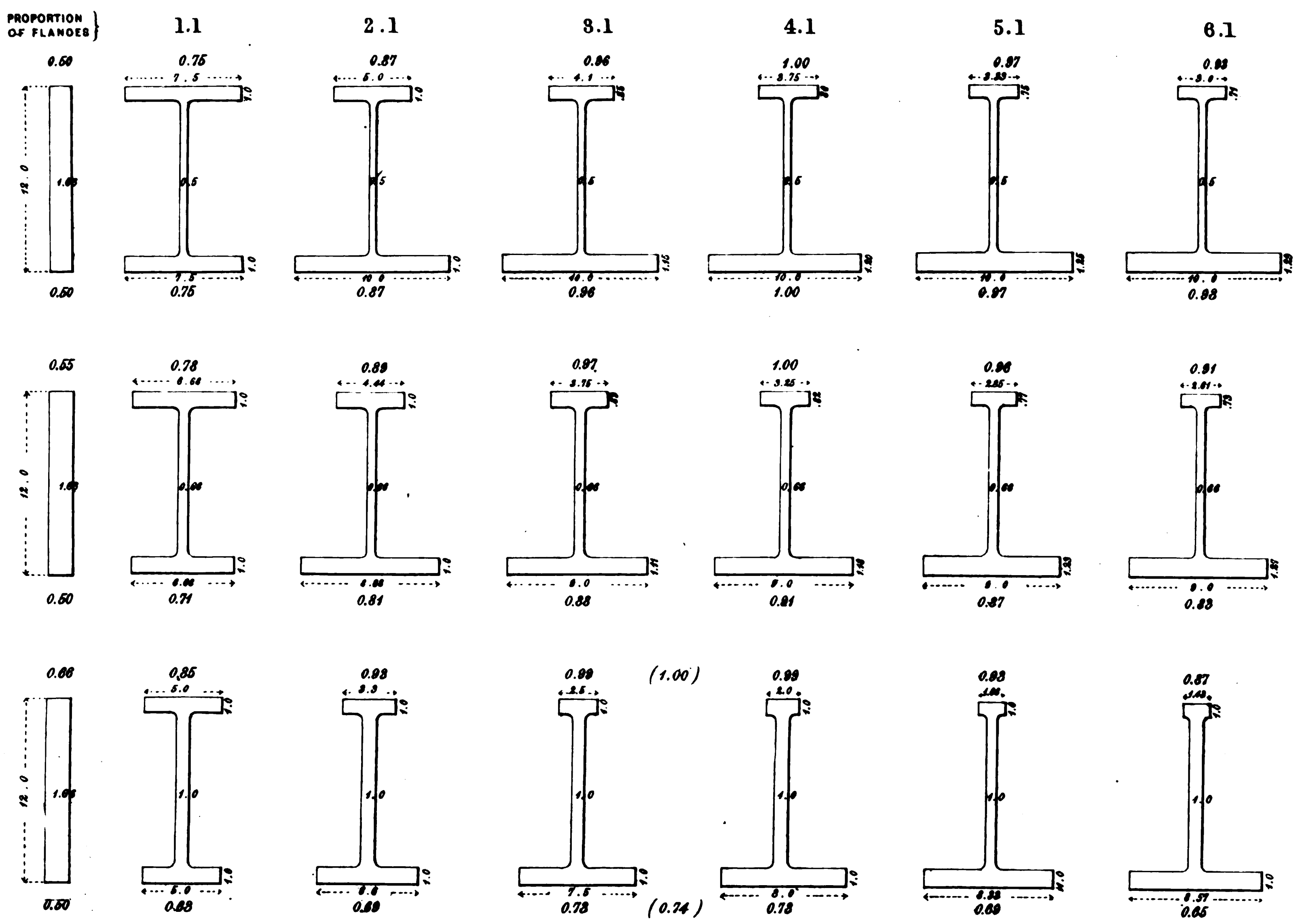
The investigations and calculations of this paper have been founded wholly on the experiments of Mr. Hodgkinson. I have not the slightest reason for doubting the accuracy of these, as they seem to have been made with the utmost care, and are most minutely detailed; yet having come to different conclusions from those of the author of the experiments, it would be satisfactory to have these conclusions tested by a set of experiments arranged specially for the purpose of fixing the law of variation in the strength of Beams of different sections.

I have therefore respectfully to propose, that this should be taken up by the Institute.

In the case of it being agreed to do so, I have to suggest, that the experiments be made with Beams cast from carefully formed patterns, so as to be exactly of the under-stated dimensions and proportions—all the Beams to be 5 feet long and 5 inches deep, and of exactly the same sectional area, and to be tested at a bearing of 4 ft. 6 in. The first Beam to be rectangular, the second with flanges 1 : 1, the web of this, as of the following, being one-third of the sectional area; the other Beams to have flanges in the respective proportions of 2 : 1, 3 : 1, 4 : 1, 5 : 1, and 6 : 1. There ought to be at least three castings of each, so as to obtain the average, and to avoid exceptional cases.

The Royal Engineers have now destroyed nearly one-half of the Old Bridge at Rochester, and the remainder will be demolished as speedily as possible. The quantity of gunpowder used in the first of the two experiments made was 300 lb. weight, divided into six charges, and therewith a pier, 45 feet long, 21 feet deep, and 13 feet wide, was shivered to pieces, and the foundations loosened. The pier was built on piles in the river bed. The object was to shake the whole without tumbling it into the river, a result completely effected. The weight of powder used in the explosions was nearly 1000 lb., and was divided into the same number of charges as in the previous experiments. Since November, the sappers and miners have been engaged in sinking two shafts in this portion of the bridge, to the respective depths of 24 feet and 21 feet, one in the pier, and the other in the abutment. At the base of each shaft sprang two galleries, each 9 feet in length, and in these were deposited the charges. The powder was contained in tin waterproof cases, enclosed in wooden boxes, 500 lb. for the pier and arch, and 300 lb. for the abutment.

EXPERIMENTS ON THE STRENGTH OF CAST IRON BEAMS.



J.R.Jobbins.

REGISTER OF NEW PATENTS.

STOP OR REGULATING VALVE.

W. H. Westwood, T. Wright, and E. Wright, Dudley, *Patentees*, June 11, 1856.

This invention consists in a peculiar arrangement of the internal parts of the chamber or valve box, by which more accurate fitting surfaces and the means of closing or opening the passage way or passage ways of such valve chamber may be worked under pressure with greater ease than heretofore, and the risk of leakage avoided.

The valve consists of two hemispherical cups, of cast-iron or other metal, secured to each other by flanges, and having a branch or short pipe upon each for the purpose of connecting the mains or pipes thereto. On the inner surface of one of these hemispherical cups is cast or fixed a circular face of metal, having two openings, whose figure is nearly a sector of a circle, the area of the two openings exceeding the area of each of the branches or short pipes before mentioned; this face is turned in a lathe, or otherwise made true and even, and upon this a disc of iron or other metal is placed having the openings corresponding with the two openings in the fixed face. This disc is made to rotate upon a centre pin which is in the centre of the fixed face, and is kept firmly on its face by a steel spring. The edge of this rotating face has a segment of a tangent wheel upon it, and motion is communicated to the same by a screw, by which means the openings in the disc and fixed face can be brought opposite to each other, which constitutes the opening of the valve, or reversed, and the valve is thus closed at pleasure. It can also by the same means be regulated or partly opened, to a greater or less extent, as may be required. There may also be an indicator upon the spindle of the screws which traverse upon two slides, and these slides form the screws for the packing of the screw spindle. The use of this indicator is to show when the valve is opened or closed. The valve is applicable to steam, gas, air, water, or any other fluids, and is capable of sustaining great pressure. For some purposes the surface of the disc may require to be covered with brass or other metal, but for all ordinary purposes iron faces are considered sufficient, as the faces are always in contact; corrosion is thereby avoided, and an extension of the durability of the valve effected. This valve having no rack or long screw, or other external appendages, occupies a smaller space, and can also be worked by a shorter and more convenient lever than is now generally required for such purposes.

Claim.—The peculiar form and arrangement of the internal and working parts of a valve box or chamber, as described, for a stop or regulating valve suitable for gas, water, steam, or other fluids.

CASTING MALLEABLE CAST IRON IN METAL MOULDS.

D. Morrison, Bordesley Works, Birmingham, *Patentee*, June 4, 1856.

Heretofore numerous articles have been cast in a description of iron known as malleable cast-iron, which, after casting, may be annealed, as is well understood; and when casting these articles, sand moulds have always been employed.

This invention consists in the use of metal moulds when casting articles from this description of iron, by which the articles may be cast with greater rapidity and with a less expenditure of labour.

In manufacturing articles of what is known as malleable cast-iron (iron which can be cast into form and then brought into a soft state by annealing), it has been usual to employ sand moulds. The patentee makes use of moulds of metals, giving the preference to cast-iron, and each mould of two or more parts, according to the nature of the article to be cast. The parts of each mould are made to fit accurately together, and the interior surfaces rendered very smooth. When using such moulds, the interior surfaces are smoked or brushed over with black lead, and the moulds are then heated to a low black heat before running in the metal. By thus employing metal moulds the same may be used again and again, and the articles cast therein will not only be more smooth, but a considerable saving will result in not having to make a new mould for each article to be cast.

BLOCKS AND BRICKS FOR BUILDING.

J. Briggs, Fleet-street, *Patentee*, June 4, 1856.

This invention consists in constructing the parts of blocks and bricks for building, whether of wood, stone, iron, earthenware, clay, or other suitable substance, in various forms corresponding with each other, and so that each separate block or brick has apertures into which may be inserted rods, bars, pins, ties, or bolts, so as to hold the blocks or bricks together. The apertures are so formed and placed that upon any two or more blocks being brought together in the position they are intended to occupy, one or more of the apertures in each block shall correspond with, or come opposite to, one or more apertures in the next block or blocks, to allow of the passage of the tie rods through them, or of their being slipped on the tie rods.

To put the brickwork together, the holes or apertures are placed so as to correspond; a pin or plug, formed of wood, iron or any other suitable material, is then driven through the holes, and mortar being placed between the bricks the whole is made perfectly secure. The blocks may be secured with pins or plugs, and are laid in the same way as ordinary brickwork, so that the joints of the different bricks shall not correspond. Grooves or channels may be formed on all sides, ends, and faces of these bricks and blocks which will admit of mortar, cement, or other suitable material being employed as well as the tie pins.

The patentee builds a paving of these blocks with the tie rods placed horizontally, giving a good foot-hold for horses by chamfering off the upper edges of the blocks and making grooves in them.

Claim.—The construction of blocks and bricks for building with two or more aperture made therein, in the manner described, for the purpose of receiving two or more pins to tie, hold, and unite together any number of the same employed to build a wall, or paving, or other structure.

SHAPING, PRESSING, AND ROLLING MALLEABLE IRON AND STEEL.

H. Bessemer, London, *Patentee*, May 31, 1856.

When ingots or masses of malleable iron and steel are formed by pouring or running the metal in a fluid state into moulds, it is generally found that the ingots or masses so produced are more or less spongy or cellular, and that owing to this circumstance, and to their crystalline condition, such cast ingots or masses are apt to be crushed or broken when put between rollers of the kind now ordinarily used for rolling malleable iron; it has also been found that the ordinary rolling mill does not afford the desired facility for rolling with heavy masses of metal, such as may be produced by casting. The object of this invention is to lessen or remove these disadvantages of the ordinary rolling mill. The apparatus employed by the patentee consists of a pair of stout frames or standards of cast-iron, further strengthened by rods or bars of malleable iron, and which are secured to a massive bed plate mounted on masonry. Between these standards are placed two segments of a cylinder or roll of very large diameter; the curved surfaces of such segments are placed next to each other, and each one is capable of motion on an axis working in suitable bearings formed in the standards, before mentioned. The curved portion of the segments formed of chilled iron or steel, and the other part of cast-iron, and one or both sides of them should be provided with segmental spur gearing, so arranged as to insure a corresponding motion of each segment, one or both of which is to be attached to a connecting rod or rods. The opposite ends of these rods are also to be connected to a crank, the constant rotation of which will produce a reciprocating motion of the segments. The crank shaft should have on it a heavy fly-wheel to regulate the motion, and it may also serve as the crank shaft to any convenient form of steam engine; or the crank shaft of the segment mill may be actuated by any suitable gearing driven by steam or water power. The face of the segments are to have grooves formed therein, similar to the grooves formed on the rolls at present in use for rolling bar iron, so that the ingot of cellular metal will thus be supported laterally during the pressing operation, and will be prevented from being crushed or broken to pieces, and will be so acted upon on every side as to weld or close up any cavities that may have existed therein, and thus render the ingot solid, and capable of bearing the action of the ordinary rolling mill. If the segments employed are parts of circles of from 10 to 20 feet in diameter, they will press on a much greater length (at one time) of the ingot than would be the case if ordinary rollers of about 18 inches in diameter were used, and also there will be much less tendency to separate the ingot into pieces when pressed between such comparatively flat surfaces as are presented by the large segments before described. The reciprocating motion communicated by the crank to the segments will cause them to act on the ingot both in passing between them, and on its coming back to its original position, so that no time will be lost in the process, and the labour of returning the mass of metal by hand, as practised in ordinary rolling mills, will be avoided. In order to bring the curved faces of the segments nearer to each other as the compressing and elongating proceeds, a hydraulic press cylinder is used, having a short ram acting on the brasses, in which one of the segments rests; a force pump, actuated by any convenient moving part of the machine, will inject a regulated quantity of water into this cylinder at each motion of the segments, and will thus bring them nearer together; or any convenient arrangement of screws or eccentrics may be used in lieu thereof if desired. At both sides of the apparatus several light guide rollers are fitted up for the purpose of receiving the mass of metal, and allowing the workman to move or turn it over as required. The ingot or mass of metal may thus be pressed and shaped into the form desired, or it may be finished by rolling in a suitable rolling mill until it is reduced to the desired form and dimensions.

In the rolling of ingots or masses of cast malleable iron or steel, care should be taken that the pressure put on them should not be such as to cause too great an elongation of the ingot at each time of passing it through the rolls; this point should be attended to more especially in the early stages of the process, or before the fibre of the metal is somewhat developed. It will also be found that the ingot is apt to be broken in returning it over the rolls if much violence is used by the workmen in its removal; a rolling mill for the express purpose of rolling ingots of cast malleable iron and steel is constructed whereby the amount of draft or elongation of the ingot at each successive rolling may be carefully regulated, and whereby the danger of breaking the ingots in the early stage of the rolling process may be avoided, and much labour saved in the process.

A strong foundation plate is placed on masonry, and a series of roller frames is placed thereon, in which suitable rolls are fitted and arranged with gearing, by which the various rolls are put in motion, each frame with its pair of rolls being placed in such a position that an ingot or mass of iron or steel may pass from one to the other in succession; the space between the rolls being occupied by several lighter guide rollers, so as to prevent the bending of the ingot in rolling, and also assist in carrying forward the ingot and forcing it into the grooves formed in the pair of rolls next in succession; the guiding rollers may be forced together by springs, so as not to take a very tight grip on the ingot or bar, and they should also be driven by a friction clutch or other suitable contrivance, so that if their surfaces do not travel at the exact speed of the ingot or bar a slipping may take place. The spaces between each set of rolls should be so adjusted as to give such an elongation of the ingot as it will bear safely, and each successive pair of rolls should be so far in advance of the other as will allow the ingot or bar to leave one pair of rolls before entering another, and thus avoid the necessity of making each pair of rolls travel at a speed increasing in the exact ratio of the increasing length of the ingot or bar. The rolls may be provided with grooves of different forms, so that one train may be made use of for the manufacture of bars, rods, or rails, of different sizes and of different sectional figures. In some cases one pair of rolls is fitted up having their axes in a vertical position between each of the pairs of rolls, which have their axes in a horizontal position, so that the ingot or bar is compressed alternately in opposite directions during its passage through the series of rolls, in a manner similar to the alternate compression on opposite sides, caused by turning round the bar in each successive groove in ordinary rolls.

Any convenient number of pairs of rolls may be used with progressively smaller groves, each of which should be only so much less in the groove as the peculiar quality of the iron or steel will safely admit of. It will be understood that grooves of other forms may be used, as already practised in rolling rods or bars of a variety of sectional forms; and also that in some cases the vertical rolls may be dispensed with, and several small supporting rollers be used in addition to the guide rolls, for the purpose of forming a support to the under side of the ingot or bar, or supporting plates may be used. The grooved rolls generally employed in the manufacture of iron and steel are subject to considerable wear and tear, and consequently entail a heavy expense in their necessary repair or renewal. This tendency to wear out is still further increased in consequence of their being cast in metal sufficiently soft to be turned in a lathe. The patentee makes grooved rolls for rolling iron and steel in the following manner:—He first casts an iron cylinder, bored out truly, and then, having two covers or ends fitted to it, several rings or hoops of malleable iron are provided, each of which is divided across the centre; these rings are accurately fitted into the cylinder, and are put down one upon another, with their junctions at opposite sides of the cylinder, the interior surface of each ring being so formed as to correspond with the intended grooves in the roll; the cylinder covers are bored through slightly conical, and the holes in them serve to form the bearings or journals of the roll. When all the rings are put into the cylinder and the covers bolted on, the fluid metal is poured in, which will form a complete roll, with its grooves and bearings all properly formed, without the necessity for turning in the lathe, and whereby an extreme degree of hardness may be given to the outer surface by chilling, while the cost will be much less than that of a roll finished in the lathe. In some cases a row of teeth is formed on the rolls at one or both ends of them, so as to cause the pair of rolls to revolve together without separate gearing. The iron used for making rolls in the manner above described may be of the same quality as that which is now generally employed, or they may be cast in steel or steely iron.

Before using the moulds for casting, they may be heated up to 200° or 300° Fah., and the interior parts brushed over with a thin coating of black lead, or a mixture of black lead and oil; or they may be smoked; and thus the patentee is enabled to cast rolls with their journals or bearings as well as the other parts thereof with sufficient accuracy to enable the same to be used without turning the surfaces of such rolls in a lathe, and form thereon one or more pinions in one piece, and whereby much of the expense of such rolls will be saved, and their durability increased by the hard surfaces produced by casting the iron or steel in metal moulds.

Claims.—1. The shaping, pressing, and rolling of ingots or moulded masses of cast steel and cast malleable iron, by means of segmental rolling apparatus.

2. The shaping, pressing, and rolling of ingots or masses of cast malleable iron and of cast steel by a combination of rollers.

3. The casting of rolls in iron moulds.

MANUFACTURE OF IRON AND OTHER METALS.

J. Weems, Johnstone, and J. H. M'Crindell, Glasgow, *Patentees*, May 30, 1856.

This invention relates to those processes employed in the smelting, or after manufacture, or working of iron and other metals and their ores, wherein air is or may be used for aiding the action of the furnace or furnaces, and consists in heating such air by means of steam-heated surfaces. The proposed improved system is preferable in practice to any of those hitherto adopted, and is capable of effecting the desired result with a diminished expenditure of fuel. In practically carrying out this invention in a manner applicable, for example, to a cupola furnace for melting iron for foundry purposes, the air, on its way from the blowing fan or other blast apparatus to the cupola, is made to pass through a number of tubes, or through spaces formed by concentric cylinders, or through passages of any convenient section, arranged in a vessel supplied with steam in any convenient manner, as for example, by admitting the waste steam of a steam-engine. The tubes or the sides of the air passages are, preferably, of metal, and the heat of the steam is communicated through them to the air passing along them, and the air is thus raised to a considerable temperature, its beneficial action on the furnace being thereby increased at an economical cost.

In applying this invention to smelting furnaces, it is proposed to super-heat the steam employed for communicating heat to the air blast. In a modification of apparatus for carrying out this portion of the invention, the air is made to pass through tubes, which are themselves enclosed in larger tubes, and these tubes are arranged in a furnace, so as to be exposed to the direct heat thereof. Steam is supplied to the outer tubes, and envelopes the inner ones, whilst the heat of the furnace superheats this steam, or surcharges it with heat, and the heat is communicated by the steam to the air passing through the inner tubes. In this manner the air blast may be brought up to a very great heat in an economical and convenient manner. This same arrangement of double tubes may also be adopted, where convenient, without applying the furnace to superheat the steam. Air blasts, heated by steam-heated surfaces, according to the invention, may be advantageously applied to smelting, puddling, melting, heating, and other furnaces employed in the manufacture or working of iron and other metals and their ores.

It is further proposed to cause an air blast, heated to a sufficient degree, in the manner already indicated, to blow upon iron or other metal whilst under the action of the hammer, or whilst being forged or worked, whereby the metal being worked is retained for a lengthened time at a workable heat, and much time and labour is thus saved.

A fan is employed for forcing in the air, or for producing the air blast, and the air is blown by this fan into a chamber, communicating with the heating apparatus, through which the air passes on its way to the tuyeres. The heating apparatus may consist of a cylindrical vessel of sheet iron, fitted with tubes passing through it from end to end. These tubes open at one end into a space between the blowing fan and the heating apparatus, and at the other end into the space communicating with the tuyeres, and the air passes through the tubes on its way to the tuyeres. Steam is admitted into the cylinder so as to envelope the tubes, whilst the products of condensation pass off by other pipes. The tubes, being heated by the enveloping steam, impart heat to the air passing through them, and it is preferred to introduce the steam near the exit end of the tubes; the products of condensation passing off at the other end, in order that as the air in its passage through the tubes gradually becomes hotter, it also comes in contact with hotter portions of the tubes, and thus takes up more heat than it otherwise would. The heating apparatus is furnished with safety valves, one opening when the internal pressure is too great, and the other when it is too little. The steam used may be the waste steam of a steam-engine, or steam may be generated in a boiler specially designed for the purpose.

Claims.—1. The system or mode of heating the air supplied to furnaces employed in the smelting, or after-manufacture, or working of iron and other metals and their ores by means of steam-heated surfaces, as described.

2. The system or mode of heating the air supplied to furnaces employed in the smelting, or after-manufacture, or working of iron and other metals and their ores by means of surfaces heated by superheated or surcharged steam, or by furnaces the heat of which is transmitted to the air through an interposed thickness or encasement of steam, as described

3. The application and use of air heated by steam-heated surfaces to blow upon iron or other metal whilst being forged, hammered, or wrought, as described.

SCREW NUTS FOR AXLE BOXES, &c.

F. P. Dimpfel, Philadelphia, *Patentee*, May 23, 1856.

This invention consists in constructing screw nuts in such a manner as to remove the liability of their becoming unscrewed or working loose while in use, as is often the case with screw nuts of the ordinary kind. For the purpose of preventing this inconvenience, it has been usual to employ a small screw, which passes through the side of the nut, and bears against the thread of the screw which carries the nut; but this mode of securing screw nuts has proved very unsatisfactory, from the tendency of the small screw to work loose or to fall out and be lost when the nut is slackened. The patentee dispenses with the lateral clamping screw, or other loose or free clamping piece, and employs instead a small clutch lever or tooth cam, mounted in a recess in the flange of the nut or of the washers of the nut, to take into the thread of the screw on which the nut is placed, and grip the thread firmly.

The clutch lever is mounted on a centre pin and chamfered at its inner end to enable it to take into the thread of the screw of the axletree or bolt, a spring being employed to press against the tail of the clutch lever, and keep it in contact with the thread. The toothed extremity of the lever will, by reason of the eccentric form of its profile, prevent the nut from being turned back until the tooth is withdrawn from the thread of the screw. The tripping up of the lever clamp (to permit of the slackening of the nut) may be effected by passing a pin or stud through the nut and pressing it upon the tail of the lever; the clamping tooth will then be raised clear of the thread of the screw bolt or axle, and the nut will be free to turn. A stop piece permanently connected to the clamp lever, and projecting through a slot cut in the side of the nut, may with advantage be used, the pressure of the finger being in that case sufficient to release the grip of the clamp. The clamp fits into a recess suitably shaped to permit of its turning, as on a centre pin (which is in this case dispensed with), and by means of a spring it is pressed forward into close contact with the thread of the screw. If required, two clamp levers or teeth may be fitted to the same nut, the levers offering a resistance to the turning of the nut in opposite directions. This arrangement is useful when the nuts are used as stops for adjusting with great accuracy the reciprocating movement of certain parts of machinery. The screw nuts constructed or fitted as described are applicable to all cases where nuts are required to be secured in any given position.

Claim.—Providing screw nuts with one or more spring catches or trip levers for taking into the thread of the male screw to which the nut is to be applied, and thereby preventing the turning of the nut, until the screw is released from the bite of the catch or trip lever.

STEAM ENGINES.

H. Cartwright, Broseley, *Patentee*, June 2, 1856.

This invention relates to steam engines having two cylinders side by side, with their pistons working to the same crank shaft, with the cranks at right angles to each other; also to engines of other constructions, and each of the cylinders having two steam cocks of the construction described in a patent dated June 2, 1855, and consists in adapting and applying to such engines another pair of steam-cocks of the same construction as those referred to, and in arranging and combining all the steam-cocks and steam passages, so as to admit of the engines being started, stopped, or reversed by means of the additional pair of steam cocks worked by hand gear.

For this purpose one of the reversing cocks is placed between the two upper steam-cocks, and the other between the two lower steam-cocks, a connecting rod or link imparting the action from the upper reversing cock to the lower; or the reversing cocks may be placed otherwise than between the reciprocating steam-cocks. The steam passages are so arranged as to admit of steam passing from the steam pipe into the open end of the upper reversing cock, and from thence through its front set of apertures to the front passage of the steam casing throughout, from whence it is conducted through the front apertures of the reciprocating cocks to act against the pistons. On the return stroke of the pistons the steam returns through the rear apertures of the reciprocating cocks into the rear passage of the steam casing, and from thence through the rear apertures of the lower reversing cock to the condenser or the atmosphere. But if the plugs of the reversing cocks are turned so that the rear apertures of the upper reversing cock communicate with the rear passage of the steam casing, and the front apertures of the lower reversing cock communicate with the front passage of the steam casing, the motion of the engine will be reversed, because the steam will be brought to act against the opposite sides of the pistons. Thus the motion of the engine is reversed by reversing the offices or functions of the passages in the steam casing. But if the plugs of the reversing cocks are moved only through half the former space, so as for each of them to close one set of apertures, and stop before the other sets are open, the steam will be stopped off from the reciprocating cocks, and the engine will stop. Also, if the plugs of the reversing cocks are moved through a still shorter space, the ports of these cocks may be partly closed, and the working of the engine thereby eased.

The action of the reversing cocks is as follows:—The steam passes from the boiler through the pipe, enters the open end of the reversing cock, and flows through the front ports of this cock into the front division of the steam casing, which is thus, for the time, a steam pipe or passage for the steam to the cylinder. At the same time the rear division of the steam casing being in communication with the rear ports of the reversing cock, the rear division is made for the time an eduction pipe or passage for the steam from the cylinder to the condenser, or to the atmosphere in the case of a non-condensing engine.

If the handle or lever be moved so that the front ports of this cock will be turned off or closed against the front division or passage of the steam casing, and the rear ports turned on or opened to the rear division or passage, thus making the latter a steam pipe; whilst by the same operation, and at the same time, the rear ports of the cock will be turned off or closed against the rear division or passage, and the front ports turned on or opened to the front division or passage, thereby making the latter an eduction pipe. And this transposition of the steam passages will extend through the reciprotating steam cocks, to the action of the steam within the cylinders, and cause the engine to be reversed. But if the handle or lever be moved through only half the above-named space, then all the ports in the plugs of the reversing cocks will be closed, and the engine will be stopped. And by moving the handle or lever through a still shorter space, the ports will be partly closed, and the working of the engine eased. Thus by moving the handle or lever, either directly or through the intervention of any suitable hand gear ordinarly employed for working the slide valves of steam engines, the plugs of the reversing cocks may be placed in the respective positions required for starting, stopping, reversing, or easing the working of the engine.

Claim.—The adaptation and application to steam engines, of the reversing cocks described for the purpose of starting, stopping, reversing, and easing the working of such engines as may be required by means of suitable hand gear in connection with such cocks.

INSTITUTION OF CIVIL ENGINEERS.

Dec. 9, 1856.—G. P. Bidder, Esq, Vice-President, in the Chair.

The Paper read was "*On the Laws of the Strength of Wrought and Cast Iron.*" By William Bell.

In this paper it was stated that the chief point had been the consideration of the longitudinal, as compared with the transverse, strength of wrought and cast iron. For this purpose the whole of the experiments made up to the present time on tearing asunder, or crushing, bars of cast-iron, and those made by breaking bars transversely, had been taken, and from them and the known formulæ of elasticity, such values of the constants in the formulæ had been deduced as would satisfy each experiment individually. And by comparison a general view of the accordance or non-accordance of theory with experiment had been obtained, and some general laws arrived at.

The mathematical theory of elasticity as given by Poisson and Navier was assumed. By finding for each experimental beam the centre of gravity of the area of cross section, through which according to this theory the neutral axis passed, and calculating the moment of the forces with respect to this axis, the application of the formulæ to the experiments was easily made.

The first constant obtained was the weight per square inch of the modulus of elasticity, and this, when deduced from the transverse strain, was taken from the deflections produced by small weights, and in all cases where the beam or bar was very little strained. For wrought iron, the most comparable experiments were considered to be those detailed in the "Iron Commissioners' Report," which gave by transverse strain from 12,200 tons to 12,750 tons per square inch, and by extension of bars from 12,200 tons to 12,900 tons per square inch. For cast-iron the averages of Low Moor, Blaenavon and Gartsherrie irons were from tension 6305 tons, from compression 5698 tons, and from transverse strain 5968 tons per square inch. Other experiments on the transverse strain of wrought iron gave from 9000 to 14,000 tons per square inch; whilst with cast-iron the results were found to vary from 4000 to 8000 tons. On this point it was stated that Mr. W. H. Barlow, F.R.S., in some experiments on the neutral axis recently laid before the Royal Society, found results nearly agreeing with the higher number.

Another mode of arriving at the value of the modulus of elasticity by means of the bending or breaking weight of "long pillars," was also examined; the ratios of the lengths of the pillars to their diameters being taken as abscissæ, and the bending weights, obtained both from theory and experiment, as ordinates. It was thus found that, for the experiments on wrought-iron pillars, given in the before-mentioned report, the curve of theory agreed very well with the curve of observation, until the length became shorter than 70 times the thickness. The experiments on cast-iron pillars examined were those in the second volume of 'Tredgold on Cast Iron.' The correspondence with theory was very good for those with the ends rounded, until the length became shorter than 20 times the diameter; and for those with the ends flat, until the length became shorter than 50 times the diameter. The hollow cylindrical pillars with one exception—that of a short pillar—gave values for the modulus of elasticity of from 4350 to 6680 tons. The correspondence between theory and experiment seemed in the author's opinion to warrant the conclusion that the theory was perfectly trustworthy when only small compressions and extensions were concerned.

The fundamental assumptions usually made in the theory of the strength of materials were then considered. First, that in a beam strained transversely, the extensions and compressions of the particles were proportional to their distances from the neutral axis. Second, that the extensions and compressions were proportional to the tensile and compressive forces known as Hooke's law, and by the phrase, *ut tensio, sic vis.* And third, supposing the latter law to hold good, that whenever in a beam subjected to transverse strain the tension or compression on the outside particles was the same as would be obtained by direct experiment on pulling asunder or crushing bars of the same material, the beam gave way. It appeared, however, from experiment, that for large compressions and extensions the law of Hooke ceased to be applicable. It was found that in cast-iron this law did not differ widely from the truth within the range of the experiments; whilst in wrought-iron, although the difference was great near the point of rupture, yet the curve of compression was similar in form to the curve of extension, the ordinates likewise being nearly equal in amount. The true law might, therefore, be roughly expressed by saying that beyond a given amount of force, the same force corresponded to all compressions and extensions, this force being nearly the force of rupture, either by longitudinal compression or extension: in other words, the force was scarcely altered by a large increase of the compression or extension. It was next considered what effect this deviation from the law of Hooke would have as to the force on the outside particles as deduced from that law; the supposition being made that the force was constant, and therefore equal to the force of rupture for all compressions or extensions. From this investigation the author thought it would be obvious that the supposition of a constant force was different from the truth in one direction, while the law of Hooke was different from it in another, so that these two laws formed limits between which the truth always lay; in cast-iron the latter law being more nearly approximated to. It was shown that the results derived from experiments by assuming the ordinary law were slightly above the truth, the difference, even in a rectangular section of wrought-iron, being probably less than 20 per cent., and in cast-iron still smaller; while in large box and double T girders with a broad bottom flange, the difference was practically insensible.

The other constant obtained was the value in tons per square inch of the tension and compression of the outside particles when the beam became ruptured by transverse strain. For wrought-iron the experiments on solid iron bars were fewer than could be wished, and gave results varying between 14½ and 18½ tons per square inch. In this material it was thought that it might probably be the compressive rather than the tensile force which determined the fracture. The only experiments on the direct compression of wrought-iron were those on two bars given in the Iron Commissioners' Report—where one gave way under a strain of 14·5 tons; the other under 13·8 tons per square inch. The quality of iron was not stated, but it was believed to have been soft. It was asserted that the better kinds of wrought-iron were able to sustain a greater tensile force, the worse kinds a greater compressive force. According to Mr. Eaton Hodgkinson's experiments, wrought-iron might be defined to have its tensile to its compressive force, nearly in a ratio of equality; cast-iron to have those forces in a ratio of about one to six. This being so, it was thought worthy of consideration, whether in the plates of a large wrought-iron bridge subjected to compression a slightly inferior quality of iron might be used, not only as more economical but as better in itself.

With regard to rivetted iron, the results from all the wrought-iron tubes in the before-mentioned report gave from 7·1 to 28·8 tons per square inch. The lower numbers were apparently caused by using thin plates for tubes of comparatively large diameter. If this were avoided, it was thought that in calculating the strength of wrought-iron tubes 15 tons per square inch might be allowed for the breaking force on the outside particles.

When the experiments on cast-iron were examined in this manner, the following fact became apparent: experiments on small bars broken transversely gave results of 20 tons, and even more, for the tension and compression of the outside particles, when the experiments were examined by the ordinary theory. If these results were diminished by 20 per cent., which it appeared would more than make up the difference caused by assuming the ordinary law, there was still a result of say 16 tons, while by direct experiments on the tensile force of cast-iron seven or eight tons was found to be the utmost that it would bear. In regard to this subject, Mr. W. H. Barlow had alluded to the alternative hypothesis that the neutral axis shifted its position as the beam became strained, and that when rupture took place the neutral axis was "at or above the top of the beam." This hypothesis was considered by the author to be contrary to the elementary principles of mechanics; for as the sum of the compressive forces on one side of the axis must be equal to the sum of the tensile forces on the other, therefore if there were tensions on one side of the axis, there must be an area out of which to get compressions sufficient to balance them on the other. As evidence on this point in one material, the observations of Sir David Brewster in passing polarised light through a piece of glass subjected to transverse strain were alluded to.

In experiments on the direct tensile strength, it was assumed that the outward force was uniformly distributed over the area of the bar; in other words, that the resultant of the external forces acting on the bar passed through, and had the same direction with the axis. This probably obtained in wrought-iron from its great extensibility before rupture; but in cast-iron there was no such extensibility, and this point was therefore to some extent doubtful. If a few experiments were made, in which the force deviated from the axis by certain large and measurable amounts, and then were made to approach the axis until some law was obtained which could be tested, this point would be set at rest. A table was then given showing the values of the forces on the outside particles at the time of rupture in tons per square inch, from which it appeared that there was a diminution as the size of the beams increased. Beams three inches by three inches, as compared with those one inch by one inch, showed a falling off of strength to the extent of about four tons per square inch. The results derived from Mr. Hodgkinson's and Mr. T. Cubitt's experiments gave about ten tons per square inch, when the sound beams only of the latter experimenter were included in the calculation, or 9·6 tons per square inch when the unsound beams were taken into account. From this table it appeared that the breaking weight of tolerably large girders might be calculated with considerable accuracy by using seven or eight tons per square inch as the force of tension on the outside particles when rupture took place.

In conclusion the author expressed the hope that he had succeeded in establishing the following propositions:—

First. That in experiments were the materials were but slightly strained theory and experiment coincided.

Second. That where the ordinary theory was applied to the rupture of beams, and especially large beams of wrought-iron, theory and experiment practically coincided.

Third. That there appeared to be no good reason for supposing that the neutral axis shifted its position to any extent worth noticing, even up to the time of fracture.

Fourth. That in cast-iron, although theory seemed to differ from experiment when the transverse strength of small bars was compared with the direct tensile strength, assuming the latter to be correctly stated at seven or eight tons per square inch, yet when the transverse strength of large girders was compared with the direct tensile strength, the coincidence of theory and experiment was nearly exact.

Fifth. That the ordinary theory of the strength of materials was more trustworthy than was generally supposed.

In an appendix the author explained the formulæ used in examining the experiments, and gave the demonstrations of the results arrived at; the experiments for ascertaining the modulus of elasticity, and the forces on the outside particles at the time of rupture being examined in great detail.

Specimens of the recently discovered iron deposits in the Himalayas, Northern India, were exhibited by Mr. W. Sowerby. These deposits were found in the lower range of hills, called the Blabur, at a general elevation of about 500 feet above the adjacent plains; and they were more or less continuous from the Sada river, on the confines of Nepal, to the river Ganges, a few miles above the head of the grand Ganges Canal, at Hurdwar, being about 150 miles in length.

There were six different beds of iron-stone, one above the other, of varying thickness and quality. The lowest bed was a rich red iron-stone associated with clay, and its thickness was in many places upwards of 50 feet. They contained on an average nearly 50 per cent. of metallic iron. The following was the analysis of these ores:—

Water and Carbonic Acid	2·00
Earthy matter	22·40
Arsenic	0·91
Lime	2·60
Peroxide of Iron	73·50
	101·41
Excess	1·41
	100·00

Metallic Iron 50·96 per cent.

The other beds were chiefly a compact brown clay iron-stone, about 15 to 20 feet in thickness, containing about 40 per cent. of metal. There were also yellow hydrates and siliceous ironstones, of less thickness, and of poor quality. Masses of the richest iron-stone, many tons in weight, were found lying on the hill slopes, and the beds were in numerous places seen exposed in high escarpments and deep ravines.

The enclosing rocks of the beds were micaceous sandstones, not unlike the sandstones of a coal formation; thin seams of lignitic and slightly bituminous coal had been found outcropping. Mountain limestone, of excellent quality for flux, formed part of the adjacent hills.

The district in which the iron ore was found was a dense primeval forest of saul, huldoo, kya, jamin, and other hard woods, in inexhaustible quantity, and peculiarly suitable for making charcoal. The number of small streams and large rivers issuing from the hills would afford ample water power for any amount of machinery.

The government of India decided on erecting a small experimental work during the cold season of 1855-56, which was entrusted to Mr. Sowerby; specimens of the iron produced were exhibited, and were so conclusive, as to have determined the question of the extension of the works.

The interior of the hills was also stated to contain immense deposits of rich hæmatite, specular and magnetic iron ores; likewise copper, galena, and other minerals. Views of the locality, and of the work erected, were also shown.

Specimens of coal, iron, copper, galena, &c., discovered by Mr. Sowerby in South-Eastern Africa, were likewise exhibited. The coal-beds were in the territory of Natal, and were traced from the sea coast to the Kathlamba Mounts, a distance of about 150 miles: they varied in thickness from a few inches to 14 feet at the outcrop. Iron, copper, &c., were found in great abundance and variety in various districts.

Dec. 16, 1856.—G. P. Bidder, Esq., Vice-President, in the Chair.

ANNUAL GENERAL MEETING.

The report of the council for the past Session, which was read, stated, that since the corresponding period of the last year, though political tranquility had been restored, the monetary crisis consequent upon the large public expenditure occasioned by a state of warfare, had retarded the resumption of works of public and private enterprise.

Some few of the foreign works in progress were then noticed; mentioning particularly the successful opening and the extension of the East Indian Railway, under Mr. Rendel, the late distinguished Past-President of the Institution. In connection with this subject, it was stated, that the honour of knighthood had been conferred upon Mr. Macdonald Stephenson, Assoc. Inst. C.E., who originally proposed, and had carried out the first portions of the vast network of railways which was destined to work such a revolution in the Indian Empire. A similar distinction was at the same time conferred upon Dr. O'Shaughnessy, the energetic projector and constructor of a system of Electric Telegraphs extending over nearly 4000 miles, through dense, jungle, or over the vast plains, rivers, and mountains of India. The Indian Peninsular Railway, constructing by Mr. James Berkley, M. Inst. C. E., under the direction of Mr. R. Stephenson, M.P., President, had now about 100 miles opened, and the great work of extension up to Sholapoor, and through the Bhore Ghaut, was now fast progressing; whilst the execution of the North Eastern extension, across the Thull Ghaut towards Nagpore and Jubbulpore, and the Berar cotton fields, would soon be commenced. The Madras, the Bombay and Baroda, and the Scinde Railways were being vigorously prosecuted, and several other lines were projected, among which was that from Seleucia, on the Mediterranean, to Jabr Castle, on the Euphrates, which river it was proposed to navigate by means of steam-vessels, of shallow draught of water. This recent project had been entrusted to Sir John Macneill, M. Inst. C. E. Since the kingdom of Oude had become a part of the British possessions, arrangements had been made for affording it the benefit of participation in the railway system, which would be commenced by the construction of a line of fifty miles in length, between Cawnpore and Lucknow, whence branches would extend to the most important districts, and be connected with the East Indian railway. Other lines were also proposed for Gorruckpore, Tirhoot, and Purneah, all contributing to the completion of the internal communications of India.

The Pernambuco railway, in the prosecution of which the late Mr. M. A. Borthwick, M. Inst. C. E., lost his life, had been placed in the charge of Mr. W. M. Peniston, M. Inst. C. E., and was making satisfactory progress.

The Dom Pedro the Second railway, starting from Rio de Janeiro, and passing up the "Serra," into the valley of the Parahiba, and through the principal coffee-producing districts, would be about 200 miles in length. The first section of 40 miles was commenced in 1855, and would be completed by about the middle of next year. The survey was made amidst a dense primeval forest, and in many places through water 5 or 6 feet deep, and great difficulty was encountered in executing the earthworks with slave labour and inadequate tools. By degrees, however, European methods were introduced by Mr. E. Price, Assoc. Inst. C. E., the contractor; and under the superintendence of Mr. C. B. Lane, M. Inst. C. E., the Engineer-in-chief to the Home Department of the Brazilian Government, the railway promised to become a fine enterprise. Mr. Charles Neate, Assoc. Inst. C. E., was also engaged under the Brazilian Government, in constructing important hydraulic works at Rio de Janeiro. They consisted of quay-walls along the sea-front of the city, with piers and jetties, formed of granite masonry set in lias mortar, for which the limestone was sent from England.

In Canada, the railway undertaken by Messrs Peto, Brassey, Betts, and Jackson, might be said to be complete, with the exception of the link to be formed by the Victoria Tubular Bridge, across the River St. Lawrence, which was now in progress.

On the continent, gradual extensions of all the main lines were being made. The Lombardo-Venetian system had been transferred to a powerful company, now preparing to act with great energy in the prosecution of their plans. The "Victor-Emmanuel" line, under the direction of Mr. Bartlett, M. Inst. C. E., acting for Mr. Brassey, Assoc. Inst. C. E., the contractor, was approaching the chain of the Alps, for the traversing of which preparations were being made, and experiments upon the machinery for the work of tunnelling on a large scale were being tried. That portion of the line from Aix-les-Bains, passing through Chambery to St. Jean de Maurienne, upwards of 55 miles in length, was opened for public traffic last October. The works were originally laid out by, and to a great extent executed under the direction of Mr. Nieumann, who was succeeded, last year, by Mr. Ricceo, under whose supervision they were now carried on.

In Turkey, and in Russia, extensive projects both for railways and steam navigation were being agitated; whilst in Egypt, H. H., the energetic Said Pacha, was completing the railway communication between Cairo and Suez, spanning the Nile by a vast iron bridge at Kaffre Azzayat, and had confided to Mougel Bey the construction of the preliminary works for the Canal across the Isthmus of Suez, advocated by M. Ferdinand de Lesseps; whilst he had authorised the establishment, upon the Nile and the Mahmoudieh Canal, of a complete system of steam towing vessels and barges, now in course of construction in this country.

One of the most important, as well as most interesting, projects of the period was the submarine electric telegraph cable proposed to be laid from Valentia, on the west coast of Ireland, to St. John's, Newfoundland, a distance of sixteen hundred miles, along the bank, or plateau, discovered by Lieutenant Maury, over which the greatest depth of the ocean did not exceed 2070 fathoms. By the method of inclosing the insulated conducting wires within a covering of ropes, composed of small wires laid in an opposite direction to that of the general "lay" of the cable, a light and flexible cable was formed, which was stated to be capable of bearing the strain of depositing in extreme depths, and having no tendency to twist or "kink" during the process. This ingenious modification of the usual construction of cable, was devised by Mr. Brunel, V. P., whose co-operation was sought by Mr. Cyrus Field and Mr. J. W. Brett, the projectors, under the advice of Professor Morse. The successful result of this daring project for connecting the Old with the New World would be more effectual than any efforts of diplomacy, in cementing that intimate union so desirable for the true interests of the two countries.

The vital questions of the Metropolitan Sewerage, the new streets, and the bridges, remained as undecided as at the period of the last report.

The principal papers read during the session were then noticed, mention being particularly made of the oral addresses by Mr. Bidder, V. P. Inst. C. E., "On Mental Calculation," the object of which was to demonstrate that the system could be taught to children, and be acquired with less irksomeness and greater facility than ordinary arithmetic. Special notice was also taken of the paper by Mr. John Murray, M. Inst. C. E., on the "Sunderland Docks," which, as an example of dock engineering, stood almost unrivalled in this country.

The members were strongly urged to continue to present copies of scientific and professional works to the library, without which its utility for reference and consultation could not be maintained.

The deceases of the members during the year were announced to have been:—The Rev. Dr. Buckland, honorary member; Messrs. M. A. Borthwick, J. Bremner, J. Chisholm, S. Clegg, jun., C. Rammell, J. M. Rendel, T. H. Statham, F. Whishaw, and T. J. Woodhouse, members; and Lieut.-Gen. D. M'Leod, Messrs. J. Beatty, T. Cubitt, D. M'Intosh, J. F. Miller, and R. Wilkins, associates. The memoirs of these gentlemen were given in the appendix to the report. The resignations of one member and two associates were announced, and it was stated that the effective increase (after deducting the deceases and resignations,) during the year amounted to 14, whilst the total number on the books was 802 members of all classes.

The statement of the receipts and expenditure showed that there was a balance of upwards of 700*l.* in the hands of the treasurer; and that the financial position was very satisfactory, so that not only would the current expenses be easily met, but a balance would remain to bring up any arrears of publication, or to provide for contingencies.

During the year the second parts of Volumes 11, 12, and 14, of the Minutes of Proceedings, had been published and issued, and the whole of Volume 15. There now only remained, to complete the series of fifteen volumes, extending over twenty years, the second parts of Volumes 7, 8, and 10, and the whole of Volume 13.

It was mentioned, that at the last Annual Meeting, Mr. Charles Manby (M. Inst. C. E.), who had held the post of Secretary for upwards of seventeen years, tendered his resignation; he had continued, however, to hold the position until the present time, but in the month of June, 1856, Mr. James Forrest (Assoc. Inst. C. E.), who was well known to the majority of the members, from his almost constant connection with the Institution during the last fourteen years, having, in fact, been partly brought up within its walls, entered on the post of Assistant Secretary, with the salary formerly devoted to Mr. Manby, who had expressed his willingness to continue to act as Secretary, gratuitously, as long as his services were considered useful to the Institution.

After the reading of the report, Telford medals were presented to Messrs. J. Murray, J. M. Heppel, H. Robinson, C. R. Drysdale, and F. M. Kelley; and Council Premiums of Books to Messrs. J. Murray, G. Herbert, Evan Hopkins, J. W. Heinke, J. Baillie, and W. K. Hall.

The thanks of the Institution were unanimously voted to the President for his attention to the duties of his office; to the Vice-Presidents and other Members and Associates of Council, for their co-operation with the President, and constant attendance at the meetings; as also to the Auditors of the Accounts and the Scrutineers of the Ballot, for their services. Special votes of thanks were accorded to Mr. Bidder, for his addresses on "Mental Calculation," and to Mr. C. Manby, Secretary, for the manner in which he had performed the duties of his office, and his constant attention to the individual wishes of the Members.

The following gentlemen were elected to fill the several offices on the Council for the ensuing year:—Robert Stephenson, M.P., President; G. P. Bidder, I. K. Brunel, J. Hawkshaw, and J. Locke, M.P., Vice-Presidents; W. G. Armstrong, J. Cubitt, J. E. Errington, J. Fowler, C. H. Gregory, T. Hawksley, J. R. M'Clean, J. S. Russell, J. Whitworth, and N. Wood, Members; and R. W. Kennard and Sir Macdonald Stephenson, Associates.

Jan. 13, 1857.—I. K. Brunel, Esq., Vice-President, in the Chair.

The paper read was "*On Submarine Electric Telegraphs.*" By F. R. Window.

In a brief relation of the early history of the Submarine Electric Telegraph, it was stated not to have been the invention of any one person, but rather the result of the combined researches and exertions of many experimenters. The first mention that the author had been able to find of any method of sufficiently insulating wires as to enable them to conduct a current when submerged in water, was, in an account of some experiments made in India by Dr. (now Sir W. B.) O'Shaughnessy, in 1839, recorded in the Journal of the Asiatic Society. In these experiments the wire was covered with tarred yarn, and enclosed in a split ratan, which was again enveloped in another coating of tarred yarn.

Shortly after this (in 1840), Professor Wheatstone gave it as his opinion, expressed before a Committee of the House of Commons, that a submarine communication between England and France was practicable. And in October of the same year, a paragraph in the 'Bulletin de l'Académie Royale des Sciences de Bruxelles,' stated, that Professor Wheatstone had discovered a means of joining Belgium and England by a submarine telegraph. The nature of the discovery was not, however, mentioned. All these experiments were made previous to the suggestion of Professor Faraday to use as an insulating agent gutta-percha, which, up to the present time, had been universally employed. An extract from an American newspaper was given, containing an account of a submarine telegraph stated to have been successfully constructed by Colonel Colt, from Hell Gate to Fire Island, and in which it was also said that the same gentleman had applied to the United States Government for funds for the purpose of forming a telegraphic line from America to Europe.

In 1848 a submarine telegraph wire, insulated with gutta-percha, was laid by Lieutenant Siemens, of the Royal Prussian Artillery, under the Rhine, from Deutz to Cologne, a distance of about half a mile. And in January, 1849, Mr. C. V. Walker towed a similar wire two miles in length out to sea, off Dover, and sent signals to London through it.

In August, 1850, a gutta-percha covered wire was laid by Mr. Wollaston, from Dover to Calais, through which signals were sent with success, but it lasted perfect only about twenty-four hours.

On the 25th of September, 1851, a cable consisting of four insulated wires incased in a sheath of ten No. 1 iron wires, was laid down from Dover to Calais, by Mr. Crampton, assisted by Mr. Wollaston, and was stated to have remained perfect to the present time.

It was stated further that it was entirely owing to the energy and skill of Mr. Crampton, who undertook the responsible task of carrying out a scheme, up to that time looked upon with distrust by some of the leading engineers of this country and France, and believed by the public generally to be impossible, that the world was now indebted for the benefits of submarine telegraphs; and the leading circumstances of the case were briefly explained. The author then proceeded to give a detailed account of the construction of the Dover and Calais cable, which was the first laid down; and the system of construction of all the principal submarine telegraphs in Europe up to the present day, with all the particulars relative to them, was shown in a comparative table.

The author discussed the respective merits of the compound cable system, or the collection of many insulated wires into one cable, as in the Calais and Ostend telegraphs; and the simple cable, containing but one wire, as in the lines of the International Telegraph Company to Holland and Ireland: the greater facility which these latter afforded for repair, and the less chance of having the business stopped by rupture, since one wire only, and not all, would be affected by the cause, was pointed out, and it was shown that the cost of the two systems did not materially differ.

The conductive power of submerged wires was then theoretically investigated, and it was shown that a considerable difference as to time existed between the transmission of signals upon suspended wires, and upon insulated wires immersed in water, or buried in the earth. That while with the former it appeared that the only limit of practical speed was the possibility of deciphering the signals, that in the latter the electric current required an appreciable period of time to arrive at its destination, and another longer period to escape from the wire into the earth, and that this period of time increased regularly with the length of the wire; consequently upon a line formed of submerged wires of considerable length, there would always be a limit of possibility of the number of signals that could be transmitted in a given time. These effects were stated to be caused by lateral induction, the insulated wire assuming the nature of a Leyden arrangement of vast dimensions where the copper wire represented the inner coating, and the film of moisture surrounding the gutta-percha acted as the outer coating. This latter amounted to upwards of 320 square feet per mile. The practical effect produced by this lateral induction was chiefly the retardation of the signals, and consequently, to a certain extent, placing a limit to the quantity of messages that could be transmitted along a submarine line. This effect was visible upon every submarine line of upwards of 10 miles in length, and even upon some of less length.

Upon the longest line yet constructed the inconvenience arising from the retardation of the current in submarine wires was not very great; it was not until the line was prolonged to upwards of 700 miles that the retardation became a serious obstruction. It was argued, from some experiments that were made at Lothbury by Mr. Latimer Clark, upon 1600 miles of subterranean wire, that signals upon the line which was about to be laid down between Ireland and America, would require about $2\frac{1}{2}$ seconds to arrive at their destination, and that after each signal, another $4\frac{1}{2}$ seconds must elapse before the line was free to receive another electric wave. Each word of average length would thus occupy about a minute; and each despatch of twenty words, would, with the necessary code signals, and unavoidable repetitions, require adout half-an-hour, thus making the limit of possibility about fifty messages in twenty-four hours.

The author argued, that since submarine lines were more costly than suspended lines, and nevertheless a smaller amount of business could be sent along them in an equal time, it was important that no pains should be spared, whereby this lateral induction, and consequently the evils arising from it, might be reduced, though, being in accordance with a law of nature, it could not be entirely avoided.

Jan. 20 *and* 27.—The entire evenings were devoted to the discussion of Mr. Window's paper, which will be given next month.

ON THE VARIOUS METHODS OF INDURATING AND PRESERVING ARCHITECTURAL STONEWORK.

By C. H. Smith.

[*Paper read at the Royal Institute of British Architects, Dec.* 1.]

The first patent for indurating and preserving stone which I shall notice was granted to François Teychenne, a foreigner, residing abroad; it is dated February, 1847; it afterwards became the property of William Hutchison. I believe the works are now carried on at Tunbridge Wells, and the patent belongs to the "Indurated Stone Company." In general terms the operation may be thus described: the stone to be indurated must be worked to the necessary form, then thoroughly dried in a heated chamber, or by some other convenient method. The solution, in which the stone is to be immersed, is composed of resin dissolved in turpentine, oil, wax, tallow, or other fatty substance; the materials are to be melted in a boiler of suitable size, and while they are in a state of ebullition the stones are put in, and the operation of boiling is continued until they are impregnated to a sufficient depth from the surface; in ordinary cases two hours boiling will impregnate the stone one inch.

The next invention for a similar purpose, patented by Barnabas Barrett, is dated October, 1853: it is now worked in the name of "The London Stone-Hardening and Preserving Company;" their office was at 41, Moorgate-street. The following is Mr. Barrett's mode of procedure: the stones to be indurated are first completely worked to their required form, then placed in a chamber or oven, which is heated from 50 to 60 degrees, to drive out whatever moisture they may contain. In all cases where it is practicable, the stones are to be operated upon in an air-tight chamber, exhausted, or partially so, and then the indurating mixture, whether hot or cold, is allowed 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, and become incorporated therewith. Mr. Barrett's indurating mixtures are classed under six varieties—the first is composed of resin dissolved in naptha, spirits of wine, or turpentine, mixed with gutta-percha, dissolved in coal tar naptha, and when warmed with steam heat, mixed with oil or any other greasy materials; after which "anti-corrosia" is ground down and well mixed with the above. Another mixture is composed of unslacked lime, with oil, or soft soap, and Russia tallow, mixed with it whilst slacking; when well slacked to be placed in a copper with alum water and "anti-corrosia," ground-up copperas, and a solution made from potatoes and beer settlings: when well boiled and mixed together they are left to settle, and the solution is drawn off. These various preparations are rather complicated, I will therefore not occupy more time by going further into Mr. Barrett's inventions.

The next patent for the same purpose, granted to John Benjamin Daines, is dated April, 1856. The specification describes the invention as "An improved mode of treating surfaces of soft and porous stone, &c., for the preservation of the same from decay," Mr. Daines' chief object is to impart to the exterior surfaces of stone or compo buildings, the power of resisting the destructive effects of the atmosphere and of damp; and in some measure to neutralise the tendency to alkaline efflorescence. To produce these results, he first applies a solution of sulphate of zinc or a solution of alum; after which sulphur dissolved in linseed or other oil. This mixture is to be laid on the surface of buildings, or building materials, by the aid of a brush, or by means of an exhausted case applied to the wall of a building, or by any other suitable means; the stone will then be impervious to moisture.

Mr. Henry Clinton Page took out a patent, dated May 1856, part of which is for "indurating common stone work generally," for this purpose he dissolves bees-wax in coal tar naphtha. But if the colour of the stone be very delicate, or the preservation of its natural colour be desired, Mr. Page substitutes double distilled camphine in place of the coal tar naphtha, and white wax instead of common bees-wax. The solution is to be applied with a brush to the surface of the stone, repeating the process as often as the stone will absorb it, and until the pores are completely filled therewith; using the solution thicker for coarse grained than for fine grained stone.

Having given an abstract of four distinct patents for attaining the same object, I will now endeavour to give a general view of the mode of operating, and of certain practical difficulties attendant thereon. Every one practically acquainted with the working of stone, whether as a mason or a carver, must be well aware of the time occupied, and of the liability to damage incurred in removing heavy masses of elaborately wrought stone after the work is finished; and that the risk of injury or breakage is far greater with soft than with hard stone. In several of the patented inventions, it is expressly stated that the stones, after being completely worked, are to be thoroughly dried in a hot air chamber, or oven; and in one instance it is stated, they are afterwards to be put into a tank of boiling solution, and boiled for several hours; in another method the stones are to be put into an air-tight chamber, exhausted, or partially so, and then filled with the indurating mixture, either hot or cold. I need scarcely state that it is an utter impossibility to exhaust, even partially, a vessel capacious enough to hold the largest stones that are generally used in a first-class building. The failure of the atmospheric railway, on the Croydon line, arose entirely from the impracticability of exhausting large vessels, as it was found impossible to make them anything approaching to air-tight. If the stones are to be completely immersed in the indurating mixture, there will be great waste, as no other part than that which is to be exposed to the weather need be indurated; in fact, the joints, beds, and back being covered with an oily or resinous substance, will prevent the mortar or other aqueous cement from adhering properly to the stone; and the result must be a certain amount of weakness in a building so constructed.

Among the writings of various patentees I find the remarkable statement, that "the process gives to the most porous stone, the hardness of primitive granite. It will be unnecessary to expatiate on this imaginary result—we will look upon it as the infatuation of a parent for his offspring. The same patentee attributes the decay in stonework to alkaline efflorescence, arising from the cement or mortar used in the walls; he has arrived at this conclusion after a variety of tests and trials during eleven years. These are assertions, but no proofs are offered. The gentleman has no doubt seen many examples of stone in an advanced state of decay, covered with a saline or alkaline efflorescence; but is he prepared to show, by experiments, that the same stone would have remained perfectly free from disintegration, had it been situated far from the influence of what he conceives to be destructive agents. I have submitted a piece of limestone, which I knew to be of a good and durable quality, to the most severe tests of both salts and alkalies—trials far more powerful than anything likely to occur to stone in the ordinary course of nature; yet with all such violent experiments, I have never been able to produce more than a mere trace of alteration or disintegration: I am therefore disposed to believe that the salts and alkalies have little or nothing to do with the decay of stone. Among the published writings of patentees I find also this remark, "In many cases the decay of stone is accelerated by the employment of sea or salt sand; a proof of the destructive effects of salt upon stonework may be observed in any seaport town." No doubt the author has observed stonework in some seaport towns in a deplorable state of decay, many of the buildings at Brighton, constructed with Portland stone, are in this condition; but we have no "*proof*" offered that such decay is occasioned by marine influence. The surface of the masonry of most of the buildings at Oxford is so decomposed, that it is peeling off like paper or rags. Had this beautiful city been erected with the same stone, on the sea coast instead of the interior of the country, many might have imagined that the wretched condition of the stonework was entirely owing to the destructive effects of sea salt, whereas it is the result of bad stone.

The Island of Portland is only five or six miles in circuit; of course it is surrounded on all sides by the sea; it contains seven villages, all built with Portland stone, and they are in an excellent state of preservation. But the most remarkable instance, which proves that sea salt has no effect whatever on good stone, is that of Sandysfoot Castle, near Weymouth, built with Portland stone in the time of Henry VIII. It is so close to the sea, that every high tide washes the lower part of the walls, and in stormy weather the building is completely overwhelmed by the spray, yet the stone is quite perfect, and the chisel marks are as fresh as when left by the workmen. The fact is, *good* stone will remain nearly perfect in any situation, during almost an indefinite period; whereas *bad* stone, if exposed to the weather, will rapidly moulder away, whether placed on the sea shore, or in the middle of a large continent. The four patents which I have described, may be classed under one general heading, because they all recommend oily or resinous mixtures to be applied to the stone in a somewhat similar manner.

I have one more invention for a similar purpose to offer to your notice, which has been reserved on account of the indurating mixtures being of an aqueous and more scientific character, and therefore differing essentially from any of the others. The inventor, Mr. Frederick Ransome, has sent me the following particulars: "The process consists in the employment of two or more separate solutions, which, by mutually acting upon each other, produce within the pores of the stone an indestructible mineral precipitate. In operating, the stone may be either immersed in, or saturated on the surface with, a weak solution of silicate of soda or potash; and afterwards with a solution of chloride of calcium or barium, when an insoluble silicate of lime or baryta is formed in the pores of the stone, rendering it impervious to moisture and insusceptibile of injurious effects from atmospheric influences. Or, instead of a silicate of potash or soda, a solution of sulphate of alumina may be employed, and then by an application of baryta, a compound of sulphate of barytes and alumina is produced."

Any of the before named mixtures, whether oily or watery, will readily be absorbed into the pores of a newly worked piece of stone; but after a building has been erected a few years in London, or any other large town, its surface becomes so thoroughly grimed with dust, soot, and impurities of a populous neighbourhood, assisted, in no small degree, by powerful winds and driving rains, that the indurating mixture cannot easily be made to soak in; it will run off the surface of the stone as it would off glass, or other non-absorbent material. But if, by some contrivance, it can be made gradually to enter within the pores, if the building should have been erected only a few months, the dirt will be so difficult to remove, that a large portion of it must unavoidably be mixed with the indurating materials, and the result will be a dirty, disagreeable appearance, permanently given to the entire edifice. Were it not for the soot and dirt, the oily mixtures applied to limestone would be so far blanched in about a year, as to cause the stone to be rather whiter than if no such process had been applied to it. To overcome these objections, some have suggested that the entire surface of the stonework should be scoured, scraped, or even chiselled afresh, in order that the indurating material may have uninterrupted access to the substance of the stone. This proceeding would not only be very expensive, but it would be liable to alter the character and effect of the mouldings, carvings, and decorations generally; and as the projecting parts are usually the first to show symptoms of premature decay, they would therefore require the greatest amount of induration. Unless the indurating fluid can be made to soak into the stone, at least half an inch, it may be worse than useless; because, in all probability, wet will get in behind the hardened surface, and thereby occasion larger portions to exfoliate than if the stone had been left in its natural state.

I may now offer a few comments on the manner of testing the merits of these patented inventions. You have already heard mentioned some extraordinary contrivances of air-tight chambers, and baking and boiling building stones to render them imperishable; such performances, upon samples like those shown to me by the patentees, are quite within the bounds of possibility; but it would be a novelty to see the Parliament Houses first placed in an oven and then in a tank of boiling liquid. If, therefore, the desired object cannot be effectually accomplished by such means; if the stones cannot be properly protected from the effect of atmospheric influences, without treating them in the manner described, the inference must be, that if a building is merely brushed over a few times with a cold solution, the result will certainly be ineffectual; if the former plan be a sure one, the latter must be very doubtful. Taking all circumstances fairly into consideration, I am of opinion that no plan for indurating and preserving architectural stonework is likely to answer the intended purpose, unless it can be applied after the building is erected, and after the mouldings and carvings are completely finished. Then comes the question, how to know what is the best material, and how is it to be successfully applied. I have seen multitudes of small specimens of indurated stone, which while fresh certainly resist the decomposing influences of air and water; but as the patentees and inventors offer no proofs whatever that the same or such pieces of stone would have rapidly mouldered away, had they not been preserved by their indurating process, how am I to know that the same pieces of stone would not have stood the weather equally well without their application? and I believe, up to this time, no one is prepared to show what condition their specimens will present after eight or ten years' exposure to the weather. I am not disposed to listen with credulity to the opinions or testimonials of individuals, however high their position—however numerous the Roman capital letters may be at the end of their names—unless they have something to relate and to show upon the subject of a more evident and satisfactory character than anything I have heretofore heard or witnessed. No doubt some may consider me captious, over scrupulous, and determined not to believe what I either see or hear; but the *weekly list of Patents*, which are taken out for supposed inventions or improvements, most of which are neither seen or heard of afterwards, shows how many men there are, who, although they do not always deceive other people, are often very successful in deceiving themselves, by believing they have discovered an invention, of great public utility, which is to "*yield* 200 *per cent. profit*," and which golden prospect their fondest admirers can neither seen or comprehend.

It would be a good plan to try the conservative power of a solution on two or three specimens of stone—Caen, Bath, and Portland for instance—choosing pieces of their respective kinds, well known to be of a perishable quality. I am sorry to say that in London there will be no difficulty in procuring such specimens; each piece to be between two and three feet long, and of sufficient girth to be accurately worked into a few mouldings, such as a piece of cornice. When the working is completed, let each piece be broken (not sawed) in the middle lengthwise, so as to leave clean fractures, with abundant indentions; the two parts will fit each other, without the possibility of either being counterfeited. Let only one piece of each specimen be well prepared with the indurating solution, taking care not to use more or less of the fluid, in proportion to the size of the specimen, than would be used if a large edifice were to be prepared for conservation; then place the prepared and unprepared specimens of each kind of stone side by side, on the top of some elevated building, where they will be fully exposed to all weathers, during several years, more or less according to circumstances. We know beforehand that in course of time the unprepared pieces will show evidence of decay; but if the indurating process answer the intended purpose, if the stones have absorbed the fluid sufficiently deep from their surface to be the means of rendering them durable, the prepared portions ought to be found after a few years unaltered, and comparatively in a perfect state, while their counterparts, having been subjected to precisely the same variations of climate, would perhaps be in an advanced stage of decay, and their architectural features nearly obliterated. Experiments thus performed and recorded would be valuable, because they would prove, as nearly as possible, whether eventually a certain process might be serviceable or useless, or indeed injurious to the stonework.

During the last twenty or thirty years I have had many conversations with several of the most learned chemists about preserving stone from decay, and have listened with attention to the remarks of intelligent and experienced practical stonemasons, for much gold is sometimes contained in the roughest ore; and a clear operative mechanic, though incapable of expressing clearly that which he conceives in his mind distinctly, will, by judicious questioning, state facts, likely to lead the studious man into a train of ideas which he otherwise might not have thought of. But after all, the object in pursuit seems to be as far off as when I commenced the inquiry; in truth some years ago I thought I knew more of the subject than I do at present; the difficulties appearing to increase as more information is collected. All the methods of induration which are now before the public are merely mechanical mixtures with the stone, a sort of fluid cement or varnish, which surrounds the grains without altering them, although to a certain extent it glues them together, and partially keeps out moisture: but each individual grain continues in the same state,—no chemical change whatever has taken place,—the elementary constitution of the stone is the same as it was before the indurating material was applied to it. It is a characteristic feature in quarries of oolite that the stone procured from the uppermost beds is generally, perhaps invariably, of a durable quality; whereas the lowest beds are the first to decay, when exposed to weather. The cause of this difference is known to depend chiefly on the quantity and quality of the cementing substance, by which the particles adhere to each other. The cement that unites the globules into a mass is formed of the same elements as the globules themselves, but more crystalline; it is in fact the decomposition of the superincumbent mass, saturating and crystallising within the beds beneath. But this natural process of indurating is not performed in a day, nor in a year, but in ages; so slow or gradual is the process, that in scarcely any case is the lowest bed so hard, or so thoroughly saturated with the crystalline material as those above.

It seems to me, that if we could pursue or imitate this natural process, it might lead to the best means of improving the natural condition of soft stone; or, in other words, we might finish the stone which is imperfectly formed in the rocks; Nature not having had time to complete her work. Man can command Nature in no other way than by obeying her laws; in all our experiments or performances, it is not we who operate, but the laws of Nature which are set in operation. The durability of compact carbonate of lime, in a crystalline state, either in the form of stalactites, or that of a porous material, rendered dense and durable by impregnation, may be witnessed in numerous instances in this country, especially in the petrifying caverns of Derbyshire. In the South of Italy and in Sicily, the production of excellent building stone, entirely formed by deposition from water, has been going on abundantly, from the earliest ages of the world to the present time. The Temples of Pæstum, constructed more than two thousand years ago, with aqueous deposit from the neighbouring rivers, are still but little decomposed, so far as the stone is concerned. Most of the modern buildings in Rome, including St. Peter's, which are constructed with a similar material, Travertine stone, or Calcareous Tufo, are generally in excellent condition.

In the waters which produce these petrifactions, there must be some solid body as a nucleus to begin upon; but what constitutes it, is in no respect important: any substance will do for the waters to commence their petrifying works upon;—hence, at the caverns, "*the wonder seeker*" is invited by the guides to purchase birds' nests, purses, and various other articles, said to be changed into stone; whereas, in fact, the objects themselves are merely encrusted with stony matter. Although this natural process is progressing now, and has been during all ages, and, to a certain extent, is well understood by chemists and others, yet it has not been applied to any important purposes, and certainly never to artificially indurating and preserving soft stone. If we could successfully imitate nature in this respect, and apply our efforts to the purpose now under consideration, I think they would be more likely to answer than any plan heretofore attempted. It is not in my power to tell you how to proceed, but the principle appears so clear and simple, that I am induced to believe the proper mode of application would soon be found if scientific men would turn their attention in that direction.

The necessity for preserving the stonework of our buildings from premature decay, is entirely an evil of modern date, which, in nearly all cases, ought not to exist; for if builders engage in a legal contract to use the best materials of their respective kinds, they are liable to an action for damage if it can be proved that defective stone has been introduced into a building, as such a proceeding must be an imposition, if not a direct fraud, upon those who have to pay for the work; and I believe I am correct in stating, that pleading ignorance of the laws of this country is not considered an excuse for the violation of those laws, and that therefore, in all probability, a verdict would be given against the contractors.

With reference to the proceedings for indurating the stonework of the New Palace at Westminster, I fear the parties in authority are rather premature in their decision. Several experimenters have been set to work without investigation or inquiry; without ascertaining which plan is best, or whether their mode of procedure may or may not be injurious to the stonework, or likely to prevent the success of some other treatment which may hereafter be found superior. With every sentiment of respect for the judgment and general discrimination of the noble and learned lord who has lately taken so much interest in this matter, I trust he will forgive me if I entertain the idea that his lordship has yet much to learn before he can properly adjudicate and decide on matters relating to the decay and preservation of stonework at the Parliament Houses.

If there ever was a time when a knowledge of good and bad stone was of considerable importance to the British public, that time is now arrived. Our government is contemplating the covering of more than twenty acres of ground, at Westminster, with official buildings of a palatial character; it is, therefore, to be hoped that the subject of our attention this evening will apply only to the times past and present; and that in future, when a magnificent structure shall be completed, the external masonry may remain unimpaired during the lives of those who were at the cost of erecting it, without the expense and annoyance of scaffolding, saturating, discolouring, and many other vexatious incidents attendant on the endeavour to make the best of a discreditable affair.

BATTERSEA PARK.

A considerable portion of the works are completed, and some thousands of shrubs and trees are planted; but still there is much to be done. A great part of the new park lies very low, and will have to be thoroughly drained, otherwise trees will not thrive. This is being done, whilst, at the same time, every exertion is being made to plant as many shrubs during the present season as possible. Whilst the park is thus rapidly progressing, the Chelsea Bridge works are advancing. One of the temporary chains has been carried over the abutments, and others will be put up in the course of a week or two, and should nothing adverse arise, it is probable that the bridge will be available for the public in the course of the summer, provided the approaches are sufficiently advanced.

REVIEWS.

Table of Quarter Squares of all integer numbers up to 100,000, *by which the Product of Two Factors may be found by the aid of addition and subtraction alone.* By SAMUEL LINN LAUNDY. London: Laytou. 1856. 8vo. pp. 214.

This work is an instance of the long unsuspected power and value which may be possessed by means of which the very simplicity has caused them to be neglected. By an algebraical formula, so simple that a boy might comprehend the proof of it in his first lesson in algebra, a simple way is found of abridging the labours of arithmetical computers, by substituting for multiplication and division the easier processes of division and subtraction. We suppose that the least learned algebraist among our readers can ascertain for himself that if from the square of $a + b$ the square of $a - b$ be subtracted, the remainder is $4\,a\,b$; and consequently that $\frac{1}{4}(a + b)^2 - \frac{1}{4}(a - b)^2 = ab$.

Suppose now that a and b are two numbers of which the product is required without the labour of multiplication. In the preceding formula this required product is shown to be equal to *quarter of the square* of the sum of the two numbers *minus* the *quarter of the square* of their difference.

Hence the utility of a table of Quarter Squares. In such a table is placed, opposite each number, the quarter of its square. For instance, the following is taken from the first page of Mr. Laundy's table:—

Number.	Quarter Square.	Number.	Quarter Square.
1	·25	16	64·00
2	1·00	17	72·25
3	2·25	18	81·00
4	4·00	19	90·25
5	6·25	20	100·00
6	9·00	21	10·25
7	12·25	22	21·00
8	16·00	23	32·25
9	20·25	24	44·00
10	25·00	25	56·25
11	30·25	26	69·00
12	36·00	27	82·25
13	42·25	28	96·00
14	49·00	29	210·25
15	56·25	30	25·00

* Here the first and third columns contain the numbers, and the second and fourth the quarters of their squares. By the principle just explained, we have but to take the number which is the sum of $a\,b$, and find its quarter square from the table, to find similarly the quarter square of $a - b$; and subtracting the one quarter square from the other, we have at once the required product, $a\,b$. For instance, to find the product of 13 and 16: the sum of those two numbers is 29, and their difference is 3.

From the table, quarter square of 29 is 210·25
" " " of 3 is 2·25

Subtracting, 208·00, required product.

This, of course, is a very simple instance; but the real value of the tables is shown when the products of higher numbers, and especially of those involving decimals, are required. It will be observed that for integers the products are given exactly, whereas products obtained by a table of logarithms are generally given approximately only.

The purposes to which a table of products may be applied are manifold. For instance, where a multitude of computations in what arithmeticians call "Practice" has to be performed, the labour of the computer may be materially abridged, especially where a decimal notation of money, weights, and measures, is used. Thus, to find the value of 74 oz. 2 dwt. 12 gr. at 4*s.* 11½*d.* per oz., *i.e.* of 74·125 oz. at £24792 per oz., we have 74125 + 24792 = 98917, and 74125 − 24792 = 49333.

Quarter square of 98917 = 244614
" of 24792 = 60844

18·3770=18*l.* 7*s.* 6½*d.*

the required result. Again, the tables may be applied to various computations of simple and compound interest, of areas and cubic contents. It appears from our author that the idea of the utility of a table of quarter squares was originally suggested, or at all events practically exhibited, by Antoine Voisin, in a work entitled *Tables de Multiplications en Logarithmes des Nombres Entiers depuis* 1 *jusqu'a* 20,000, published in 1817. Another table was pub.

lished of quarter squares of numbers up to 40,000, by M. Merpaut, Professor in the College of Vannes, in 1832; and Professor Leslie, in his 'Philosophy of Arithmetic' (2d edit. 1820), gives a smaller table. Another such table is given by Galbraith, in his 'General Tables' (1836), who remarks upon the utility of such tables to astronomers and surveyors. Our author is of opinion, however, that Galbraith and Leslie merely copied from Voisin's tables. Professor Sylvester—whose fertile mind, not contented with the profoundest mathematical researches, has occupied itself also with numerous more elementary. but almost equally valuable arithmetical investigations—has contributed to the knowledge of the subject before us papers in the 'Assurance Magazine' and the 'London and Edinburgh Philosophical Magazine.'

The subject of quarter squares is briefly noticed in an article in the 'Penny Cyclopædia.' Another article on 'Tables,' in that work, gives an account of another class of tables having the same object—namely, tables of multiplication, which give products directly. The oldest noticed is that of Murhard, published at Munich in 1610. The others referred to are 'Hutton's Tables of Products' (1781), of which the accuracy is doubted; 'Riley's,' (1775); 'Dodson's,' (1747); 'Crelle's Rechentafeln,' (1820); 'Schubler's,' (1739); 'Oyon's,' (1824); and 'Cadet's' (1797); the tables of Crelle being the most extensive of all.

Of these works we have examined that of Crelle only, which was published at Berlin in two thick volumes, and contains every product of integers up to 1000 times 1000. Another more important work by Crelle (omitted in the notice in the 'Penny Cyclopædia), is his 'Erleichterungs Tafel' (Berlin, 1836), which gives the products of all integers up to 10,000,000 by the integers 1, 2, 3, 4, 5, 6, 7, 8, 9, respectively. By setting down in their proper places the products of any number containing not more than seven cyphers, as given in this table, we obtain by mere addition any product we please of such a number. For numbers higher than those indexed in Mr. Laundy's table, and within the compass of Crelle's table, we apprehend that the process of multiplication would be more easy by the latter. For instance, Crelle gives the following example of the use of his table to multiply 9815734 by 7259483:—

```
                      9  8  1  5  7  3  4
                      7  2  5  9  4  8  3
                     ---------------------
                2  9  4 |4  7  2  0  2
             7  8  5 |2  5  8  7  2
          3  9  2 |6  2  9  3  6
       8  8  3 |4  1  6  0  6
    4  9  0 |7  8  6  7  0
 1  9  6 |3  1  4  6  8
6  8  7 |1  0  1  3  8
-----------------------------------------
7  1  2  5  7  1  5  4  1  0  5  5  2  2
```

Crelle's tables are so arranged that the products of each multiplicand by the integers up to 9 are given on one page. We have therefore to turn to but one page to obtain each required result. The products for the first five digits of the multiplicand are given in one column of the page, and for the remaining digits in another column. Therefore, in the preceding example, there are required 14 findings all on one page, and one addition. To obtain the same result by Mr. Laundy's tables, a process is necessary which seems more laborious. According to Mr. Laundy's method, the multiplicand would be divided into two parts, say 9815 ($= A$) and 734 ($=$ B). The multiplier is similarly divided into two parts, say 7259 ($= a$) and 483 ($= b$). We have then to find the sums and differences of four pairs of these quantities, viz., $A+a$, $A+a$, $B+a$, $B-a$, $A+b$, $A-b$, $B+b$, $B-b$, (eight operations). We have then to find the quarter squares of all these quantities (eight findings); then to find the differences between each successive two of these quarter squares (four more operations); and, lastly, to add all these differences, with certain cyphers, together (one more operation). The comparison between this method and Crelle's stands thus—This method requires eight findings on different pages, and thirteen operations; Crelle's method requires fourteen findings, all on one page, and only one operation. The latter method appears, therefore, far more expeditious and easy than Mr. Laundy's, and it certainly requires fewer figures to be written down. But though Mr. Laundy's method thus appears at a disadvantage when high numbers are involved, it is by no means to be inferred that his tables are every way inferior to those of Crelle. On the contrary, for all numbers of which the quarter squares are actually tabulated (namely, all integers up to 100,000), Mr. Laundy's method of multiplication is simple and concise; and we doubt not that for most practical purposes his tables will be found extremely useful. The printing and arrangement of the figures are admirable.

BLASTING OPERATIONS AT HOLYHEAD HARBOUR.

This great national undertaking, which is being carried out under the direction of the Board of Admiralty, by the Messrs. J. and C. Rigby, of Westminster, and which was designed by the late Mr. Rendel, affords periodically to the civil and military engineer, an opportunity of witnessing the effect of large quantities of powder brought to bear in the dislodgement of immense masses of the hardest description of quartz rock, amounting in several instances to upwards of 100,000 tons. One of these stupendous operations took place on the 16th ult. The engineering arrangements were under the personal direction of Mr. Charles Rigby, assisted by Mr. Reitheimer, resident engineer.

The aggregate charge in the four chambers, acting upon a face of 210 feet in length and 115 feet in height, with a line of least resistance of about 25 feet, was 16,000lb. of powder. The voltaic battery was placed a short distance from the quarries, and the spectators were within a protected battery or observatory in front of the mountain, at a distance of only 600 yards, from which they were enabled to witness the explosion without danger, not a stone having been propelled 100 yards from the face of the quarry. We may here mention that nearly 6,000,000 tons of stone have been already dislodged by this means for the construction of the harbour, without failure and without accident. In the mining operations which take place for this purpose the quantity of gunpowder used annually exceeds 500,000 lb., or more than 250 tons, and the stone deposited in the sea for the formation of the rubble foundations and embankment exceeds yearly 1,000,000 tons. In addition to the agency which gunpowder affords for the rapid construction of the breakwater, there are employed upwards of 1200 men, a large number of locomotive engines, stationary engines, travelling cranes, with steam power, and every modern appliance which mechanical skill can bring to bear to accelerate its completion.

To show its increasing utility, it may be mentioned, that in 1854, 1788 vessels, with a tonnage of 137,169 tons, anchored under shelter of the northern breakwater, and this number has been increased to upward of 3000 vessels during the last year.

The system adopted of constructing this breakwater so as to combine the advantages of obtaining stone from the adjoining mountain with economy and rapidity of execution, has been that of forming timber stages, with railways over the line of the breakwater, about 80 feet above the bottom of the sea, and depositing the masses of stone of all dimensions, by dropping them vertically from iron railway wagons, in trains of from 10 to 12 at a time, into the required positions, thus bringing up the mass simultaneously to above the level of the sea. In this manner as much as 25,000 to 30,000 tons have been deposited in one week; and this vast demand is supplied by the great blasting operations. Although the severe storms which have repeatedly occurred on this exposed coast have done from time to time much injury to portions of the stages, not a stone has been displaced from the superstructure now in course of construction upon the rubble embankment, thus showing the judgment and skill evinced by the late Mr. Rendel in the adoption of this system of engineering as applied to the rapid and successful formation of harbours of refuge. The eastern breakwater (forming the inner area), and packet pier will be shortly commenced, with which the Chester and Holyhead Railway will be connected, so that passengers can, without delay, embark under cover on board the packets from the Harbour Railway Station, avoiding thereby any interruption to the traffic in the transfer from the packets to the trains, and saving thereby nearly an hour. This pier will also admit of being used as a store for at least 2000 tons of coals for the use of the packets or other vessels that may avail themselves of the harbour.

The works were commenced in 1848, under the authority of her Majesty's government, by Messrs. J. and C. Rigby, and have since that time been unceasingly carried forward by them. When completed, it will stand unrivalled as one of the most stupendous achievements of the present age, and will form one of the finest and largest artificial harbours in the world.

NOTES OF THE MONTH.

The Commissioners of Patents, in connection with the Great Seal Patent Office, have undertaken the formation in the Museum Building, at Kensington Gore, of a museum of models of patented and other inventions, and of a library of works on subjects relating to the industrial arts. The building is now ready, and possessors of models desirous of having them exhibited in the museum at Kensington, will be informed what space can be allotted to them on application by letter to the superintendent, at the Great Seal Patent Office, 25, Southampton-buildings, Chancery-lane. The models will be kept in perfect order, and in glass cases when required.

At a meeting recently held at the Institution of Civil Engineers, the following resolutions were passed:—"Resolved unanimously, —That Mr. Charles Manby, who has for upwards of seventeen years held the post of secretary of the Institution of Civil Engineers, having retired from the more active duties of the office, the present is a fitting occasion to acknowledge the important services rendered by Mr. Manby during his tenure of office, as well as his general usefulness to the profession. Resolved, —That the following gentlemen be a committee to carry out the above object:—The Council of the Institution of Civil Engineers, and Messrs. T. E. Blackwell, T. R. Crampton, W. T. Doyne, G. W. Hemans, J. E. M'Connell, G. Peel, members; and Messrs. J. G. Appold, J. Freeman, J. Hamilton, jun., W. Piper, J. Allen Ransome, G. F. White, and T. H. Wyatt, associates, with power to add to their number." At a subsequent meeting of the committee, it was resolved, that the object of the committee being to make the testimonial as general as possible, each subscription be limited to two guineas. Mr. G. P. Bidder has been requested to act as treasurer to the fund, and Mr. J. Forrest has been appointed honorary secretary to the testimonial committee.—A portrait of Mr. Manby, painted by Mr. Sydney Hodges for Mr. T. R. Crampton, C.E., has been presented to the Institution, and ordered to be suspended in the meeting-room of the society.

Monsieur Hittorff, Architect, Honorary and Corresponding Member of the Royal Institute of British Architects, has just been elected President of the Class of Fine Arts of the Institute of France. Monsieur Rohault de Fleury, another architect and correspondent of the Institute of British Architects, a Vice-President.

At the Conversazione of the Architectural Association, held at Lyon's Inn Hall on the 23rd ult., Mr. Ruskin delivered a lecture on "The Use of Imagination in Modern Architectural Design." There was a very full attendance, and the lecture gave great satisfaction. We believe it is the intention of Mr. Ruskin to publish it.

At the recent meeting of the Middlesex Court of Justices, the design of Messrs. Banks and Barry was selected for the New Middlesex Industrial Schools. The first premium had been previously awarded by the magistrates to Messrs. Aickin and Capes, and those gentlemen have circulated a lithograph of their plan, with a letter, showing their objections to the design now adopted, and the advantages of their own. Their design having been selected as the best, they urge—and we think most properly so—that they ought to have been employed to erect the building.

It is fully expected that the government will agree to a vote of 20,000*l.* towards the erection of a breakwater in the Bay of Wick, in the estimates for 1857.

Plans for the erection of a new town at Milford have been prepared, and application is to be made in the next session for an act to carry the same into effect. It is laid out in front of Milford Church, and is ultimately to be extended to Castle Pill. The surveyors have been actively engaged in marking out the ground. The plans are elaborate, and comprise terraces, shops, and detached villas, with a complete system of lighting, water, and drainage. The erection of public baths and an assembly-room has been settled; and in conjunction with the line from Johnstone it has been determined to erect a new pier, a desideratum long needed. To carry out these improvements a company has been formed, who are taking the necessary steps to procure an act for the formation of gasworks, cemetery, water-works, &c., and the customary parliamentary notices have been issued.

The Hastings Board of Health have determined on carrying out and completing the extensive works of sewerage and drainage of the town. They have approved of the plans of their surveyor, Mr. John Laing, C.E.

It is understood that the East Indian Railway Company has not yet succeeded in finding a successor to Sir Macdonald Stephenson in the agency at Calcutta. It is a prize well worth the attention of the best men in the railway world.

At a recent meeting of the Society of Arts, a paper was read on "Central America, and the proposed Honduras Inter-Oceanic Railway," by Mr. E. G. Squier. The attention of the meeting was first drawn to the peculiarly advantageous geographical position of Central America, which, in fact, almost realises the ancient idea of "the centre of the world." The line of the proposed work commences at Puerto Caballos, in the bay of Honduras, in lat. 15° 49′ N., and long. 87° 57′ W., and runs nearly due south across the continent to the Bay of Fonseca on the Pacific, in lat. 13° 21′ N., and long. 87° 35′ W. Its total length from anchorage to anchorage is 148 geographical miles, equal to about 161 statute miles. The line does not present any serious engineering difficulties, nowhere involving a gradient of more than 60 to 80 feet to the mile. Mr. Squire noticed the various resources of the country the proposed railway would develope, particularly the silver mines, which are unsurpassed in the amount and richness of their ores.

A memorial has just been erected at Bow-bridge, Leicester, whereon it is recorded that near that spot lie the remains of King Richard III. It is a handsome stone, set in the gable of a new building there. The monument is in Kelton stone, the design being good and the execution of a first-rate character.

A company, under the name of the Thames Ironworks and Ship-building Company, has been formed, for the purpose of continuing the Orchard Yard Works, Blackwall, lately belonging to Messrs. Mare and Co.

Experiments have recently been made at Messrs. Collinge and Co.'s, Westminster-bridge-road, by the Patent Timber Bending Company, to try the effect of their machine for bending timber of large size. In this instance, the "stick" put in was 12 feet long and 16 × 7 in thickness; and upon the machine being put in motion, its operation fully showed the correctness of the principle. The machine is of cast-iron, of right-angular form, a centre pin being provided so as to allow the moveable arm to be brought nearly parallel to the fixed one. The timber to be bent, which is previously prepared by steaming, is firmly secured by a screw to the end of the moveable arm, so that by bringing the extremities of the arms together, it is gradually drawn round a mould of the form required, it being prevented from expanding on the outer side by a strong chain, acting as a back strap, and the application of pressure at the end. It appears that woods of all kinds, and almost any size, can be bent to any curve by this simple machine, and that the strength is actually increased by the operation, although by the usual method, which is expensive and unsatisfactory, the part where the curvature is greatest is rendered, invariably, the weakest. This invention admits of the employment of arched timbers for architectural purposes, where otherwise expense would prevent it. Already a Roman Catholic cathedral has been built in the United States, with a dome formed of wood bent by this process; and it is much lighter, stronger, and cheaper than the combination of metal, brick, and papier-maché, frequently employed. The wood, after being bent into the required form, has to be kept in the same form, by mechanical means, for some time, in order that it may cool and dry; but it is then almost impossible to re-bend it to its former shape.

Mr. Taplin, from the engineer's department of Woolwich Dockyard, having been deputed by the Lords of the Admiralty to proceed to Portsmouth on board the *Dee*, in order to note the progress of Mr. Weathered's apparatus for super-heating steam, fitted on board that vessel, has confirmed the reports already forwarded to the Admiralty, and has fully corroborated the former statements, detailing the specific amount of economy obtained thereby, without causing the slightest perceptible injury or extra strain to the machinery of the ship. A second invention, the production of a Mr. Lees, for super-heating steam, was lately brought forward and subjected to a preliminary trial on board the steam vessel *Water Sprite*, during a run of two miles down the river from Erith. The apparatus consists principally of a hydro-caloric engine, by which the steam is first produced in a small boiler or generator. It then passes through a second, which is named a "coil boiler," and traverses a coil of 36 circles of coiled tubes, and, issuing thence red hot, is received into a third, where it is condensed with water and boiled. It is supplied in that state for the use of the engine. The experiments were highly satisfactory, and were recommended for further trials, as the method, subject to a slight revision, is considered likely to become of considerable importance in the navigation of steamers.

A company has been formed to carry out the patent of Captain Stephen Rendoll Smith, for submarine purposes. The power brought to bear in Captain Smith's submarine lifting-apparatus is steam supplied in two flat-bottomed iron vessels. The sunk vessel is sought for in deep water by the surveying apparatus, with divers on stages, with chain ladders, and drawn along by a screw-steamer, the chain ladders having on either side the ordinary air and speaking apparatus of divers. When the vessel is found, the flat-bottomed screw-vessels are placed on each side, and powerful steam machinery, with crab-winches and chains, are applied and worked with the help of a series of iron tubes passing from the deck of each lifter, through its central line, to the bottom, so that the lifting power is applied from the centre of each vessel without lurching or disturbing their vertical position, and by direct action and a dead pull upon the wreck or other weight to be lifted. When raised to a sufficient elevation it may be carried onward to a beach, or other destination, by the screw propellers of the lifters; or the wreck, it is said, can be floated by further processes.

At the Great Western Railway Station, Paddington, a very large amount of building is in progress (in the way of additions to the enormous establishment), from the designs of Mr. Brunel, the chief engineer. Amongst the most prominent of them is a new goods station, the platform portion of which is 520 feet in length, with an average width of about 80 feet. The roof is of corrugated iron, and supported by iron columns, from which spring segmental arches, roofed in with glass and slate. At the eastern end of this large platform is a warehouse of irregular plan, the length of which is 150 feet, and its greatest width 90 feet. This warehouse has a height of four stories, the ground floor being 17 feet in height, the first 11 feet, and the second and third floors, 9 feet each. Some very large workshops are also now nearly completed, extending to a length of 300 feet; the upper one, to be used as a carriage trimming shop, being 34 ft. 6 in. wide; and the lower one, which is appropriated to the repairing and painting carriages, being 81 ft. 6 in. in width. These lower shops are 400 feet in length. In addition to these, there is also the Queen's carriage shed, which is 42 feet long, by 32 ft. 6 in. wide. This shed is finished in a somewhat superior manner, being roofed with iron girders, arched between and plastered, and heated with Perkins's hot-water apparatus, with the view to the preservation of its contents, as a preventive of damp. Mr. John Jay, builder, of Macclesfield-street North, City-road, has the contract for the works now in progress, and Mr. Robert Rowel is the clerk of the works, Mr. Bertram being the resident engineer, the whole being under the general supervision of Mr. Brunel.

A statue of the great Earl of Chatham, by M'Dowall, has just been added to the group of eminent statesmen which line the grand entrance to the new Houses of Parliament. Two more—those of Grattan and Burke—are still wanting to complete the series determined on for this magnificent apartment.

At a public meeting in North Shields, Mr. Wm. Reed, C.E., who has been engaged in conducting experiments for testing the competing plans for the 500*l.* premium offered by the Steam Coal Collieries Association for the best device for consuming smoke, observed, as to smoke prevention, the description of boiler experimentally employed, and the mode of managing the furnace:—"1. The boiler by which the experiments are carried out is a marine multitubular one, and generally considered the worst adapted form for the prevention of smoke. 2. The fire-bars are only half the thickness of those commonly used by engineers; and instead of using a closed dead-plate, there is a perforated plate. The coal experimented on is that of the Cramlington Colliery. In my arrangements of the fire-grates, the smoke has been prevented. I find that it is quite easy to prevent smoke without apparatus to measure exactly the quantity of air going into the furnace—having used nearly double the quantity in one experiment more than in another, and preventing the smoke, evaporating the same quantity of water to each pound of coal, in the same time, which proves an exact quantity is not important. Likewise it is as easy to prevent smoke using 17 lb. of coal to each square foot of grate surface per hour, as with using only 12 lb. under the same treatment. I find by experiment, no loss of heat in preventing the smoke; on the contrary, in favour of smoke prevention about 3 per cent. saving over smoke making. The person in charge of the fires ought to fire at regular times as nearly as possible, and the quantity of fuel to be sufficient to keep a thickness of fire no less than 6 inches in the thinnest part—the consumption to be regulated to the time by the damper, and not by putting on small quantities to the fires. The best smoke preventor is a careful fireman, with an ordinary fire-grate, and flues well arranged. These statements are made from practical experience and observations on experiments—the quantity of fuel weighed, the water measured, the air entering the furnaces measured—the gases from the chimney analysed—temperature of the flues taken—the temperature and state of the atmosphere during the experiments—and the residue of the fuel accounted for in the calculations—the whole being carefully arranged so as to get data to be practically useful."

Aluminium is now being employed in the casting of bells. It is affirmed that no metal, or combination of metals, yields a tone so musically sweet when struck. Provided, therefore, that the cost of its production be not too great, no metal can compare with it for bell-casting.

APPOINTMENTS.

The three officers to whom Sir Benjamin Hall has entrusted the task of deciding upon the Great London Drainage Scheme, are Captain Douglas Galton, of the Royal Engineers, Mr. Simpson, and Mr. Blackwell, both well known in the engineering profession. The scope of their inquiries will be very comprehensive, as they are not only empowered to consider the plans of the Metropolitan Board of Works, but to initiate others, should they think it expedient to do so.

Captain William S. Moorsoom, civil engineer, has been appointed by Mr. Secretary Labouchere to be chief engineer to the government of Ceylon, for the purposes of a railway survey.

The commissioners have appointed Mr. John Fowler, C.E., as their engineer-in-chief to carry on the Nene Valley Drainage Works, originally commenced by the late Mr. Rendel, C.E.

OBITUARY.

At his residence, Burton-street, Burton-crescent, aged 86, John Britton, F.S.A. He was author of the 'Beauties of England and Wales,' 25 vols.; of the 'Architectural Antiquities of Great Britain,' 5 vols.; the 'Cathedral Antiquities of England, 14 vols.; the 'Public Buildings of London,' 2 vols; A dictionary of the Architecture and Archæology of the Middle Ages;' 'Architectural Antiquities of Normandy;' 'Picturesque Antiquities of English Cities;' and several other works. His autobiography is left unfinished. A deputation of the Council of the Royal Institute of British Architects attended his funeral at Norwood Cemetery.

At Upper Seymour-street, Porman-square, aged 59, Andrew Ure, M.D. F.R.S., F.R.A.S., F.G.S. In the year 1818 he brought forward his 'New Experimental researches on some of the leading doctrines of Caloric, particularly on the relation between the elasticity, temperature, and latent heat of different vapours, and on thermometric admeasurement and capacity,' which was read before the Royal Society, and published in their Transactions for that year. Mr. Ivory, Mr. Daniell, and other philosophers have adopted the calculations afforded in this paper as a bases of their meteorological theories. In 1821 appeared the first edition of his well-known 'Dictionary of Chemistry.' In 1822 appeared his paper 'On the ultimate Analysis of Vegetable substances' in the Philosophical Transactions. In the year 1829 his 'System of Geology' was published. In 1835 his 'Philosophy of Manufactures' followed, and in the following year his work on the 'Cotton Manufactures of Great Britain,' in two volumes. His next great work was the 'Dictionary of Arts, Manufactures, and Mines,' a work of immense labour and research, the last edition of which appeared in the year 1852. This work has been translated into the leading continental languages.

On the 23rd November last, at Cairo, Mr. Thomas Seddon, artist. He was prosecuting a professional journey to the East, and shortly after his arrival at Cairo was attacked with dysentery.

Recently, at his residence at Banesooth, Mr. Brebner, the well-known railway contractor.

FOREIGN RAILWAYS.

Austrian Railways.—The Emperor has signed the concession of the East Galician Railroad. The line of the Vienna-Salzburg railroad is not yet definitively fixed.

Turkish Railways.—Mr. Layard's proposition for the construction of railways in Turkey is the subject of much discussion. The proposed line is to connect the Danube and Black Sea with the Archipelago; with branches, ultimately, to the different towns of Roumelia and Bulgaria. It is to commence at Rustchuk or Silistria, and pass by Shumla and Adrianople to Suez, or some other approximate point in the Archipelago. Its course is directly west to east, and will be the high road of Turkey. The entire distance is estimated at 320 to 350 miles. Mr. Layard himself is most sanguine on the point, for he asks for no guarantee from the Government, and considers that the traffic will increase so rapidly, and such valuable districts will be thrown open, that there will be no occasion for the security of any minimum rate of interest.

Punjaub Railway.—The projected line under the above title is an extension of the Scinde railway from Mooltan to Lahore and Umritsir. It is now being surveyed with the sanction of the Hon. East India Company. It is stated to be exceedingly easy of construction.

Railway between France and Spain.—The French engineers who were sent some time back into Upper Arragon to examine the question of carrying a railway across the Pyrenees, to effect a communication between France and Spain, have terminated their surveys, and the result has been arrived at, that the line should start from Tarbes and end at the city of Huesca, passing by the bridge of Gavarni. In the neighbourhood of Huesca, not fewer than 3000 men are employed in the preliminary works. It appears from the surveys, that the passage across the Pyrenees is not so difficult as was believed. The great drawback to the uninterrupted working of the line will arise, it is thought, from the great quantity of snow which is to be found in these districts during four months of the year.

Nova Scotia.—A line of railway is in course of construction from Halifax, in Nova Scotia, to connect with the Grand Trunk line, which is designed to obviate the difficulties arising from the long ice blockade of the St. Lawrence.

COMPETITIONS.

The Burial Board for the Parish of Sunderland, near the Sea, Durham, require plans and specifications for enclosing and laying out ten acres of land, for the purpose of a Burial-ground with Two Chapels, and Cottages. A plan of the ground may be seen at the offices of the Burial Board. Each chapel to accommodate 100 persons, and not exceed 600*l.* including the fittings. The two cottages, with store-room, not to exceed 450*l.* The Board will give 20*l.* for the plan and specification approved by them. Plans to be delivered at the office of the Board, No. 5, Church-street, Sunderland, by the 2nd of February.

Plans are required for the intended new chapel of the Methodist New Connexion, Woodhouse-lane, Leeds. Information of Mr. Slater, 8, West-bar, Leeds. Plans to be sent in by the 5th inst.

The Committee appointed by the Town Council of Bristol, to superintend the erection of a New Pauper Lunatic Asylum, offer premiums of 100*l.*, 50*l.*, and 25*l.* for the three best designs for the same. Plans to be accompanied with specifications and estimates. The building to receive 200 patients, with requisite offices, and accommodation for resident officers. The amount to be expended on the building to be between 15,000*l.*, and not exceeding 20,000*l.* The building material found on the intended site to be used as much as possible. The elevation to be of a simple but cheerful character. The "Suggestions and Instructions" for building Lunatic Asylums, published by the Commissioners in Lunacy, to be, as far as practicable, complied with. The plans to be deposited at the Town Clerk's office, Council-house, Bristol, by the 14th February. A lithographed plan of the intended site, and copies of the "Suggestions," may be obtained upon application to the Town Clerk's office

The Committee of the Etheridge Monument, Bilston, Staffordshire, are desirous of receiving Designs, Specifications, and Estimates, from architects and sculptors, for a Monument to be erected in the Bilston Cemetry, to the memory of the late Mr. John Etheridge. The monument to be constructed of some material capable of resisting the weather. Total cost not to exceed 200*l.* Designs, specifications, and estimates to be sent in on or before the 14th inst., distinguished by cypher or motto, the name of each designer to be enclosed in a sealed envelope. The description of materials, and all other particulars, to be left to the persons sending in the designs, but subject to the approval of the Committee. Any further information may be obtained of the Secretaries, Committee Room, Bilston. No premium will be given for rejected designs.

Designs for a church to be erected at Berne are invited from architects of all countries by members of the "Catholic parish of the city of Berne." The cost not to exceed 6000*l.* The first prize is 60*l.*; four medals, gold and silver, are also offered.

The Guardians of the Medway Union are desirous of being furnished with Plans, Estimates, and general Specification for the erection of a New Workhouse for that Union on a site near Magpie Hall-lane, Chatham, to contain 650 inmates. A lithographed plan of the site, with sections and instructions to architects, as to the wards, rooms, and offices required, and all other particulars may be had on written application to Mr. G. Buchanan, Clerk to the Board of Guardians, Chatham. The maximum sum proposed to be expended in the building is 11,000*l.* The plans are required to be sent, addressed to the Clerk of the Board, by the 23rd inst.

The Committee of the Lurgan Mechanics' Institute wish to receive a Plan and Specification for the erection of a building suitable for such an Institute; cost not to exceed 1200*l.* The Committee will employ the architect whose plans and terms may be considered the most eligible; and, on his accepting the employment, will give 20*l.* to the architect whose plans may appear to them the next in order of merit. Should the architect whose plans are deemed the most eligible decline to undertake the superintendence of the Works, he will be paid 20*l.* for his trouble in preparing such plan. The plans and specifications, together with a letter from each architect, stating whether he will undertake the execution of the Works, and his terms for so doing, to be lodged by the 28th inst. with John Hancock, Esq., J. P., Lurgan, who will give any further information.

The Plans for the Main Drainage of the Metropolis having been referred to Capt. Douglas Galton, R. E., James Simpson, Esq., C. E., and Thomas E. Blackwell, Esq., C.E., notice has been given that all persons desirous of communicating with those gentlemen upon the subject, may direct letters, plans, &c. to them at their Office, No. 29, Great George-street, Westminster, up to the 28th inst. The following conditions must be observed:—All communications to contain the names and addresses of the parties forwarding them, and to be written on half sheets of foolscap paper, on one side only, with 2-inch margin on the left. If plans are sent in, those plans which are district plans must be on a scale not less than four inches to the mile. Sections of lines of drainage, present and proposed, to be on a scale of 20 feet to an inch vertical, and not less than four inches to a mile horizontal, and to have the gradients marked on them in all cases, with the heights in feet and inches at every change of gradient. A blue line to denote Trinity high-water mark, to be shown on all sections. Drawings of works must be on a scale of one-eighth of an inch to a foot.

The Directors of the Dundalk Exchange and Market Company are prepared to receive Plans and Estimates for the erection of Exchange, News room, Assembly Room, and General Markets: for the approved plan of which they will give a premium of 30*l.*, and for the next approved of 15*l.* Plans to be submitted before the 1st of March. Further particulars will be given upon application to the Honorary Secretaries, Peter Russell and James Shekerton.

The Commissioners of Her Majesty's Works and Public Buildings invite architects of all countries to furnish them with designs for Offices for the Secretary of State for Foreign Affairs, for the Secretary of State for War, and for laying out the ground between the Thames and St. James's-park, adjoining Great George-street. The drawings to be made to a scale of 16 feet to the inch. General specifications of the materials proposed to be used in the buildings must accompany each design. A block-plan showing how the site may be so appropriated that the two buildings proposed to be erected may form part of a large and comprehensive scheme for concentrating the principal public offices, and for the improvement of the leading thoroughfares, including Westminster-bridge, whether as regards its present or any other site. Seven premiums for the best designs for the War Office of 800*l.*, 500*l.*, 300*l.*, 200*l.*, 100*l.*, 100*l.*, and 100*l.* Seven premiums for the best designs for the Foreign Office, of 800*l.*, 500*l.*, 300*l*, 200*l.*, 100*l.*, 100*l.*, and 100*l.* For the best design for a block plan, three premiums of 500*l.*, 200*l.*, 100*l.* Plans of the ground, and other particulars will be forwarded on application to Mr. Alfred Austin, Office of Works, Whitehall. Designs to be sent in by the 20th of March.

Designs are invited from artists of all countries for a Monument to be erected in St. Paul's Cathedral, to the memory of the late Duke of Wellington. The cost, with all expenses, not to exceed 20,000*l.* Premiums of 700*l*, 500*l.*, 300*l.*, 200*l.*, and five of 100*l.* A ground-plan of the cathedral, and the site of the proposed monument, &c., will be forwarded, on application to Mr. Alfred Austin, Office of Works, Whitehall. Designs from artists residing in the United Kingdom to June 1st, 1857; from artists residing abroad to the 25th of the same month.

Designs are wanted for a New Town-hall, to be erected in St. Andrew's—the cost of erection not to exceed 3500*l.* Particulars may be had of Messrs. Grace and Yoole, Town-clerks, St. Andrew's, Scotland.

Designs are invited for a statue in marble of the late Lord Plunket, to be placed in the Hall of the Four Courts, Dublin. Information of Colman M. O'Loghlen, 20, Merrion-square South, or Robert Johnston, 3, Henrietta-street, Dublin, Secretaries.

The Town-hall Company, Rugby, have adopted the design of Mr. Murray; the cost being estimated by the architect, with certain additions, at 2800*l.* The design by Messrs. Clarke and Worthington was put aside, their estimate bein 4107*l.*

The designs of Mr. John Johnstone, architect, Newcastle-on-Tyne, have been selected for the new Corn Exchange and Concert Room for Berwick-upon-Tweed. There were fifty-four competitors.

A Design by Mr. Thomas Oliver, jun., architect, of Sunderland, has been adopted for the New Congregational Church and Schools, proposed to be erected on the North Cliff, Scarborough.

The plans of Messrs. Bidlake and Lovatt, architects of Wolverhampton, were selected from four sets of plans submitted in competition for the extension of the Wolverhampton Workhouse.

NEW PATENTS.

PROVISIONAL PROTECTIONS GRANTED UNDER THE PATENT LAWS AMENDMENT ACT.

Dated September 11.

2128. J. T. Pitman, Gracechurch-street—Improvements in the construction of iron bridges. (Communication)

Dated November 20.

2751. R. A. Brooman, Fleet-street—A method of and certain varnishes or compositions for rendering wood and other substances uninflammable and fire-proof, applicable also to the indurating of calcareous earths and stone, and to the rendering of paper and fabrics damp-proof, together with apparatuses for manufacturing such compositions. (Communication from Madame Boulard)

Dated November 21.

2762. W. Jacobs, Albert-road, Globe-fields, Mile-end—An improved composition for bedding and rendering bricks in furnaces

Dated December 3.

2866. T. Crabtree, Halifax—Improvements in card-setting machines, and in certain machinery or apparatus employed in the construction thereof, which apparatus is also applicable to similar purposes

Dated December 8.

2903. C. J. Lewsey, and G. Nasmyth, Bucklersbury—Improvements in the treatment and application of wood used in the construction of casks and such like vessels, and for other purposes

Dated December 9.

2918. A. M. Macé, Paris—A new manure for preventing the vine and other diseases arising from the soil, and for other similar purposes

Dated December 16.

2976. C. F. Vasserot, Essex-street, Strand—Preserving salmon, trout and other fish. (Communication)

2978. W. F. Thomas, Newgate-street—Improvements in sewing machines

2980. F. W. Gerhard, Trafalgar-square—Improved means of obtaining aluminium metal, and the adaptation thereof to the manufacture of certain useful articles

2982. W. Gossage, Widnes, Lancashire—Improvements in the manufacture of sulphuric acid, and in the construction of apparatus used for such manufacture
2984. A. V. Newton, Chancery-lane—Improvements in printing presses. (Communication)

Dated December 17.

2985. J. Smith, Heywood, Lancashire—Improvements in machinery for pumping
2986. P. A. le Comte de Fontainemoreau, South-street, Finsbury—Improvements in obtaining motive power. (Communication)
2988. J. Platt, Oldham, Lancashire—Improvements in mules for spinning. (Communication)
2990. F. Levick, jun., and J. James, Cwm Celyn and Blaina Iron Works, Monmouth—Improvements in the mode of utilizing the waste gases of blast furnaces
2992. C. Cowper, Southampton-buildings, Chancery-lane—Improvements in electro-plating. (Communication from L. I. Cassinus, Paris)
2994. V. L. C. Renou, Jersey—An improvement in the manufacture of spirit when rice is used

Dated December 18.

2995. F. B. Howell, Lebanon, Ohio—Improvements in machinery for cutting or making corks. Communication)
2996. J. Elce, and S. Hartley, Manchester—Improvements in machinery for moulding
2997. W. Hartley, Bradford—Improvements in spinning frames for spinning wool, hair, alpaca, cotton, silk, flax, or any other fibrous substances, on spools, paper tubes, or any kind of bobbins
2998. J. Draper, Chiswell-street, Finsbury—Improvements for apparatus for grating and crushing salt and sugar
2999. G. M. Clarke, Goldington, Herts—Improvements in the manufacture of moulded candles
3000. J. Bower, Hunslet, near Leeds—An improvement in treating animal matters in preparing them to be used for the manufacture of manure
3001. W. K. Wigram, Lincoln's-inn—An apparatus for igniting lucifer matches, or matches tipped with phosphorus or igniting composition
3002. C. Fay, Manchester—Improvements in railway carriages and breaks
3003. J. Brown, Liverpool—Improvements in the construction of ships' yards
3004. F. Donny, Ghent, Belgium—Improvements in the manufacture of lamps.
3005. W. A. Simonds, Boston, Massachusetts, U. S.—An improved life-preserving float

Dated December 19.

3006. L. Beaver, Manchester—Improvements in machinery for propelling vessels
3007. W. Rye and James Simpson, Oldham—An improved self-acting willow for opening cotton and other fibrous materials
3008. R. H. Greg and H. R. Greg, Manchester, and J. Hope, Reddish—Improvements in machinery or apparatus for polishing or finishing yarns or threads
3009. C. Massi, Greville-street, Hatton-garden — Improvements in apparatus for mounting cameras
3010. J. Penny and J. Booth, Heckmondwike, York—Improved machinery for washing, cleansing, and drying grain

Dated December 20.

3013. H. Batchelor, Newport, Monmouthshire—Improvements in steam boilers
3014. J. Edridge, Birmingham—Improvements in the manufactury of hair-pins, shawl and other dress pins, parts of which improvements are also applicable to the manufacture of clasps and similar dress fastenings
3015. T. White, Sleaford, Lincoln—A new or improved manufacture of boots, shoes, and other coverings for the feet
3016. G. A. Harrison, Capt. 79th Highlanders—Improvements in breech-loading fire-arms
3018. T. Newbury, Taunton, U. S.—Improved machinery for making screws
3019. C. C. Wilkinson, Hermes-street, Pentonville—An improvement in carving-forks

Dated December 22.

3020. T. Dethier, Pimlico—An improved knife cleaner
3021. R. Gibson, Hull—An improved self-acting apparatus for signalling on railways
3022. W Mill, Birmingham—Improvements in joining bands, in connecting fastenings to bands, and in attaching bands to articles requiring the same
3023. W. J. Payne, Waterloo-road, Lambeth—Improvements in casting and finishing cocks for general purposes
3024. F. Sampson, Gordon-street, Bradford—Improvements in apparatus employed in singeing fabrics
3025. L. A. Lang, Rue de Chaillot, Paris—A new system of rotatory motion for all kinds of vehicles
3026. E. Thornton, Huddersfield—Improvements in furnaces
3028. T. L. Thurlow, Baynard's-park, Surrey—Improvements in reaping machines
3029. W. H. Stratton, Lambeth-walk, Lambeth—Improvements in the fire-doors of furnaces
3030. J. Redgate, E. Ellis, and J. Cropper, Nottingham—Improvements in bobbin net or twist lace machinery
3032. G. Davis, Clerkenwell—An improved name and business plate for the outside of doors and windows
3033. E. Stanford, Charing-cross—An improvement in the manufacture of envelopes
3034. W. B. Johnson, Altrincham, Chester—Improvements in steam-engines and apparatus connected therewith
3035. W. Smith, Salisbury-street, Adelphi—Improvements in railway rolling stock. (Communication from J. B. Humphreys, Rio de Janeiro)
3036. F. Prince, Trafalgar-square—Improvements in fire-arms

Dated December 23.

3037. J. S. Bailey, Keighley, York—Improvements in machinery for combing wool and other fibrous materials
3038. W. Spence, Chancery-lane—Improvements in the manufacture of felt. (Communication from E. P. J. M. Albert, Rue de l'Empereur, à Montmartre, Seine)
3039. J. R. Dick, Alnwick, Northumberland—Improvement in window sashes
3040. W. E. Newton, Chancery-lane—An improved mode of manufacturing capsules for containing medicines. (Communication from J. Hegnauer, Uster, near Zurich, Switzerland)
3041. W. E. Newton, Chancery-lane—Improvements in meters for water and other liquids. (Communication)
3042. J. Anderson, Woolwich, Kent—Improvements in protecting floating batteries, ships, land batteries, martello towers, or other constructions, against shot or shell, or other projectiles
3043. W. F. Ecroyd, Marsden, Lancashire, J. Heyworth, of the same place, and G. Scarr, Burnley, Lancashire—Improvements in looms for weaving
3044. J. Lark, Bridge-foot, Vauxhall-cross—Improvements in kilns for burning materials in the manufacture of lime and cements
3045. J. L. G. Bailly, King-square—Improvements in winding up or maintaining the power of clocks
3047. F. Dehaynin, Paris—Improvements in machinery for moulding and pressing artificial fuel and plastic substances, and for driving the same from the moulds
3048. G. W. Van Abbott, Croydon—An improvement in bank notes, which is also applicable to share certificates and other similar documents
3049. A. Heather, Portsmouth—Improvements in ferry boats

Dated December 24.

3050. W. MacNaught, Manchester—Improvements in steam-engines
3051. B. Goodfellow, Hyde, Chester—Improvements in the construction of steam-boilers
3052. W. Macpherson, Manchester—Improvements in machinery for spinning and doubling cotton and other fibrous materials
3053. G. A. G. Nani, Sablonière Hotel, Liecester-square—Improvements in toys for the use of children
3054. W. Taylor, Nottingham—Improvements in producing various ornamental effects upon fabrics, paper, and other surfaces
3055. J. S. Barraclough, Halifax—Improvements in the means, machinery, or apparatus used for grinding dyewares
3057. R. A. Brooman, Fleet-street—Improvements in treating pile and cut pile fabrics, and in the manufacture of certain new pile fabrics. (Communication from C. A. Callou)
3058. J. Elliott, Sunderland—Improved machinery for manufacturing rivets, bolts, spikes, and other similar articles
3059. C. F. Varley, Gloucester-terrace, St. Paul's-road, Islington—Improvements in electric telegraphs

Dated December 26.

3061. J. Hostein, Essex-street, Strand—An improved mechanism for stopping railway trains
3062. D. Macdonald, Glasgow—Improvements in washing, bleaching, cleansing, and preparing textile fabrics and materials
3063. W. Smith, Margaret-street, Cavendish-square, and D. Bethune, Cambridge-terrace, Hyde-park—Consuming or preventing smoke in chimneys and furnaces
3065. W. Irlam, Gibraltar Iron-works, Newton-heath, Manchester—Improvements in the construction of railway turntables and weighing cranes
3066. S. Newburg, Islington, and C. Steinhart, Great Alie-street—Improvements in keys, and certain means for preventing the picking of locks. (Communication)
3067. F. Campin, Strand—The manufacture of a certain textile fabric, which the inventor terms "tissue buffle." Communication from P. H. Moullin, Paris)
3068. J. Clay, Birmingham—A new or improved portable printing or impressing instrument
3069. J. McIntyre, Newcastle-upon-Tyne—A safety-sounding apparatus or alarum for sailing ships and steam-vessels
3070. H. H. Goodman, Rue Grange Bateliere, Paris—Improvements in the construction of locks. (Communication from W. H. Alkins, United States)
3071. W. L. Mitchell, Albert-terrace, London-road, Southwark—Improvements in railway switch and signal apparatus
3072. G. Heppell, Uttoxeter, Stafford—An improved method of producing signals in railway trains by means of air
3073. W. C. Deeley, Devonshire-terrace, Hyde-park—Improvements in reducing copper ores. (Communication)
3074. W. Clark, Chancery-lane—Improvements in air and waterproof coatings, and in their application. (Communication)

Dated December 27.

3075. R. R. Cox, Fareham, Hants—Improvements in the manufacture of artificial fuel, and in machinery for that purpose
3077. W. E. Newton, Chancery-lane—Improvements in sewing machines. (Communication)
3078. T. Shaw, Ilkeston—Improvements in furnaces or fireplaces
3079. J. Petrie and W. McNaught, Rochdale,—Improvements in steam-engines
3080. T. W. Lord, Leeds—An improved mode of drying flax, tow, hemp, silk, cotton, and other yarns, in the process of dressing, warping, sizeing, beaming, and preparing yarn for weaving
3081. W. Swain, Birmingham—Improvements in heating and ventilating
3082. G. Ritchie, Ponsonby-street—Improvements in the manufacture of beds and mattresses
3083. J. C. Wagstaff, Cannon-street—Improvements in the manufacture of felted cloth. (Partly a communication)
3084. I. Atkin and M. Miller, Nottingham—Improvements in folding lace, paper, and other fabrics
3085. J. Morel, Gap, France—Improvements in casters for fitting under the feet of tables, seats, and other similar pieces of household goods

Dated December 29.

3087. H. Vaughn, Providence, Rhode Island—An improved method of hardening and tempering steel, and in hardening cast and wrought-iron
3088. J. H. G. Wells, Essex-street, Strand—Improvements in pumps and valves used therewith. (Communication from H. F. Bérenguire, Toulon)
3089. T. Alden, New York, U.S.—Setting and distributing printing types
3090. J. J. Speed, jun. and J. A. Bailey, New York, U.S.—Improvements in the manufacture of seamless pipes and tubes

Dated December 30.

3091. W. A. Gilbee, South-street, Finsbury—Improvements in treating beet-root for the manufacture of vinegar. (Communication)
3092. J. L. C. F. Grainville, South-street, Finsbury—Certain improvements in heating apparatus
3093. W. E. Newton, Chancery-lane—Improved means of preventing the explosion of steam boilers. (Communication from M. E. Scrive, France)
3094. R. A. Brooman, Fleet-street—Improvements in the construction of portable houses and other buildings. (Communication from F. Seiler)
3095. R. A. Brooman, Fleet-street—Improvements in lifting jacks. (Communication from Mr. Michel)
3096. R. A. Brooman, Fleet-street—An improvement in sawing machinery. (Communication from Saint Alban Hugues)
3097. R. A. Brooman, Fleet-street—Improvements in manufacturing articles of earthenware and other ceramic materials, and in the machinery and apparatus employed therein. (Communication from M. Seneque)
3098. G A. Shaw, Dartmouth-row, Blackheath—An improved machine for thrashing and cleansing corn or grain. (Communication from C. Vai, Turin)
3099. J. Lane, Manchester—Certain improvements in Jacquard looms. Communication from Chevalier E. di San, Second, Turin)

Dated December 31.

3100. J. O. Henry, South-street, Finsbury—Improvements in the production of embossed surfaces on wood
3101. P. Madden, Half Moon-street, Piccadilly—Improvements in furnaces or fire-places applicable to such in use for either heating of drying kilns, roasting of substances, or heating of boilers
3102. W. Bray, Folkestone—Improvements in traction engines
3103. C. W. Williams, Liverpool—Improvements in apparatus for mechanically charging furnaces with fuel
3104. A. R. Terry, Bedford-row—Improvements in machinery for cutting sugar and other substances
3105. W. McCulloch and T. Kennedy, Kilmarnock—Improvements in stop-cocks or valves
3106. W. C. Mann and F. J. Ingram, East Parade, Leeds—An improved mode of embossing cloth or other fabrics

Dated January 1.

1. J. T. Pitman, Gracechurch-street—A machine for making carpet lining and other similar articles. (Communication)
2. C. C. Reinhardt, Baltimore, U. S.—An improvement in the manner of fastening metallic backs to truss pads of glass, porcelain, or other analogous substances
3. W. Rigby, Salford, near Manchester—Improvements in machinery or apparatus for engraving metallic cylinders or rollers employed for printing calico and other substances
4. J. Bourne, Billiter-street—An improved steam train for navigating shallow rivers
5. E. T. Noualhier and J. B. Prevost, Paris—Improvements in applying metals over hard vitrified or any other surfaces by galvanoplastic process
6. J. Smith, Great Bridgewater-street, and H. Wiseman, Great Ancoats-street, Manchester—Improvement in shutters for shop fronts, and in apparatus connected therewith
7. F. H. Maberley, Stowmarket, Suffolk—Improvements in the construction of wheeled carriages
8. F. Ayckbourn, Lyon's-inn, Strand, Improvements in stockings for personal wear
9. F. S. Stott, Bradford, York—Improvements in slide valves applicable to steam and other motive power engines
10. A. Lorimier, Bedford-square East, Commercial-road—An improvement in preparing the surfaces of printers' inking rollers and other articles when vulcanised india-rubber is used
11. W. H. Phillips, Essex-street, Strand—Improvements on stereoscopes
12. J. Fowler, jun., Havering, near Romford—Improvements in giving motion to ploughs and other agricultural implements
13. W. Lawrance, Chelsea—An improved chimney cap or cowl and ventilator
14. E. V. J. L. Georges—Improvements in preserving animal substances for food
15. J. House, Minories—Improvements in concentrating and preserving milk and other liquid articles of food

Dated January 2.

16. J. McLennan, Park-place, Highbury, J. Palmer, and J. H. Palmer, Mildway-street, Stoke Newington—An economical gas light generator and consumer
18. J. Pettigrew, Glasgow—Improvements in the manufacture of bread
19. J. H. Johnson, Lincoln's inn-fields—Improvements in apparatus for roasting meat. (Communication from P. de Musigny, Dijon, France)
20. J. H Johnson, Lincoln's-inn-fields—Improvements in pressure guages. (Communication)
21. A. Gras, Marseilles, France—Improvements in obtaining motive power
22. J. Baird, Govan, near Glasgow—Improvements in planting potatoes.
23. N. C. Szerelmey, Bermuda-place, Bath-road, Peckham—Improvements in preparing combinations of materials for rendering walls and other structures waterproof
24. J. Turner, King's-Lynn, Norfolk—Improvements in oscillating cylinder steam engines
25. J. Harris, Hanwell, Middlesex—Improvements in obtaining and transmitting motive power
26. R. A. Brooman, Fleet-street—Improvements in rotary steam-engines. (Communication)
27. R. A. Brooman, Fleet-street—An improved steam-engine. (Communication)

Dated January 3.

28. L. W. Watkins, Charlotte-terrace, New-cut—The manufacture of a composition, commonly known as putty, to be used in glazing and other purposes
29. F. Ferro, Genoa—The manufacture of paper from a vegetable or herb that grows in the isle of Sardinia and Spain, and which he proposes to call Ferus paper
30. W. E. Newton, Chancery-lane—Improvements in the means of connecting, accumulating, retaining, and applying reserved power for the application of railway breaks in sudden emergencies. (Communication)
31. A. A. Croll, Harold's Wood Lodge, near Romford—Improvements in the manufacture of coal gas
32. R. A. Brooman, Fleetstreet—Improvements in winding, twisting, and doubling fibrous materials in the machinery employed therein, and in the mode of driving the same, parts of which improvements are applicable to the communicating of rotary motion to other machinery.—(Communication from J. B. Heiller, Mulhouse)
33. C. Binks, London—Improvements in treating ore in the manufacture of iron, and in obtaining products therefrom
34. C. Binks, London—Improvements in obtaining certain compounds of cyanogen

Dated January 5.

35. T. Forsyth, Manchester—Improvements in locomotives and other steam engines
36. J. Ingham, and E. Ingham, Bradford, and B. Ingham, Halifax—Improvements in apparatus employed in finishing textile fabrics
37. A Brundish, Birmingham—Improvements in mounting knobs, and in constructing and mounting roses for locks, latches, and other such like fastenings
39. F. Braithwaite, Gower-street, Bedford-square—An improved method of extracting the iron from tin ores
40. D. Baker, Gisbro' Alum Works, Yorkshire—An improvement in the manufacture of paper
41. W. Gossage, Widnes, Lancaster—Improvements in the manufacture of sulphuric acid, and in the construction of apparatus used for such manufacture
42. J. Oldham, Preston, Lancaster—An apparatus for closing the supply cocks of gas burners
43. J. M. Hyde, Cumberland Iron Works, Bristol—Improvements in iron and wooden ships or vessels, and in the adaptation of machinery for propelling the same

Dated January 6.

44. F. F. Dumarchey, S. Levy, and J. Mayer, Paris—Improvements in wheels and axles for common road carriages
45. T. W. Kennard, Sussex-gardens, Hyde-park—Improvements in metallic piles
46. T. Holmes, Pendleton, Lancaster—Improvements in the prevention of consumption of smoke in furnaces and fire-places
47. L. A Ritterbandt, Warwick-street, Regent-street—Improvements in the treatment of substances containing earthy phosphates
48. J D. Tripe, King's-place, Commercial-road—Improvements in mechanism for affording increased security to valves, taps, or other apparatus used for regulating or interupting the flow of gases, vapours, and liquids
49. F. H. Maberley, Stowmarket, Suffolk—Improvements in constructing receptacles for sewerage, for separating the fluid from the solid portion thereof, and for purifying, storing, and carrying away the same
50. H. Bougleux, Leghorn—Improvements in steam boilers
51. C. E. Wright, Green-street, Blackfriars—Improvements in preparing lubricating compounds
52. R. A. Brooman, Fleet-street—Improvements in knitting frames. (Communication from Mr. Puech)
53. A. A. Dunbar, Glasgow—Improvements in lifting, lowering, and disengaging ships' boats
54. M. Trattles, Staithes, Inderwill, York—Improvements in tools for cutting cylindrical and conical forms
55. C. Cook, Mount-street, Grosvenor-square—Improvements in apparatus for generating draughts in chimneys and for other purposes

Dated January 7.

56. B. Hargreaves, Habergham Eaves, near Burnley, and A. Mossdale, Burnley—Improvements in looms for weaving
57. C. F. Claus, Latchford, Chester—Obtaining tin or compounds of tin from the scraps or clippings of tinned sheet iron
58. J. Morris, New Kent Road—Improvements in washing machines
59. P. Pilkington and T. Entwistle, Accrington, Lancaster—Improvements in machinery or apparatus for washing, cleaning, agitating, grinding, polishing, or mixing various materials
60. W. J. Curtis, Crown-court, Old Broad-street—Improvements in railway axletree-boxes
61. W. Y. Smith, Sydney-street, Sheffield—An improvement in sawing all kinds of wood
62. H. C. Hill, Croydon—Improvements in screw and lifting jacks, and in machines for lifting, pressing, and lowering

Dated January 8.

63. G. P. Cooper, Walworth—Improvements in the manufacture of shirt collars
65. R. Newton, Birmingham—A new or improved manufacture of metallic boxes
66. W. Prestwich, Oldham—Improvements in gas burners
67. E. J. Hughes, Manchester—Improvements in the manufacture and application of compounds resembling gutta percha and caoutchouc, from flour, fibrine, gelatine, and other vegetable and animal substances. (Communication)
68. J. Harris, Hanwell—An improved lock, and method of acting upon lock-bolts, latches, taps and valves, railway and other signals, bells, and other like apparatuses
69. A. McDonald, Polished Granite Works, Aberdeen—Improvements in the manufacture of columns, pilasters, and other similar structures of granite, marble, porphyry, jasper, serpentine, sienite, and other stones capable of receiving a high polish
70. T. Lawes, Chancery-lane—A machine or apparatus to be used in cleansing, purifying, and drying animal and vegetable substances
71. T. Ball and J. Wilkins, Nottingham—Improvements in manufacturing looped fabrics, suitable for the making of gloves and other articles
72. J. J. Russell, Wednesbury, and J. B. Howell, Sheffield—Improvements in the manufacture of steel tubes, applicable to the flues of steam boilers and other uses.
73. T. W. Keates, Chatham-place—Improvements in the treatment of Rangoon naphtha, and other varieties of petroleum
74. J Roberts, Upnor—Improvements in the stoppering or closing of jars, bottles, and other vessels, applicable also to the joining of earthenware and other pipes
75. R. Turnbull, Harwich, Essex—Improvements in cradles for heaving up ships.

Dated January 9.

76. J. R. Day, and J. Hinks, Birmingham—Improvements in constructing and attaching knobs and handles of drawers and doors, cupboard turns, and other such like articles
77. J. H. Johnson, Lincoln's-inn-fields—Improvements in machinery or apparatus for sewing or uniting and ornamenting fabrics. (Communication from Chevolot and Ligney, Paris)
78. R. Smith, Longridge, near Preston—Improvements in the manufacture of corded skirtings and corded petticoats
79. J. H. Johnson, Lincoln's-in-fields—Improvements in the application of the electrotype or galvano plastic processes. (Communication from Lenoir, Paris)
80. J. A. Carruthers, Over Darwen, near Blackburn—Improvements in the mode or method of forming the lease or shed in sizeing, warping, or weaving.
81. J. Hardacre, Manchester—Improvements in machinery or apparatus for preparing cotton, wool, and other fibrous substances to be spun.
82. J. Gibbs, Abingdon-street, Westminster—Improvements in extracting gold and silver from their matrices and from other substances or materials with which they are combined, mixed, or associated

Dated January 10.

84. J. and C. Gratrix, Preston—Improvements in looms
85. L. J. Brethon, Tours, France—Improvements in machinery for manufacturing draining pipes, bricks, tiles, and all other similar plastic articles
86. D. D. Kyle, Albany-street, Regent's-park—A method of retarding or stopping railway trains and carriages, applicable also to carriages on common roads
87. J. Adams, Ivy Cottages, Queen's-road, Dalston—A minié or other rifle-sight on a new and improved plan
88. J. Chanter, Borough-road, and J. Wakefield, Suchicore, Dublin—Improvements in the fire-boxes or furnaces of locomotive engine boilers
89. J. Hodgson, Sweeting-street, Liverpool—An improvement in constructing wrought iron masts, yards, bowsprits, and other ships' spars
90. F. X. Kukla, Raven-row, Mile-end-gate—Improvements in apparatus for heating stoves by gas
91. C. R. Olliffe, Park-lane, Hyde-park, and J. A. Gollop, New Oxford-street—Improved apparatus for cleaning knives
93. P. Desrues, Paris—Improvements in purifying gas
94. W. Watt, Belfast—Improvements in treating or preparing Indian corn and other grain and amylaceous vegetable substances for fermentation and distillation
95. R. A. Brooman, Fleet-street—Improvements in galvanic batteries and in apparatus connected therewith. (Communication from MM. Grenet, jun., and De Fonvielle)
96. R. A. Brooman, Fleet-street—Improvements in propelling ships, boats, and other vessels. (Communication from F. Jeandeau)

Dated January 12.

97. B. Biram, Rotherham—Improvements in machines for washing coal and other minerals
99. A. Goodwin, Guildford-street—An improvement in fixing the tubular flues of steam boilers
101. U. Scott, Camden-town, and F. Holdway, Bayswater—Improvements in the manufacture of metal type, and the arrangement of the same for various purposes
103. R. Chrimes, Rotherham—Improvements in apparatus for regulating the pressure of fluids

Dated January 13.

105. J. Hinks, and G. Wells, Birmingham—An improvement or improvements in metallic pens
107. W. Gossage, Widnes, Lancashire—Improvements in the manufacture of sulphuric acid, and in the construction of apparatus used for such manufacture
109. M. Potter, Manchester—The application of certain materials in the manufacture of healds for weaving
partement of the Seine), France—Improvements in obtaining extracts from madder
111. F. A. Verdeil, Rue St. Sulpice, Paris, and E. Michel, Quai Impérial Puteaux (dé-for dyeing and printing
113. R. Russell, Derby—Improvements in stoves and fire-places.

PATENTS APPLIED FOR WITH COMPLETE SPECIFICATION.

3056. J. H. E. Mareschal, Paris—Improvements in hydraulic presses—Dec. 26, 1856
3060. C. S. Rostaing, Dresden—Improvements in preparing and combining metallic substance for the production of colours, and in manufacturing the same—Dec. 26, 1856
3076. G. White, Laurence Pountney-lane, Cannon-street—An improved poultice. (Communication from Dr. Anteime, France)—Dec. 27, 1856
106. W. Thurtell, Wells, Norfolk—Manufacturing cases of deposit for adhesive stamps, labels, or papers, so arranged that such adhesive papers are moistened and kept in a moistened state distinct and separate—Jan. 13, 1857

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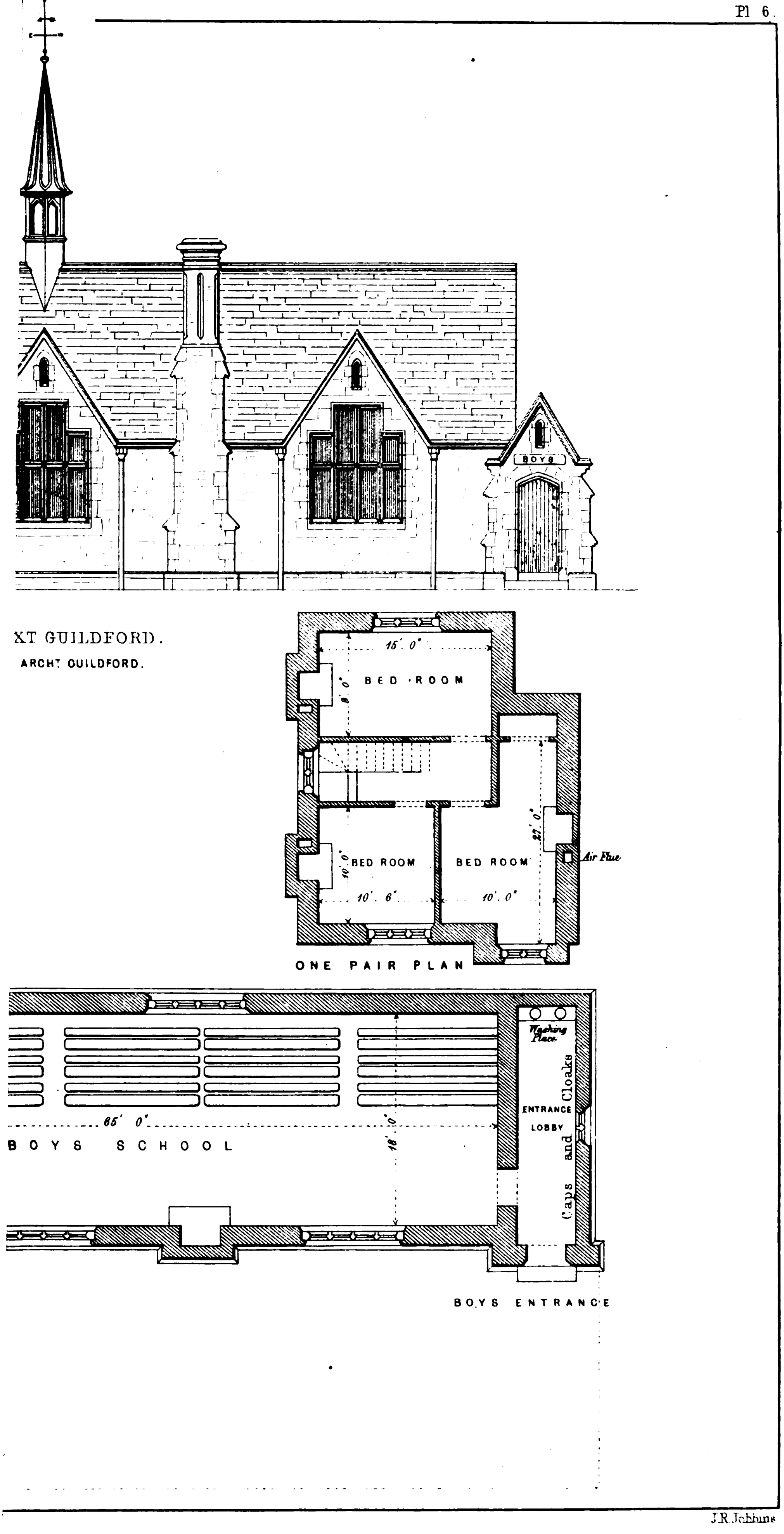


STOKE SCHOOLS.

(*With an Engraving, Plate* VI.)

These schools are situated near Guildford, and are built of Bargate stone—which is analagous to and worked the same as Kentish rag, and is found near Godalming—with dressings, water-tables, &c., of the best white local bricks. Each schoolroom is 65 × 18, and 25 ft. 6 in. high to ridge; the roof is open. The turrets are for ventilation. The whole is arranged upon the government system, and to accommodate 326 children. The contract, including fittings, entrance gates, approach road, fences, &c., was 1296*l.* 12*s.*, for which sum they have been executed by Mr. W. Swayne, builder, Guildford, under the direction of Mr. Thomas Goodchild, architect, of Guildford.

ON THE APPLICATION OF MACHINERY IN THE WAR DEPARTMENT.*

By John Anderson, Inspector of Machinery in the Royal Arsenal, Woolwich.

Small-Arms.

The small-arms manufacture of England, both in the public and private establishments of the country, has not kept pace with other branches of industry, in the application of labour-saving machinery. This has resulted from various causes, partly from the peculiar organisation of the system of hand labour, by which the various parts of the musket have been hitherto produced, thus rendering it difficult to apply machinery qualified to compete therewith, and which, at the same time, would repay the necessary outlay.

The musket being an instrument of considerable refinement, requiring from those who make it a high degree of skill, and an extreme nicety of workmanship in many of its component parts, the obstacles in the way of applying the ordinary machinery of the machine maker are numerous; for although there may appear some resemblance between muskets and small machinery, yet, when compared minutely, the similarity soon vanishes. The forms employed by the machine maker have, with a few exceptions, been simplified into the line, the plane, the circle, the cone, and the sphere, all of which are very easily produced by simple apparatus. The parts of the musket, on the contrary, are of forms so various and nondescript as to call for another description of tools, involving a higher and more advanced state of the arts to insure its successful introduction. The parts of ordinary machinery, although accurate, as compared with the general work of carpenters, still come far short of the precision required in the fabrication of small arms, where the form and dimensions are determined to the thousandth part of an inch.

For the last hundred years, machines, such as the rose lathe, have been made to produce the most refined instruments, so accurate, indeed, that no hand labour could imitate them; but the work is performed so slowly as to render its produce far too costly for the workshop of the gunmaker, who requires a system of apparatus which shall afford the utmost exactness, fully equal to that of the philosophical instrument maker, but which, at the same time, will yield a rate of production equal to that of the more simple and less refined workmanship of the machine maker.

The difficulty of reconciling these two conditions, has hitherto been of so formidable a character, as to have offered a complete barrier to the extensive application of machinery in the manufacture of small arms.

Had the manufacture of muskets been carried on in the same manner as that of machinery, in factories where the several parts of stock, lock, barrel, and bayonet, were made under one system of management, the general introduction of refined tools would have been sooner arrived at; but from the construction of this branch of industry, with the separate parts produced by different masters, and then afterwards collected in the workshops of another master to be there put together, there is little difficulty in arriving at one cause of the limited application of machinery; and all the more so that the prejudices of those engaged in that manufacture were naturally opposed to a system which put their old arrangements to one side, and which demanded a degree of refinement in tools and machinery not to be met with in any extensive manufacture in the kingdom.

* Paper read at the Society of Arts, London.

Before a manufactory for small-arms could be satisfactorily organised, the world had to undergo a certain course of training. The inventions of Watt and Arkwright led to the manufacture of machinery on the largest scale, while the inventions of Bentham and Brunel contained almost all the essential elements of modern tools, and more especially the germ of the application of machinery to copy intricate forms from a pattern; a principle of operation which has been most successfully developed in the new small-arms manufactory of the war department.

Although the difficulty of introducing radical changes into the gun trade of the whole world, where it has existed for centuries, and where there are obstacles of a traditional and local character to be overcome (besides the private interests with which they come into collision), are very great; still, it is not surprising that in a new country like the United States of America, where the price of labour was very high and ingenuity abundant, in establishing the manufacture of small arms, they should pursue a different track (and all the more so when placed under the management of such an able machinist as the celebrated Whitney), in which the successful inventions and mechanical principles of other departments of art are assembled together, and specially adapted to the requirements of muskets or pistol manufacture, at the same time combining them with the true manufacturing principles which have been so eminently successful in other branches of industry.

There having been some difficulty experienced in obtaining the Minié rifle in 1853 and 1854, the government determined to erect a manufactory of small-arms which should combine all modern appliances for saving labour and securing the most rigid accuracy of production. Accordingly such an establishment has been completed on a scale capable of producing about 1000 muskets per week. It comprises about 150 horse-power, 3000 feet of shafting in motion, and upwards of 1000 machines, or apparatus, for the various purposes of the manufacture. Upwards of 200 of these machines have been brought from America, a few were obtained in Belgium, but by far the greater number, between eight and nine hundred, were made in England, and, in order to insure perfect success, the details are being carried out by an American gentleman, brought over by the government, who possesses a thorough and practical experience in the working of this system in the United States, and who has the assistance of several of his own countrymen, from the small-arms factories of New England.

The leading principle upon which this manufactory has been organised consists of an extreme subdivision of operations, to produce each of the separate parts composing a musket, in order that each operation or process may be in itself so simple, as that it may be performed by an unskilled individual, and at the same time may afford that rigid accuracy of form and dimensions which are essential to perfect fitting, and to ensure that amount of precision which will enable the parts of several muskets to interchange with each other. The operations performed by the several machines are so arranged consecutively, that the greater portion of the work is done, or material removed, by a preliminary class of machines, thus leaving to those that follow after comparatively little to do, merely to produce that degree of exactness which is absolutely essential.

In the smithing department, articles such as the bayonet, the several parts of the lock, the ramrod, and even the barrel, are produced by a system of copying either by the forging machine, by dies in the American drop hammer, by rolls containing the form required upon their surface, or by some other modification of that principle, in which the form of the article does not depend on the operator so much as on the apparatus. When forged, such articles as the bayonet and the parts of the lock, pass to an annealing department, where they are put into ovens to be softened; they then proceed onwards to the pickling branch, where, by means of acid, all the oxide or scale is removed, and the pure metallic surface is laid bare; by this means the cutting instruments in the finishing department are preserved from the injury and blunting to which they would otherwise be exposed. In the machine or finishing room (which has an area of 40,000 square feet), where the several parts are cut to the proper dimensions, the tool or instrument which is principally employed in the machines for cutting metal articles is some modification of the circular cutters, technically termed "milling tools." These milling tools are made i[illegible] have every variety and form to produce the required shape [illegible]ne, would several articles, and they are mounted on adjustable s[illegible] the red-hot article to be cut being held in a peculiar vice or h[illegible] powerful apparatus, adapted to itself, and by a self-acting motion passing transversely against the revolving cutter, which is so arranged that when the operation is completed the machine stops of itself. When holes have to be drilled in an article, as in the lock-plate, for example, it is enclosed in a perfectly fitting steel box, having a lid provided with holes corresponding with those required; the drilling machine contains a number of spindles, each carrying a drill of the required size, and running at the proper speed. These drills in succession are passed through the respective holes in the lid of the case, at the same time piercing the soft article which it contains; thus perfect identity and absolute accuracy are obtained; and as each machine is used for a single operation only, that operation is thereby rendered extremely simple, and requires but a small amount of care or skill in its performance.

The bayonet, from first to last, undergoes seventy-six operations, each of which is definite and simple, and at the conclusion of the last one, the several bayonets are as much alike as the different pieces of money from the Mint, and they present a degree of accuracy which could not be equalled, even at three times the cost, by the tools and apparatus which have hitherto been employed in England.

To secure such a degree of precision in an article which has to be made by the thousand, involves an entirely different system of manufacture to that pursued by the machinist or the engineer; to select a single illustration out of hundreds that might be named if time permitted—the formation of the hole through the bayonet socket, where it fits upon the end of the musket barrel. The solid iron socket, as it comes from the pickling room, is first put into a milling machine, where, by means of a pair of milling instruments, it is cut at the ends to within the fiftieth of an inch of the proper size; then, by a second machine, it is bored or drilled out roughly, and nearly to the correct dimensions; then, by a third machine, it is bored out still nearer and very carefully by a stationary instrument, with the socket revolving. It then proceeds to another description of machine, to have one end of the socket completed by a revolving tool, then to another similar machine to have the other end completed in the same manner. By a sixth machine the hole is slightly tapered; then, after a number of other operations have been performed on different parts of the bayonet, this hole is again entered by another tapering tool, making the hole within a thousandth part of an inch of the finished dimensions; and, lastly, after the bayonet is all but completed, the hole receives the finishing touch. By this system the holes in the socket of each bayonet are perfectly alike, and as the instruments which perform the more delicate parts of the process have so little work to do, they continue for months without the smallest variation. A similar treatment is bestowed on every other part of the exterior of the bayonet socket, on its neck, on the blade and locking ring, also on every other metal part of the musket, but which to describe minutely at the present time would occupy too much space; yet such is the precision of this system on the several parts, that when completed with a small amount of hand finish and polishing, the several parts interchange, and may be selected at random from a heap, to be put together.

The gun stock is an article which, from the irregularity of its form, and the extreme degree of exactness required in those parts where it has to receive the lock, the barrel, and its other components, is obviously a most difficult thing to produce by machinery; this, however, has been done to the utmost degree of perfection. In its manufacture the stock has to pass through some twenty operations, all of which are on the copying principle, leaving only the polishing process to be performed by hand labour, the fitting of the lock, trigger guard, barrel, and all other nice parts being such as could only be equalled by the most careful workmen, no hand finishing being required, while the time occupied in performing the several operations is under half-an-hour, which includes the fixing and unfixing of the gun stock in the several machines.

The same system is pursued in the manufacture of the gun-barrels, and of all the other parts of the musket, but which, for want of time, cannot be described at present.

The small-arms manufactory is now all but completed, and the specimens of its produce, which have been selected at random, are laid on the table for examination. In an economic point of — this establishment will well repay the outlay which has

'rred in its erection, but it will be found of still greater

and value as an agent that will afford a higher 'racy and refinement, that will secure that minute degree of precision by which the several parts of muskets may interchange; and if the military gunmakers of England are wise in their generation, they will not despise this system of manufacture, but, on the contrary, will adopt it, for it will secure for them a high vantage ground in competing with other parts of the world. Nor are the peculiar advantages of this system confined to that branch of trade alone, it is capable of extensive application in other manufactures; and the American machinery which has been introduced into England by the War Department is so peculiar and different to that usually made in this country, that it presents a rich mine of mechanical notions, worthy of being studied by our machine makers. The gun-stock machinery, especially, is a positive addition to the mechanical resources of the nation.

An attentive examination will bear out this statement, and will show that our translantic competitors are not behind us in the race of machine-making; that they show an originality and a common-sense in many of their arrangements which are not to be despised, but, on the contrary, are either to be copied or improved upon; and, knowing all the circumstances, I consider that the government of this country are justly entitled to a large share of credit for the determined perseverance with which they have carried out this great, but unpopular, undertaking, which, I am sure, will be fully appreciated by the nation, when its numerous advantages are properly understood.

Ammunition Stores.

During the latter part of the French war considerable life was infused into the construction of laboratory articles, but the method of producing them continued, with little alteration, until within the last few years. After this lapse of time it is difficult to account for indifference to such an important particular, seeing that the numerous inventions of Sir Samuel Bentham and others, which would have been so serviceable, were well known and made available in other departments of the service.

Between the years 1840 and 1853 a few machines were introduced into the manufacture of percussion caps, spherical bullets, and metal fuzes; but, upon the whole, there was comparatively little done to improve the system of production.

In 1853 the government determined to erect suitable factories or workshops, which should embrace the leading principles of the best conducted manufactories, in which the raw material should enter at one side, and, by a gradual advance, arrive at the store house on the opposite side a finished article, and the machinery, as far as possible, should be self-acting. The instructions which were then given have been fully carried out, and to a much greater extent than at that time was anticipated.

Of the more important applications of machinery to manufacture this numerous class of articles, may be enumerated that for producing the ammunition for small arms, shells, fuzes, and war rockets.

The adoption of the Minié rifle having created a demand for the elongated bullet in large numbers, and of extreme accuracy in weight and dimensions, to meet these requirements a plant of apparatus has been provided, capable of producing 500 bullets per minute, or more than a quarter of a million daily. In this manufacture the lead is first put into a cylinder, from which it is squirted into a long rod by means of hydraulic pressure; the lead rod is then wound upon iron reels, which are transferred to the machinery for compressing the bullet. The bullet machines are entirely self-acting, and unwind the lead rod from the reels as they require it, first cutting off the required quantity, then compressing it into form, and then delivering the bullet ready for the cartridge.

For each cartridge a conical wooden plug, of peculiar form and exact dimensions, is required. These plugs are made by means of self-acting machinery, for which the wood is first cut up into long square rods by means of circular saws; one end of the rod is put into the iron hands of the machine from the extremity of which the plug is fashioned by a revolving cutter and then cut off by another instrument, and so on until the rod is used up, a boy being sufficient to attend upon several machines: the produce is equal to a quarter of a million daily.

Hitherto small-arm cartridges have been made up with several pieces of paper that were rolled into the proper form, to hold the bullet, plug, and powder, an arrangement which has been found liable to some important objections. A few years ago, a method of making seamless sugar bags direct from the pulp, and without the intermediate stage of sheet paper having been invented, an enquiry was made in regard to its applicability for cartridges, and it having appeared, after careful examination, to offer several important advantages, more especially with respect to strength with a given quantity of paper, economy, and still more in regard to accuracy of dimensions, that system has, accordingly, been introduced.

In the manufacture of articles, such as cartridges for small-arms, which are required by the hundred thousand, a very trifling additional operation having to be performed during their production, will materially affect the question of economy, and will frequently determine for or against its application; it is, therefore, of essential importance in manufacturing these small seamless bags, that they should undergo no unnecessary handling, or even have to be subjected to the operation of packing previous to the introduction of the bullet and gunpowder, seeing that if they are crushed or even crumpled, the process of opening, in order to receive the bullet and powder, would have to be gone through, thus involving an expenditure of time and trouble nearly equal to the value of the material. Under these circumstances the government determined to erect a manufactory on purpose; this establishment necessarily contains the ordinary machinery of the paper maker for the reduction of the rags into pulp, and also, in addition, the special apparatus required for this peculiar manufacture, but without the sheet paper-making machinery of the ordinary paper-mill.

The special apparatus required for the small-arm seamless cartridge-bag consists of a number of small perforated moulds, of the same form as the cartridge-bag, which are clustered together on the end of a flexible pipe, in which a vacuum is kept up by means of an air pump. Each finger in this group of moulds is covered with a worsted slip cover, or mitten, and the whole cluster is then dipped into a cistern containing the liquid pulp, which in an instant is drawn upon them through the agency of the internal vacuum, combined with the external pressure of the atmosphere. The worsted mittens, with their paper covering, are then placed on driers of the exact dimensions, that are heated by steam, the whole operation of forming and drying occupying about a quarter of an hour.

The same principle of manufacture is also applicable for various other purposes, to some of which it has been already applied, and it will be fully taken advantage of in due time. When the additional apparatus that is now being constructed is completed, it will require daily 500 ammunition barrels to contain the produce. To meet this requirement, a complete plant of machinery is now being provided for the barrel manufacture.

Machinery has yet to be devised for the insertion of the powder and the bullet, as also to perform the operation of twisting and fastening the mouth of the seamless bag. As these processes are both delicate and hazardous, the contriving of a machine for this purpose is better fitted for the leisure of peace than for the feverish bustle of the last few years.

Shells.

Passing to another class of apparatus, that for the production of shells and fuzes, a subject which has occupied a large share of attention.

In 1854, the demand for the ordinary cast-iron shells having been extremely urgent, many of the more eligible foundries of the kingdom engaged in their manufacture; still from numerous difficulties which are almost invariably experienced by a new maker in producing shells of the required exactness, there was considerable delay and much disappointment experienced, both by the government and the contractors.

Before shells can be made economically and satisfactorily, it is necessary to become acquainted with a number of minute points of detail, the knowledge of which is essential to ensure that rigid precision of form, dimensions, sphericity, concentricity of the core, and perfect soundness of the casting; qualifications which are imperatively demanded. In this extremity it was considered advisable to erect a model foundry, for the purpose of assisting new contractors with the requisite information, and also with the intention of devising a more accurate, and, if possible, a more economical system of manufacture, the method commonly employed having been considered very defective. A new foundry was built accordingly, and furnished with a set of apparatus, which more than realised all that had been anticipated; indeed, so important did the result appear, both in regard to accuracy and the economy of production, that a still larger foundry was determined upon, there being immense stores of old iron, guns, and other castings, available for the purpose of being cast into shells. Such a foundry has been erected capable of delivering 200 tons of shot and shells daily, if such should ever be required. It is provided with 50-horse power to work the machinery, 8 large cupolas, and every facility for carrying on the shot and shell manufacture economically. The fuel and iron pass in at one side of the establishment; the moulds are conveyed by railway from the moulding area to the vicinity of the cupolas for the reception of the liquid metal, then, without having been removed from the carriage, they are conveyed onwards to the breaking up and cleaning department; the shells are put into the cleaning machine, and the moulding boxes with the core spindles undergo a rigid examination before being returned to the moulding area. The sand also has to be broken up, remixed, and sifted by machinery before it is returned to the moulders. The shells roll on to the bushing machines, after which, by their own gravity, they will roll along a suitable rail across the Arsenal, out into the river by means of a long tube, and into the hold of a vessel for transportation.

The chief peculiarity in this foundry is the moulding apparatus, which is such, that accurate shells are produced with unskilled labour after a few hours' training; its leading feature consists of an arrangement by which the pattern is drawn through the iron plate upon which the mould is formed, thus preserving the fragile edge of the mould from fracture on the withdrawal of the pattern. Each machine has two sets of apparatus, corresponding with the two halves of the mould, but the two halves have no connection until they, along with the core, are assembled on the carriage for the casting process.

The whole of the moulding and core apparatus, together with the boxes, have been made with as much accuracy as can be obtained in the present state of the arts, by the processes of turning, planing, and scraping; and it is invariably found, that with correct apparatus, the chances of failure are reduced to a minimum. To perform the operations of drilling, screwing, and bushing shells, for the reception of the fuze, a large plant of compound drilling and screwing machines has been provided. In one day of twenty-four hours, during the late war, upwards of 10,400 shells passed through this machinery, a feat which probably could not have been accomplished in any other workshop in the world.

From the completeness of the arrangement, these shells only require to be lifted once, after which they roll onwards till completed; this economical system of rolling has been introduced during the war, and has proved of essential service to the department.

Towards the close of 1854, an urgent demand was made from the Crimea for wrought-iron shells, an article of peculiar shape, not unlike an immense champagne bottle, which it was found impossible to get by contract in sufficient time and quantity to meet the demand. In this emergency, a factory capable of producing 100 of these shells daily was erected; it covers 30,000 square feet, contains 4 steam-engines, 7 steam-hammers, and upwards of 40 machines of various descriptions, many of them original and specially adapted to this manufacture; and this establishment was in operation within two months from the date of order, and that, too, during the severe winter of 1854-5, a fact which is worthy of being recorded.

These shells are made out of a single plate or slab of iron into an article resembling a bottle in form, with six or seven heatings; a remarkable example of what well-organised arrangements will accomplish. Two of the machines that are employed in this manufacture may, from their novelty, be referred to. The shells, having to be of one uniform weight, are turned in a lathe, both inside and externally. The lathe-spindle, however, is a hollow trunk, which holds a shell at both ends, and each shell is acted upon by a dozen or more cutting-tools simultaneously on both sides, and in opposite directions; thus the whole apparatus is thrown into a condition of equilibrium, and relieved of the inordinate amount of friction which would otherwise exist, and the time required is reduced in proportion. The other machine that has been referred to is for converting the red hot cylindrical mass into the form of a bottle, which it does in less than five minutes. To have performed this operation by the ordinary means of the smithery would have involved many extra heatings of the article, would have greatly injured the material, and, at the same time, would have been very expensive. By this contrivance the red-hot mass is put into the giant grasp of a most powerful apparatus, and is acted upon in all directions by an intense percussive force, thus leaving the article no alternative but to change into the required shape, and without any crumpling of the edges, as might be expected.

Another branch of the shell department is the manufacture of the wooden sabots, which has been well developed. In this plant of machinery, the whole of the cutting-instruments are mounted on a combination of slide rests, which are all actuated by one movement in their several directions, until brought into contact with a fixed stop. The adjusting of this stop determines the several dimensions of the article, while the shape is dependent on the position of the tool-holders. These things were formerly made by the ordinary tools of the wood-turner, in the usual manner; but, with this apparatus, boys or unskilled men are quite sufficient, and the relative rates of production are increased from 7 to 50.

The hemispherical interior of the sabot, where it has to fit the shell, is cut out in an equally ready manner. The gouge, or cutting tool, is fixed on a moveable centre, with the cutting edge set at the proper radius, then, by giving a forward movement with the left hand, and a sweep to the tool-holder with the right hand, the true surface is produced in a few seconds, the exact depth being determined by an adjusted stop.

A very perfect and extensive plant of machinery has been provided for the manufacture of the different sorts of shell fuzes, both wood and metal, capable of producing 8000 daily, which, for accuracy and economy, it will be found difficult to excel, and in regard to production, it is fully equal to the wants of any emergency; but to enter into detail would require more space than is at present disposable.

War Rockets.

The manufacture of war rockets is a subject which has occupied a large share of attention, and the greater portion of a plant of machinery has been erected, which will, when completed, produce 500 daily. The wrought-iron tubes will be made by the lap-welding process, then cut to the proper lengths, bored, turned, and drilled by specially adapted self-acting machinery. Hitherto war rockets have been filled with the composition by hand, and driven by means of a falling weight worked by a number of men. This system is now being abandoned, and hydraulic pressure substituted. As this is a dangerous operation, the new works are removed from the vicinity of the other manufactories to a piece of ground consisting of about 114 acres, which has been enclosed from the marshes, and now forms a part of the Royal Arsenal. On this piece of ground a steam-engine, with the requisite hydraulic machinery has been erected. The water-pressure is conveyed through pipes to the several press houses, which are separated from each other by strong traverses, which in the event of accident, may prevent communication; indeed, everything which may be considered as conducive to safety, has been done regardless of expense.

Machinery on an extensive scale has been applied to the manufacture of percussion caps, friction tubes, and to every description of this class of war stores, and also to an extensive range of articles, which are made of sheet-copper or tin-plate; most of these machines have been brought from America, and are well worthy of extensive application in the general tin ware manufactures of the country.

Guns and Gun Carriages.

Passing to another class of articles—to the manufacture of guns and gun carriages, it will be found, to say the least, that the tools and machinery in the establishments of the War Department are not behind any private manufacturers, either in regard to efficiency or an economic system of production.

About the year 1780, boring mills, to be worked by horses, came to England from the Hague; these were in use till 1842, and although clumsy, were provided with veritable slide-rests, and in their day must have been considered fine specimens of engineering. Between 1842 and 1851 a complete plant of machinery was introduced for the manufacture of brass ordnance, which, although on a limited scale, was fully equal to anything which has since been accomplished, and is all the more interesting from the circumstance that here the course of improvement may be said to have commenced. In 1855 the demand for brass guns was so great that a considerable extension had to be made to the plant, in order to raise the production to twelve guns per week; and many improvements have been introduced, more especially in the casting department. Brass guns had hitherto been moulded on a loam model, requiring renewal for each casting, a system which is still employed in most of the continental foundries; this, however, has been abandoned, and a system of metal patterns with sand moulds in iron boxes has been substituted, by means of which more accurate castings are obtained, and at a less cost. Extensive additions have also been made in the erection of additional machinery for the boring and finishing branches, and also for producing the several mountings required, both for brass and iron ordnance for the army and navy, in any quantity likely to be required during a period of war.

From the great failure of the iron mortars at Sweaborg, and the great difficulty experienced in obtaining iron of the proper quality and strength of metal, without previous preparation on the part of contractors, the Government determined to erect a foundry and boring mill capable of producing five heavy iron guns daily. In this establishment the great aim will be to secure metal of the strongest quality. An extensive course of preparatory experiments is now going on with Indian, Swedish, and Nova Scotia irons; as also with the best of the British brands and their several mixtures; these tests are both chemical and physical, and from them important and useful results are likely to be derived.

In this manufactory of iron guns, every detail conducive to economy has also been attended to. In the foundry there are 10 wrought-iron casting pits, from 15 to 20 feet in depth, 20 boring machines suitable for the heaviest description of ordnance, with the other machinery and lifting cranes of a corresponding character; altogether this will be one of the finest establishments in the War Department, and fully commensurate with the present requirements of the service.

The manufacture of gun carriages had been in advance of the other departments in the employment of labour-saving machinery for working wood. During the latter part of the French war, the inventions of Brunel, Maudslay, and Bramah, were made available to a limited extent, consisting chiefly of sawing, planing, and other machines, but still the greater part of the work was done by hand labour.

Within the last few years all the improvements of modern machinery have been applied; upwards of 300 labour-saving machines have been brought into operation; besides some twenty steam engines. In such an extensive collection, while many of the machines are common, there are a number which have been brought from America and France, that contain many novelties worthy of the attention of private manufacturers; but which, in a short paper, cannot even be named. Of the more important works may be enumerated a new saw-mill, with 80-horse power, containing all the latest improvements in sawing machinery; the saw frames are large enough to admit a log of timber 5 feet square; the mill contains a circular saw 66 inches in diameter, which is arranged to square the ends of the logs in the several frames, and to cut in a transverse line from one side of the mill to the other, the saw being moveable, and the timber stationary; it is also provided with apparatus worked by the power, for drawing the heavy baulks of timber and delivering them on the trucks between the saw frames. Adjoining the saw mills a large timber field has been laid out, which is provided with a system of railways, on which are a number of overhead travelling cranes, arranged to traverse the whole field, and to pile up the baulks of timber in the best position for seasoning.

Until recently the wheels of gun and other carriages were made entirely by hand labour; they are now wholly made by a system of copying machinery, which has been very successful, and is worth examining by private manufacturers who may still make their carriage wheels by hand. The wheel making is carried on in a room 100 feet square, covered with the saw roof arrangement, which admits only of a northern light; it is provided with parallel lines of shafting at every twenty feet. Among the more interesting machines may be named the endless ribbon saw, which is extensively used in the War Department for many purposes; here it is used for cutting out segments and every description of intricate sawing, which it does in a style as regards both speed and quality, superior to any other. Endless ribbon knives on the same principle, are being employed in cutting out the cloth in the flannel bag cartridge manufacture. The wheel felloes are turned in a lathe in which the *form* of the *corner* is made in the cutting tool; this tool being held in a slide rest is pushed against the revolving felloe, which is completed in a few minutes. The nave is turned in a lathe, in which the cutting tool is guided in the required irregular line, irrespective of the workman, a copy or profile of the nave being attached to the slide rest. The morticing of the felloes and naves for the reception of the spokes, is also done by machinery. The spokes are cut to the proper shape by self-acting copying lathes, in which an iron pattern of the required shape is placed, and is accurately traced by the apparatus, which is so simple that a labourer can attend upon three machines. When the several parts of the wheels are completed, they are laid in position within a circle of six hydraulic presses, all pushing towards a common centre, by which they are quickly, securely, and firmly put together. This manufactory also contains an American dove-tailing machine, the first of the kind in England, which only requires to be known to the cabinet trade to insure its general introduction; another machine, termed the American Eagle moulding machine, has also been ordered by the War Department, but it has not yet arrived; this will also form a useful auxiliary to the cabinet-making trade of this country, more especially in the manufacture of chairs; it is also used for many other descriptions of irregular copying in the United States.

A peculiar feature in the application of machinery in the War Department is, the frequent and successful attempt to congregate a number of instruments together, in such a manner that they may act on an article, or a series of articles, simultaneously. To select two examples—one machine is mounted with twenty or more circular saws, on different spindles, horizontal, vertical, and at various angles, so arranged that a passage through the whirling group will produce the required shape or form; a number of pieces of timber are fixed to a moving table, and one after another pass through the saws, and are instantly transformed into shape. Again, there are machines in which some twenty or more drills are arranged in the same manner, and placed so as to drill upwards, in order to get rid of the chips; this principle of operation is extensively used for hard-wood morticing purposes in various ways, and is very expeditious.

Ordinarily, the sand and glass preparing of wood-work, even in large manufactories, is performed by the hand; in the War Department the glass is mounted on drums, about four feet in diameter, which are driven at a high speed; by this arrangement the work is performed more rapidly, and yet with sufficient nicety for the class of articles to which it is applied.

An extensive manufacture of wooden boxes and packing-cases is carried on, in which the whole of the preparatory work of sawing, planing, morticing, drilling, and dowelling, is performed by special machinery, leaving only the putting together to be done by hand. During the war, there were upwards of a thousand of these boxes made daily, which involved considerable expenditure of labour in the mere conveyance of the material to and from the machinery, and onwards to the central depot, where the parts are assembled. A saving of labour has been effected by an arrangement of endless horizontal bands. The principal band extends along the side of the building that contains the machinery, and is in constant motion towards the depot; within the building and from each machine is placed a series of similar, but shorter, bands, all working at right angles to the former. As each piece of wood is completed at any machine, it is thrown upon the transverse band by the workman, and by it is delivered upon the long band which conveys it to the depot, where the parts are separated into bins, ready for the workmen who put the pieces together into boxes.

The quantity of this class of articles that is required is enormous. Last year they numbered 287,171. Of heavy mortar-beds, gun-carriages of different descriptions, with the limbers for the travelling-carriages, and traversing platforms, the large number of 3715 were produced, and the total number of complete articles which passed through the department amounted to 445,231. Their component parts would number many millions.

A considerable amount of forged wrought-iron work is employed in the construction of gun carriages, and from the circumstance that many of the articles are required of the same shape, an opportunity has been afforded of producing many of them by means of steam hammers and other machines, which, were a fewer number required, would have to be made by the hammer and hand of the blacksmith. An extensive variety of such articles is made in dies under the steam hammer; the piece of iron is first roughly bent into the shape, then made welding hot and put between the dies; a single blow squashes it into every crevice, and the fin which is left in the middle where the dies join, is afterwards cut off by being pushed through another die by means of a punching machine.

A rolling mill and scrap forge, in connection with the smitheries, has been found exceedingly useful in affording the means of obtaining peculiar forms of iron bar that are not to be had in the market, and also to work up the whole of the scrap iron of the departments. An interesting feature in this rolling mill is a method of making large flat rings, or segments of bar iron, 4 or 5 inches in breadth, and from 4 to 8 feet in diameter; to roll such a bar into the form of a hoop is common, but the making of rings is not so general; it is accomplished by placing a rigid guide behind the last groove in the rolls, so that, as the red hot bar issues therefrom, it comes into contact with the guide, and thereby is constrained to sweep round into the curve required, which it does in an instant of time, and without any additional expense having to be incurred. An immense number of similar and equally important contrivances could be named if the time permitted, for although these minute details constitute the keystone on which the success of a manufactory mainly depends, still, from their number, they are not admissible into a general statement.

Gunpowder.

During the French war there were three government manufactories of gunpowder; there now remains but the one at Waltham Abbey. From the large stock of powder on hand at the peace in 1815, this establishment, by the year 1840, had sunk to a very low state. At that time the produce was only equal to about 3500 barrels per annum, and the greater portion of the plant and machinery was completely worn out. In that year commenced a course of improvement which has been continuous up to the present time, the produce now being about 17,000 barrels, and, in a short time, it will amount to 20,000 barrels per annum.

One of the leading features in the many improvements is the substitution of metal for wood in the construction of the powder machinery. The wooden water-wheels, erected by the celebrated Smeaton, are being replaced by light iron wheels, with every modern appliance to make the most of the water-power.

The driving gear of the incorporating mills has been placed underground, so that in the event of explosion it may be safe from the destructive effect; and water-tanks have been placed overhead, ready at any moment, to deluge the mill in the event of explosion in the adjoining house, the communicating arrangements being self-acting.

A new system of granulating machinery has been introduced to take the place of the far more dangerous process of hand-corning. As this is by far the most critical part of the manufacture, a large amount of care has been expended to make the operations as safe as may be attainable. The machine has been made self-acting to an extent which dispenses with any attendance. A quantity of pressed cake is put into a hopper before the machine goes to work; from this magazine it supplies itself by means of an endless band, and then, by toothed rollers, it breaks the hard cake into the different sorts of grain, then, by an arrangement of sieves, it separates them and deposits the various qualities of coarse and fine grain in their respective boxes; as these boxes become filled, the machine removes them of its own accord, and puts down empty ones instead, until its supply is exhausted, when it stops of itself, and after having done so, and all danger being over, it then rings a bell for its attendant, who, meanwhile may have been reading a book in a place of safety provided for the purpose.

This manufactory contains twenty-one water wheels, each on an average of four horse-power, and one steam-engine of 30-horse power, and upon the whole is a very creditable establishment, while in regard to quality the powder is considered second to none in the world.

Floating Factory.

The numerous wants of the army in the Crimea, and its great dependence on mechanical resources, suggested the idea of sending out a floating factory. A screw steam-vessel, of 600 tons, having been procured, she was fitted up as a factory, with gearing and all the usual tools of an engineer's establishment; it contained a cupola, four smith's forges, twenty-eight heavy machines, and many thousand small tools, and a general assortment of such stores and materials as were likely to be required; it also contained a complete saw mill, with all the requirements of a brass and iron foundry, an arrangement of portable engine, standards, and shafting to set up a manufactory on any level piece of ground ashore, if such should be required. The engines of the vessel were arranged to work either the screw of the ship or the machinery;

and in ten weeks after the War Minister gave the order this vessel was ready for sea, with a manager and as fine a body of picked workmen as could be desired; they were all selected in the vicinity of Newcastle-upon-Tyne. On arriving at Balaklava the immense importance of the establishment was at once demonstrated; a foundry was set up on shore, which was kept in constant employment while the vessel remained in the Crimea. Requisitions poured in from all branches of the service, which were executed with an alacrity that excited the commendation of all concerned. Seventy-nine requisitions were made for repairs to the railway plant, forty-nine from the navy, and sixty-eight from the steam transport corps, independently of the legitimate work of the factory for the commissariat and land transport corps.

Besides the floating factory, several other plants of machinery were sent out; among the rest a complete saw mill, with suitable steam engine to Sinope, another to Balaklava, with both circular and frame saws, and other machinery.

Pier and Hydraulic Cranes, &c.

Of miscellaneous services carried out during the war, one of the most important was the erection of a pier at the wharf of the Royal Arsenal, extending out into deep water, by means of which four of the largest class of vessels can lie alongside during all conditions of the tide: and in connection with this pier is the application of hydraulic power to work the cranes.

Hitherto ships had to lie off in the river, and to be loaded or unloaded by means of barges, which were floated alongside, and to or from the wharf.

By the new arrangement four ships can draw up to the pier at one time, and by means of the hydraulic cranes, the work of a week is reduced to ten hours, the limit to speed being the time required to stow away or sling the articles within the hold of the vessel.

During the six months ending the 30th November, 113 transports, representing a tonnage of 69,975 tons, were unloaded, which is exclusive of the ships that brought home the land transport corps, the troops, horses and their several equipments. The whole expense of this service, including the steam-engine and hydraulic and accumulator apparatus, and the cranes, amounting to nearly 33,500*l.*, was cleared off in the saving of the time of vessels alone during the first six weeks that it was in operation—an important consideration, although secondary to the far higher advantage which it affords the War Department, in the rapidity with which it can embark war material and stores.

Until last year all ordnance stores were conveyed to the outposts and sailing sloops; but small screw steamers are now being introduced, the advantage to be derived therefrom being so obvious as to require no explanation.

The Armstrong hydraulic apparatus, for working the cranes, is also being adapted as an immense fire-extinguishing engine, with an air vessel to produce the continuous squirt of water. This air vessel is in the form of a cylindrical steam boiler, with hemispherical ends, and is placed vertically. In connection therewith an iron reservoir, 100 feet in diameter, has been placed on a hill in the vicinity, 220 feet above the Arsenal, and is filled through the fire mains by the hydraulic apparatus. In case of fire, the water in the reservoir is always ready, meanwhile the steam engines, equal to 30 horse-power, will go to work on the pumping apparatus as an auxiliary, and the two combined will afford a plentiful supply of water, equal to the requirements of any probable emergency.

There are 69 steam-boilers in the War Department,—it is, therefore, of importance that everything conducive to safety and economy in fuel should be carefully attended to. In order to secure these two conditions, a system of reporting has been organised, for the purpose of showing the working history of each boiler, in regard to proof, times of examination, cleaning and repairs, also the consumption of fuel, the quantity of water evaporated by a pound of coal, and other particulars. The greater number of the boilers are supplied with Kennedy's water meter, by means of which, precise and definite knowledge of the comparative merits of the several boilers, and the evaporating value of different coals, will be obtained.

ON TALL CHIMNEY CONSTRUCTION.*

By R. Rawlinson, C.E.

Chimney construction may appear to many a very humble theme, and if we examine most of the structures erected to pass smoke and foul vapours into the atmosphere, we shall find such structures are as bald as the theme is humble. To be "as hideous as a factory chimney" has passed into a by-word, or proverb of comparison; and most certainly huge piles of brickwork, without break in line or contour—bare, bald, and grimy—cannot be said to present to the eye much to admire. For the most part, factory and other tall chimneys have one form—a vertical base finished with a plain string-course; then a uniform batter, finished at the top by a plain stone string-course or coping. Some few tall chimneys have heavy, over-hanging cornice finishings, cramped and bound in place. Many of these are, however, lumpy and painful to sight, and dangerous to the structures. Campaniles, watch towers, and minarets exist as tall and as slight in sectional area as many of our tall chimneys.

These remarks will give the key-note to the designs now placed before the society. The Moresque, Eastern, and Italian features will no doubt be recognised.

In Italy and throughout the East, a bare or positively ugly chimney-shaft or group of chimneys, is rarely to be seen. I do not remember to have seen such, but I saw hundreds which in design and form pleased the eye. A first vision of British chimneys, as contemplated from our railways, must, I fear, have caused many a nightmare to sensitive foreigners. Our house chimneys are for the most part brick abortions, made more frightful by pipes and cowls of pot, zinc, and iron. To be ugly is an evil; but such chimneys are not only ugly, they are also dangerous.

It has been said, "there is a time for everything." In Italy during the middle ages there was a time of building tall towers. In 1159 there was about 10,000 tall towers in Pisa,† and a proportionate number had been erected in most of the principal cities of Italy. The towers of Asinelli and Garisenda at Bologna show how tall chimney-like they were in appearance. The Asinelli tower remains almost entire, and is 376 feet high. Mr. Gally Knight designates it "a standing monument of pride and absurdity"—an Asinelli folly. The nobles of Italy built these towers first as a means of defence, but subsequently in rivalry, as a symbol of illustrious birth. They were fashionable; and what will man not do to head a prevailing fashion? The trade requirements of modern times necessitate the building of tall chimneys; and Manchester can match the 10,000 tall towers of Pisa, as the manufacturing towns can match the other cities of Italy. I sincerely hope it may become fashionable to strive after grace and ornament. A tall chimney need not be ugly.

Mediæval Chimneys.

The chimney constructions of mediæval times are only named for the purpose of directing the attention of the student members to their beauties. Examples are to be found in castles, baronial residences, and in mansions, dating from 1400 downwards. Britton may be consulted relative to brick constructions and chimneys in the second volume of 'Architectural Antiquities,' page 95; engraved representations are also to be found in other well-known architectural works. Old English mansions may also be inspected, but there are many modern imitations in pot, in terra-cotta, and in cement. Few are worked out as they were worked out in the honest old times.

Tall Chimney Foundations.

The foundation of any building must be the first constructive care of an architect. The foundation of a tall chimney may require extraordinary precautions. Rock will be excavated and dressed off to a level and even bed. Clay, marl, gravel, sand, or varying mixtures of these may tax all the resources of the engineer or architect. An unequal or uneven foundation, part soft and part hard, is most to be dreaded. A compressible foundation is also unsafe—that is, clay, marl, or shale, compressible by weight. Many of the oolitic and tertiary marls are compressible to considerable depths, and ought not to be trusted, however solid they may seem to be. The probability is that most of the leaning towers of Italy are founded on such strata. Some of them

* Paper read at the Liverpool Architectural and Archæological Society.

† My authority is Gally Knight. But I think there must be some mistake; 10,000 towers in one town is a large number. Upon investigation, the cat anecdote may be equalled. We know, however, there were more than two.

may stand as designed—architectural tricks—but most of the leaning towers are no doubt foundation failures.

The modern architect has at his command means and appliances of the greatest utility, which were unknown to men in former times. Steam can be brought to aid in driving timber piles, and simple applications of water or air will sink hollow iron piles with comparative ease. The old Eastern plan of forming deep wells and then filling them up with concrete has been too much neglected. Modern well-sinkers will go down in any strata almost to any depth—certainly to any depth required in practice; and a secure foundation may thus be made for the loftiest structure in the most difficult ground. Masses of concrete or of brick or stone work placed on a compressible substratum, however cramped and bound, may prove unsafe. Solidity from a considerable depth can alone be relied on.

Enlarging the area of a base or foundation by footings can be resorted to; but mere enlargement of area may not in itself be sufficient. A lofty structure which is to stand secure must have solidity sufficient to maintain each part in the position in which it is first placed.

Foundations are too frequently slighted, or labour and material are wrongly applied. The compressibility of oolitic and tertiary clays can only be overcome by piling, deep sinking, heavy ramming, or heavy weighting. The point of bearing must be carried below any possibility of upward reaction. A heavy embankment or heavy pile of building frequently disturbs the surface ground at a distance of many yards, the subsidence causing a corresponding rise around or on either side, as the case may be. A tall chimney, or tower of like proportions, built on such a foundation, if not made safe to a sufficient depth, would most likely become a "leaning tower," if not actually a falling tower. Probably the depth of a foundation in compressible ground ought not to be less than one-fourth the intended height above ground; that is, for a shaft of 200 feet the foundation should be made secure to a depth of 50 feet. This could easily be done by piling, or by well sinking and concrete.

Bricks and Mortar.

The lofty towers of Italy and the minarets of the East are for the most part constructed of bricks and mortar. I have examined the bricks, and I have tested the mortar, and found that neither the one nor the other is better than, if so good as, the modern architect may have at his command. The proportion of brick to mortar in the foreign structures differs, however, most materially from modern practice.

The bricks of Italy and of the East are very thin in proportion to area of bed—nine inches square by inch, or at the most inch and a quarter, in thickness. These bricks, or, as we should almost designate them, tiles, are frequently set or bedded in mortar as thickly spread as the brick, so that there is almost as much mortar as brick. From my examination I have no hesitation in saying that the permanence of the work is in a great measure dependent on this liberal use of hard-setting, tough mortar. The tornado's sweep and the earthquake's shock have alike failed to overthrow these slender and lofty piles; though many times they must have shaken, vibrated, and bent under the furious effects of the contending elements and dread tremblings of the earth. The elasticity and tenacity of the mortar, have, in my opinion, alone preserved the structures from sudden overthrow. It is a modern practice to stint the use of mortar. Specifications generally set forth that a bed of mortar shall not exceed one-eighth of an inch. It will be a new clause—but not any less useful one—if at times we specify that a bed of mortar shall not be less in thickness than half or quarter of an inch. In tall chimneys or towers the mortar should be of the best quality; it should be ground by horse or steam power, and should be used liberally.

Those who wish to ascertain the quality and power of mortar have only to visit the Liverpool docks, and inspect the works of Jesse Hartley. They will there find river and dock walls having in their composition almost as much mortar as stone, and the one as enduring as the other, although that stone is the hardest and best granite.

With thin bricks and thick beds of mortar the Italians used [illegible] bolts for bond, and some of the Eastern minarets have poles of timber enclosed vertically in them. Timber cannot, of course, be used in tall chimneys, but hoop-iron for bond is well known to the profession, and its aid is highly desirable for many purposes. [illegible]or bolts of wrought iron, to give vertical tie, may be used; but all tall structures should depend on the strength, cohesion, and gravity of the materials, for stability and permanence, rather than on iron or other aids.

Tall chimneys have elements of destruction to contend with which are absent in Italian tower and Eastern minaret, namely, great heat, and gases which may affect and destroy both bricks and mortar. The only remedy against these elements will be so to design and construct the chimney as to have an inner lining of the flue, which may be cut out, taken away, and be replaced without endangering the structure. A space or air chamber betwixt the true shaft and lining will be of great service in preserving the whole.

Towers and minarets have, for the most part, internal stairs, or means of access up them. Our largest and tallest chimneys may easily have means of access provided, as also means for erecting temporary scaffolding for examination and repairs, should repairs be required. This hint will, I doubt not, be sufficient. An architect or an engineer should provide for all contingencies, and not build a tower or chimney 300 feet in height, and remove his scaffolding, without having considered the means of future examination and repairs. A recess, with step and hand-irons, and put-lock holes at regular stages, properly formed for easy use, may furnish means within the shaft. Openings through the shaft may form part of the design, such openings having the character of sunk spaces, the formed space being filled in, but affording means for the removal of the filling without fracturing the main work of the shaft. All tall chimneys or towers must have proper electric conductors, secured in the best manner.

Colour and Ornament.

Colour and ornament may be used in tall chimneys; contrast of colour may be made to produce ornament. The common bricks of almost any district may be sorted so as to produce contrast in tint or tone—red, and yellow, or cream colour. This tint of the bricks may be preserved and heightened by using mortar of the same tone or tint. Furnace ashes and lime will produce a dark mortar; pounded red brick or red tile mixed with lime will give a red tone to mortar; and cheap mineral colours may be added to mortar for pointing. The colour of mortar is sadly neglected, as the same white lime and sand are used for all tones of colour in bricks, and not unfrequently white putty mortar is used for jointing the reddest as well as the lightest-coloured bricks; the light-coloured work having harmony of breadth and keeping—the red brick portion being frittered and broken up by the contrast betwixt bricks and beds and joints.

If precedent may be our guide in outline it may also be a guide in the use of coloured contrast; and although the use of marbles of various colours with stone and with bricks is designated "strange and preposterous," I must confess to a leaning in favour of colour, and most strongly advocate its use where dingy monotony may be relieved. There are plenty of brick and stone fronts dreary and wearying to the imagination. The oppressive feeling produced by a red brick built town—if I may judge by my own sensations—is one of lasting disappointment. My earliest sensations were matured in Lancaster, a clean, stone-built town. My first journey was to Preston, a town of red bricks. At this distance of time I do not forget the disagreeable feelings which came over me, and which I suppose I never shall forget.

I would earnestly recommend all architectural students to study the best brick structures of England and of the continent, at also the buildings in which alternate courses of bricks, stone, or marbles are used. I would not shrink from using "white, black, red, brown," or any other colour, if monotony could be prevented and the eye and mind gratified. The classical man may call me a Saracen if he thinks proper—I hold to the use of colour.

In advocating colour, I need scarcely say that at the same time I advocate breadth and harmony, that is, "keeping." The laws of colour must be well understood, and these laws must be attended to. As in music so in outline and in colour, the student must learn well the gamut, and attend to his thirds, fifths, and octaves, or discord will be the result of his labours—and discords in architecture are quite as disagreeable to the feelings as discords in music.

The time is ripe for originality of design in the use of brick, if our young architect will only grapple boldly with existing difficulties. Manufacturers may be found who will second his wishes if his plans and sketches are only practicable. They must be practicable, not only to the maker, but also to the bricklayer.

Any new form of brick must work in bond, or in course with common bricks. The dimensions of any new forms in brick or terra-cotta should also not exceed the easy manipulation of the material from the clay state to the finished and burned brick or tile; and the form in all cases should be one of strength, both before use and after it has been set in any building. The form and dimensions of a common brick are perfection; there are strength, facility of handling, and adaptability to work any useful bond. Common bricks may also be arranged to form a vast variety of ornament.

I would direct attention to the late Architectural Exhibition, where many of these materials were shown. The catalogue gives full information both as to makers and places of manufacture.

Vertical Lines.

In the designs now submitted, vertical lines are, for the most part, used where existing structures (tall chimneys) invariably batter. There is, I conceive, great beauty in a vertical line used as proposed. For precedent I must refer to Italian examples, the chaste campaniles and towers, which I would fain see more studied. I may refer to San Frediano, Lucca; Santa Francesca Romanu, Rome; San Zenone, Verona; San Michele, Lucca; the great work of Giotto, the Campanile of Florence; the Palazzo Publice, Sienna; the Cathedral, Trent; and others.

Description of Sketches.

The architectural student will readily father the several designs—that is, name their origin and type. I will not, therefore, cumber my notes with elaborate descriptions, but simply describe each sketch, as numbered, giving my ideas of the material to be used, and naming any peculiarities of construction. Most of the designs are for detached structures, and it is desirable that tall chimneys should stand detached, on their own base. A special foundation must then be prepared, and the chimney will not depend on any building for support, nor injure or be injured by vibration, or partial settlement in the foundations, or in the materials used. The vertical form adopted almost throughout may be objected to as offering a larger area for the wind to act upon. My reply is, the wind will not injure a sound structure standing on a good foundation. The force of the wind in our greatest storms rarely reaches 30 lb. on the square foot; the gravity of any chimney is much greater than this. Eastern minarets and Italian towers stand not only storms of wind, but also shocks of earthquake.

In no case are quoins shown, either in plinth or shaft, and their use is repudiated to the uttermost. Whatever material is used must set in course with the bricks, or must form entire courses round plinth or shaft. This rule must have no exception, but must apply from foundation to summit. An external band of stone may be backed up with brick to receive the action of fire or heat; but in such case the stone must set in bond with some exact number of courses of bricks, so that the whole may be grouted and flushed into solidity.

In arranging cornices and roofs on chimneys, it may be necessary to use iron bond and iron cramps. In such case great care must be taken so to use the metal as to run the least risk from contraction or expansion. It is practicable to combine iron with stone and brickwork so as to ensure strength and safety, but the combination must not be lightly undertaken nor carelessly made. There should not be any cutting of bricks, if possible; but all face-work should have the fire-skin preserved.

In proposing contrast in colour by brickwork, I do not contemplate the necessity of obtaining costly bricks from a distance; but for the mass of the work the common bricks of a district may be so assorted and set in mortar of the same tone of colour as to effect all the contrast required. Moulded bricks for ornamental purposes, being required in small quantities, may be obtained from a distance without adding very much to the whole cost of the work.

The Soulages Collection of Italian Art.—After having been submitted to public criticism at Marlborough House, since the 7th December, the exhibition of this collection was closed on Saturday the 7th February. During this period it has been visited by 48,093 persons, which is just double the usual number attending at this season. Among these visitors as many as 5126 have paid for admission, being ninefold the average number paying. We understand that the offer of sale has been made to the Government for 13,620*l.*, with the recommendation that if bought for the nation, it may be sent to Manchester.

MANSION OF CHARLES BUXTON, Esq., SURREY

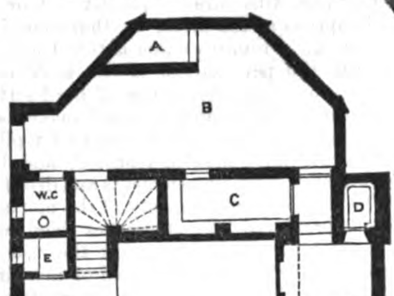
(*With an Engraving, Plate* VII.)

This building exhibits a very successful adaptation of th style of the old manor-hosue. The principal peculiarity is th all the exterior moulded and ornamental work is executed in re brick. It is well known that a serious objection to the adoptic of this material is the difficulty of obtaining straight horizont and vertical lines; but that difficulty has been ably surmounte in this case. Some of the bricks for the angles of the b windows are as much as 12 inches each way on the section, ar 18 inches high. The plan includes the usual accommodation f a residence of this class. It is intended to dispense wit painting in the interior: all the joiner's work is to be of picke clean deal, sized and varnished.

A peculiarity is introduced on the south side of the hous consisting of an open arcade communicating with the two prin cipal rooms and staircase, and commanding extensive views; this will have a parquetry floor, and the walls will be lined wi encaustic tiles, above an ornamental door of moulded brick. A an example of brick moulded work, it does great credit to th brick-maker Mr. Luff, and also to Mr. Saunders, the contracto for the manner in which it is executed.

The architect is Mr. Frederick Barnes of Ipswich.

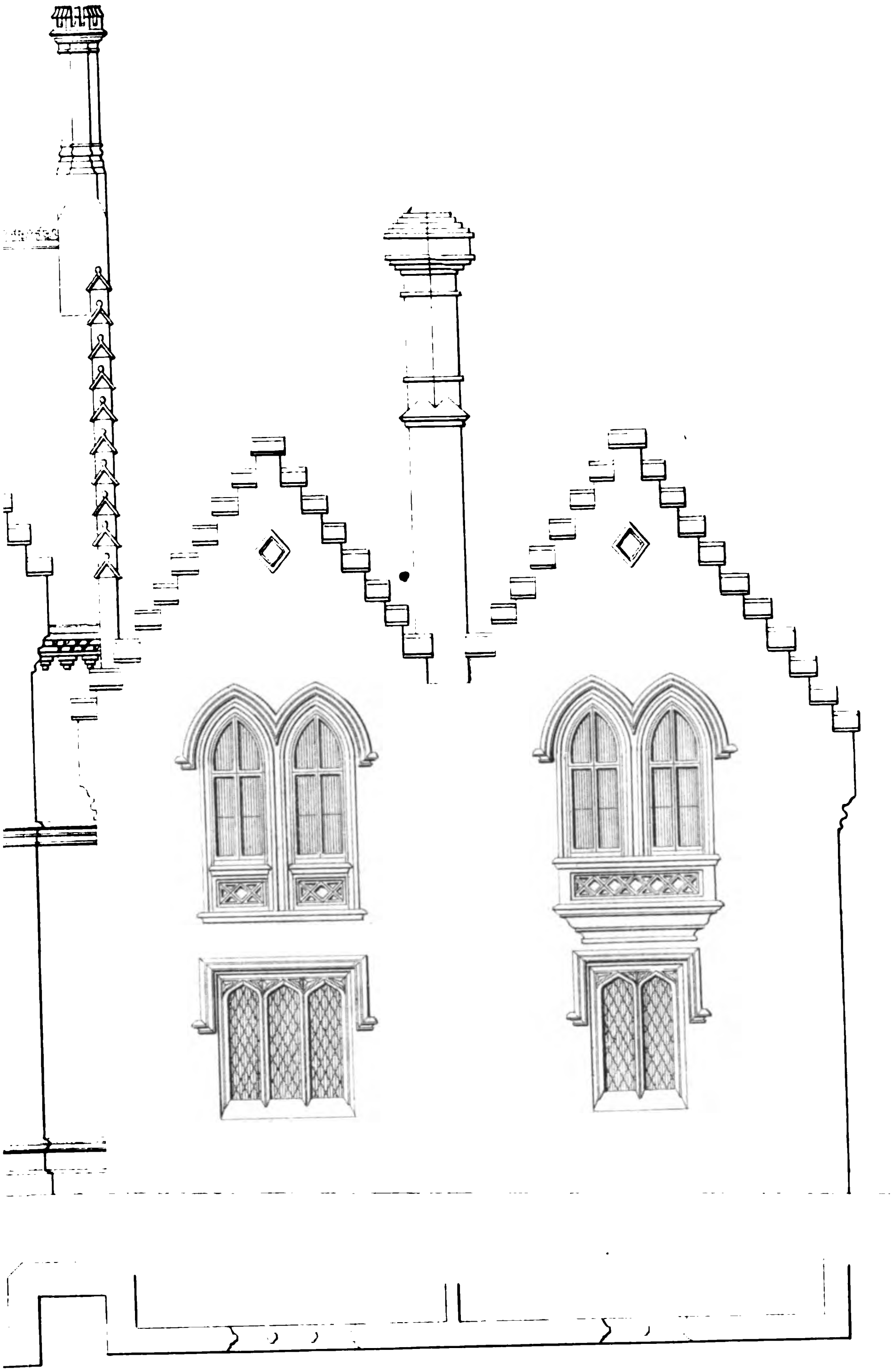
GATE LODGE, LILLESDEN, KENT.



A. Ash-pit. B. Court. C. Pantry. D. Oven. E. Pantry. F. Inner Porch. G. Living-room. H. Scullery. I. Porch.

This lodge was built in 1855-6, at the entrance to the groun surrounding a mansion erected in 1854-5, for E. Lloyd, jun., E The materials are red brick, with moulded angle-bricks to openings, and moulded white brick arches and strings, &c. addition to the accommodation on the ground-floor, there cellars below the living-room, and two bed-rooms above.

Mr. William Reid Corson was the architect, and Mr. Ha Croydon the contractor.



Front Wall

Note. The moulded & ornamental work is in Red Brick.

RREY. F. BARNES, ARCH^T

J.R. Jobbins

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ON THE SCIENCE OF THE ENGINEER.*

By W. J. Macquorn Rankine, C.E., F.R.SS. London & Edin.

The Engineer is he who, by art and science, makes the mechanical properties of matter serve the ends of man. In the widest sense, almost every man is more or less an engineer. The first man who bridged a torrent with a fallen tree, had in him something of the engineer; the first man who dug a new channel for a brook,—the first man who cleared a pathway in the forest, had in him something of the engineer; but the title of engineer is more properly restricted to those who make the useful application of mechanical science their peculiar study and profession.

Man is by nature a constructive creature; by instinct he is moved to put together the bodies which he finds around him into structures and engines for his use. He is gifted, though not with innate skill, yet with the desire and the power of acquiring skill in construction; and be his other pursuits what they may, he delights in that skill which enables him to master the elements.

Since the earliest recorded antiquity, men in power have sought to perpetuate their fame by great structures of one kind or another. The kings of Egypt had their pyramids and their canals; the Roman consuls and emperors their roads, aqueducts, and harbours. Cæsar, in the history of his conquests, often narrates a victory in a few words, but he devotes the whole chapter to tell how, in the face of great difficulties, he made a bridge over the Rhine; and there are works in the passes of the Alps, which will immortalise, more surely than all his battles, the name of the first Napoleon.

Nations, too, feel an interest and a pride in the art of con, struction. They are wrongly accused of having, in ancient times honoured and remembered their conquerors and tyrants only, and of having neglected and forgotten their benefactors, the inventors of the useful arts; on the contrary, the want of authentic records of those benefactors of mankind has arisen from the blind excess of admiration, which led the heathen nations of antiquity to treat their memory with divine honours, so that their real history has been lost amongst the fables of mythology. In our own time, each work of mechanical skill creates an interest extensive in proportion to the importance of the work; the opening of a bridge collects the inhabitants of a great city; the opening of a railway, those of many counties; the completion of a Crystal Palace is a national festival; and when a track is to be hung in air over the Menai Straits, or the Falls of Niagara, the result is anxiously awaited by the whole civilised world.

Creatures lower than man have the disposition and the ability to construct; but the constructive power of each kind of animal is limited to one kind of structure; and within that limit its operations are directed by unerring skill, and neither can be, nor need be improved.

Man's constructive power is not limited to any one kind of structure; but his skill, far from being unerring, is never wholly free from error; he does not possess innate skill, but only a greater or less capacity for acquiring skill by study and practice; and his operations are capable of indefinite improvement, not only in the same man, but from man to man, and from age to age.

In the history of mechanical art, two modes of progress may be distinguished—the *empirical* and the *scientific*. I do not say the *practical* and the *theoretic*, for that distinction is fallacious; all real progress in mechanical art, whether theoretical or not, must be practical. The true distinction is this: that the empirical mode of progress is purely and simply practical; the scientific mode of progress is at once practical and theoretic.

Empirical progress is that which has been going on slowly and continually from the earliest times to the present day, by means of gradual amelioration in materials and workmanship, of small successive augmentations of the size of structures and power of machines, and of the exercise of individual ingenuity in matters of detail. This mode of progress, though essential to the perfecting of mechanical art in its details, is confined to making small alterations on existing examples, and is consequently limited in the range of its effects.

Scientific progress in the mechanical arts takes place, not continuously, but at intervals, often distant, and by great efforts. When the results of experience and observation on the properties of the materials which are used in a class of structures, and of the laws of the actions which take place in a class of machines, have been reduced to a science, then the improvement of such structures and machines is no longer confined to amendments or enlargements in detail of previously existing examples; but from the principles of science practical rules are deduced, showing not only how to bring the scructure or machine to the condition of greatest efficacy consistent with the available materials and workmanship, but also how to adapt it to any combination of circumstances, how different soever from those which have previously occurred. When a great advance has thus been made by scientific progress, empirical progress again comes into play, to perfect the results in their details.

But the best mode of explaining the distinction and the proper functions of empirical and scientific progress in mechanical art is by a passage in its history; and I select for that purpose the progress of the steam-engine. The Egyptians used steam in an imperfect way to move small pieces of mechanism, from an unknown period of antiquity, as we know by the writings of Hero, more than a century before our era. For seventeen centuries after Hero's time, we have no record of any progress in the use of the motive power of steam; but with the revival of learning came the introduction of Hero's writings into Western Europe; and then began the empirical progress of the steam-engine, which lasted for about a century and a half, and consisted in improvements by slow degrees, in matters of detail. At the commencement of the seventeenth century De Caus applied the direct pressure of steam to raise a jet of the water itself from which the steam was produced. Forty or fifty years afterwards, Lord Worcester added a separate boiler. After thirty years more, Papin invented the cylinder and piston. Then Savery introduced the use of the condensation of the steam by a stream of water. Early in the eighteenth century, Newcomen combined the inventions of his predecessors into the atmospheric engine; in which, for about half a century, improvements in detail continued to be made by Potter, Beighton, and others, until, in the hands of Smeaton, it became, considering the general condition of practical mechanics at the time, a very perfect machine in workmanship and mechanism. But all this improvement had been merely *empirical*; and in everything that depended on principle, the steam-engine of that period was a most rude, wasteful, and inefficient machine. Then came the time when science was to effect more in a few years than mere empirical progress had done in nineteen centuries. Watt set to work scientifically from the first. He studied the laws of the pressure of elastic fluids, and of the evaporating action of heat, so far as they were known in his time (and you well know that near this spot he pursued his studies); he ascertained as accurately as he could with the means of experimenting at his disposal, the expenditure of fuel in evaporating a given quantity of water, and the relations between the temperature, pressure, and volume of the steam. Then reasoning from the data which he had thus obtained, he framed a body of principles expressing the conditions of the efficient economic working of the steam-engine;—and the first engine that was made according to those principles completely succeeded, and fulfilled Watt's anticipations exactly. The specification of Watt's first patent contains no minute details of mechanism; it consists almost entirely of broad general principles; and down to the present day, the practical improvements in the steam-engine have consisted chiefly in the carrying out and development of the principles of Watt, and in the gradual perfecting, by *empirical progress*, of the workmanship and mechanism.

Watt's success was owing to this—that before proceeding to put his invention in practice, he had well studied its theory. It is true that the empirical practice of all arts is more ancient than the theory; and this indeed is necessary, because practice furnishes part of the data on which theory is founded, and propounds questions for theory to solve. But periods from time to time arise (such as that of the discoveries of Watt) when it becomes necessary for theory to take the lead of practice, and to lay down the principles by which future practice must be guided; principles founded, not only on the facts of former practice of the arts in question, but on the study and comparison of all the natural phenomena which are connected with that art.

And herein lies the most important advantage of the application of science to practice. Those who study practice empirically alone have for their guidance only the structures and machines of former engineers, with the waste of material, and loss of power

* An Introductory Lecture, delivered to the Class of Civil Engineering and Mechanics in the University of Glasgow.

and other faults involved in them; and, with all the patience and ingenuity which can be applied to those data, considerable improvements can only be attained at the cost of repeated failures, and errors in principle may remain for ever undetected;—but he who studies the sciences that bear upon his art, has before him, in natural objects, and in the order of the universe, structures in which there is no waste of material, and machines in which there is no loss of power. Thence he learns to see in each work of human art how far it falls short of perfect efficiency; and, although perfect efficiency be unattainable, he learns to judge in what direction practice ought to strive, in order to approximate to perfect efficiency as nearly as is possible to human skill.

In the sequel of this course I shall have frequent occasion to show how the theory of a structure or machine sets before the mind of the engineer an *ideal* perfectly efficient model, not capable of being fully realised, but serving as a guide to the efforts of practical improvement.

I will now point out more specifically the nature of those branches of science which are applicable to the art of the engineer.

Those branches of science fall under the general head of *Mechanics*; but they are distinct in method and application (though not in principle) from *astronomical mechanics*, which treats of the motion of the stars, and from those parts of *physical mechanics* which relate to such subjects as the transmission of sound and light. They are also so far to be kept distinct from *pure* or *abstract* mechanics, that in treating specially of mechanics as applied to engineering, certain fundamental principles are to be taken for granted, the demonstration of which forms part of the course of Natural Philosophy. To that course, also, must be left all mechanical problems, which are interesting in a scientific point of view only, and not practically useful.

I have already frequently referred to *structures* and *machines*, as being the objects to which the science of the engineer relates.

Strictly speaking, all *machines* are *structures*, though all structures are not machines; but it is convenient to limit the term *structures* to those combinations of solid materials, whose parts are not intended to have relative motion; and which are thus to be distinguished from *machines*, whose parts are intended to have relative motion and to perform work.

The theory of structures is founded on the principles of statics, or the science of equilibrium. It is divided into two parts, relating respectively to the two requisites of a structure, *stability* and *strength*:—stability being the power of resisting forces tending to overthrow the structure, or to derange the parts of which it is made from their proper relative positions,—and strength, the power of resisting forces tending to alter the figures of those parts, or to break them in pieces.

For example, in a bridge, *stability* requires certain relations to exist between the distribution of the load, the figure of the arch, and the dimensions of the abutments, in order to prevent the dislocation of the arch-stones, or the overthrow of the abutments; and *strength* requires the arch to be of a thickness sufficient to resist the tendency to crush it.

In applying the principles of stability and strength to structures, regard must be had to the special properties of the materials employed, whether earth, stone, bricks, cement, timber, iron or other metals, as well as to the kind of workmanship to which each material is subjected, and the forms in which it is used.

The end to be aimed at in every scientifically designed structure, is to adjust exactly the position, form, and size of the whole and of each part, to the forces which it has to sustain. The more nearly this end is attained, the better will the structure be, not only in efficiency, durability, and economy, but also in beauty. This, independently of ornament, is the fundamental principle of beauty in architecture, as well as in engineering.

The theory of *machines* is founded on the principles of *cinematics*, or the science of motion considered in itself; and on those of *dynamatics*, or the science of the relations between motion and force.

Pure mechanism is the name which has been given to the *cinematical* part of the theory of machines, or that which takes into consideration their action in transmitting and modifying motion only, without regard to the force which is at the same time transmitted. As examples of its application I may cite parallel motion, the arrangement and proportioning of wheels, and the correct shaping of their teeth. The science of pure mechanism has of late been brought to a very complete state, and reduced entirely to the consequences of one general principle.

The *dynamical* part of the theory of machines considers them as transmitting at once, both motion and force, or performing *work*. It treats of the resistances, whether from solids or fluids, which impede the action of machines, the means of regulating that action, and the nature of the sources of motive power, whether animal strength, the gravitation of water, the currents of the air, or the mechanical action of heat. The entire theory of the work of machines is founded on one principle, that of the *conservation of energy*.

Machines have further to be considered with reference to their *strength*, or capacity for sustaining without injury the forces which they transmit.

The term *Civil Engineering* is applied to a wide and somewhat indefinite range of subjects; but it may be defined as embracing those applications of mechanics, and of the arts of construction generally, which belong to *lines of transport* for goods and passengers, whether roads, railways, canals, or navigable rivers, —to works for the conveyance of water, whether for drainage or water-supply,—to harbours, and works for the protection of the coast. All these kinds of works are combinations of structures and machines; they comprise *structures*—in earthwork, as cuttings, embankments, and reservoirs,—in masonry, timber, and iron, as bridges, viaducts, aqueducts, locks, basins, piers, and breakwaters; they comprise *machines*,—such as carriages and locomotive engines, lock-gates, sluices, and valves, pumping steam-engines, dredging-machines. Their principles therefore consist to a great extent of the general principles of construction and machinery, combined and adapted to suit the circumstances of each kind of work. But Civil Engineering has besides some principles peculiar to itself. It involves the art of laying out lines of transport, and selecting the sites for works, in the best manner possible with reference to the features of the country, so as to secure economy in execution and working. Hydraulic engineering involves the laws of rainfall and of the supply and the flow of streams; and the engineering of coast works requires a knowledge of the action of the waves and tides.

Such is a brief and general outline of the nature of the branches of mechanical science which contain the principles of the art of the engineer. The application of those principles to practice is an art of itself; for this amongst other reasons:—that the exact expression of a mechanical principle is often of considerable mathematical intricacy; whereas it is desireable, that rules for practical use should be as simple as possible; and the engineer, in such cases, requires to be able to judge how far it is allowable, for practical purposes, to sacrifice absolute exactness for the sake of simplicity.

Although Mechanics is the science with which the engineer is chiefly concerned, and although the course of lectures which I am about to deliver must be confined to mechanical facts and principles, with their consequences and applications,—still it is right that I should point out other departments of science which every engineer would do well to study. These are, Geology and Mineralogy; Chemistry, especially in so far as it relates to the properties and treatment of metals, and of building materials; and Botany and Vegetable Physiology, with special reference to timber trees.

Besides the knowledge of the scientific principles of his profession, there is a kind of knowledge required by the engineer which may be called *purely practical*, and which no lectures, books, or study can teach. It comprises the power of judging of the quality of materials and workmanship, which can only be acquired by inspecting them on every oportunity;—the art of directing the operations of workmen,—that of judging of commercial questions connected with engineering schemes,—and that of conducting business generally, which are to be learnt by personal experience alone. But the engineer who has studied the science of his profession possesses a great advantage in the acquisition of purely practical knowledge, and learns much more rapidly and soundly from his personal experience, than one who is without theoretical knowledge;—for the scientific engineer possesses a system of principles, the embodiment of the experience of his predecessors, and of the experiments and reasonings of those scientific men who have studied practical mechanics, which enable him to classify the facts that he observes, and to draw from them sound conclusions.

I rejoice to know that no place in the world affords a better field for the acquisition of the practical knowledge of the engineer than the great city which surrounds this University.

The trite antithesis of practice and theory, with a view to exalt or to disparage the one or the other, is a remnant of a false philosophy, used to cloak the blunders of pretenders both to theoretical and pratical knowledge;—two kinds of knowledge which can exist only in harmony, and whose harmony is nowhere more important than in the art and science of the Engineer.

At the commencement of this Lecture, I referred to the natural delight and interest which men feel in the art of construction. The ordinary advantages which attend skill in that art, such as wealth and reputation, are too well known and obvious to need to be treated in detail.

But beyond the impulse of a natural delight in construction, and beyond the inducement of reputation and wealth by which men are led to practice and to encourage the art of the engineer, the enquiring mind can perceive great beneficial ends, physical and moral, towards which that art is an instrument. Physically, the continual improvement and extension of the engineering art is essential, not merely to the comfort and enjoyment, but to the health and subsistence, of the continually accumulating population of great cities and populous nations. But for the powerful means of transport by land and water afforded by modern improvements in practical mechanics, the multitudes assembled in great cities could not be punctually supplied with food and fuel, but for the means now afforded of swift and economical travelling, the workmen of populous districts would often fall into destitution, from being unable to reach a market for their labours. The highlander finds health and strength in the spring near his door, and the air around his dwelling; but the citizen would degenerate and perish, were it not for the railway and the steamboat that carry him to the mountain air, and the aqueduct that supplies his house with the waters of the mountain stream.—Morally, the art of the engineer tends to diminish the frequency and the duration of war,—to promote the frendly intercourse of men and of nations,—and above all, to assist in the rapid and extensive diffusion of knowledge and of truth.

Let the young Engineer, then be convinced, that the profession which he studies is not a mere profitable business, but a liberal and a noble art, tending towards great and good ends; and that to strive to the utmost to perfect himself in that art, and in the sciences on which it depends, is not merely a matter of inclination or of policy, but a sacred duty.

ON WARMING AND VENTILATING.*

By Dr. Neil Arnott.

I.—*Open Fires.*

The open fire, although it is more wasteful than the close stove, and has other disadvantages, still has properties which cause it to be generally preferred wherever fuel is cheap. It is so simple that any person can learn to light and feed it; it is pleasing to the sight, and it is felt by many to be in winter a cheerful companion. The great faults of open fires of the common type are: 1, smoke; 2, waste of fuel; 3, unequal heating of the rooms; 4, trouble of management and watching. In London alone, for instance, examination has ascertained that on account of the smoky atmosphere the inhabitants have to pay for washing their clothes two millions and a half sterling per year more than if they lived in the country; that they now consume at least another million's worth of coal more than even with good open fires would be needed; that a considerable part of the winter diseases and premature mortality of the city is due to faults in respect to temperature and ventilation; and that the number of domestic servants is much greater because of their having to manage the present open fires.

It is but lately that these evils connected with common open fires have been fairly looked at and acknowledged by scientific men, and particularly by architects, whose business it was to avoid and correct the errors. Architects have been earnest in devising beautiful forms, but have deemed the chemistry and mechanics of the fireplace and chimney not worth their notice. The construction and management of grates were left, therefore, almost entirely to the care and misconceptions of little-educated workmen and servants. It is true that M. Gauger and others in France, Dr. Franklin and others in America, and Count Rumford and others in England, made important remarks, and gave very useful counsel respecting fires, and that the latter particularly improved not a little common practice by explaining the advantages of narrowing the chimney throats; but many lessons are required to change established practice founded on popular ignorance. Rumford showed that of the heat produced in the common fires of his day about seven-eighths went up the chimney to waste.

In 1838 Dr. Arnott, published a little work on warming and ventilating, in which many common errors were pointed out, and some modes of remedying faults were described. He also has published a second treatise on the same subjects, containing the substance of the former treatise, with additions. For the novelties deemed of importance, the Council of the Royal Society, in 1854, awarded him their Rumford Medal. The principal novelties are: 1, the smokeless open fire; 2 self-regulating and self-feeding close stove; 3, the same, with modifications, for warming spacious buildings by hot water or steam; 4, ventilating pump for large edifices; 5, the heat-transferrer, by which hot foul air passing away is made to warm pure air entering.

The President of the General Board of Health named a commission to examine and report on the performance of some of the objects above mentioned, which are already in use. This has been done to test again the merits; and, if merit be found, to lessen obstacles always existing to the introduction of novelties, and especially if no individual has pecuniary interest to labour for their adoption.

In the new *smokeless fire* are combined various particulars which intelligent men at former times had thought of and used singly, but of which, when used singly and imperfectly, the value was so small that they have not been duly appreciated.

1. Such was the narrowing of the throat of the chimney proposed by Count Rumford, which, when effected in the exact degree required, allows only what may be called the *true smoke* to pass away, and not also four or many more times as much of the pure warm air from the room accompanying the smoke to waste, as happens in common wide-throated flues; but, for want of a throttle valve or other register in the flue, with an index always clearly seen, which might be adjusted carefully, after lighting the fire, to the force of the chimney draught as influenced by the wind and other causes, the brick-contracted throat of Rumford was found generally to be either too much or too little contracted, and the true value of the contrivance was not understood.

2. Such, again, was the plan of Mr. Cutler and others, of placing the charge for the day of fresh coal in a box underneath the fire, so that when coal was wanted, it could be raised up into the grate by mechanical force, ensuring that all the smoke issuing from it should pass through the ignited coal to be burned. But because of the complexity of the raising mechanism used, and the want of a proper throttle-valve or damper for the chimney, as above described, with contraction of the space over the fire (yet to be explained), to give strong draught and perfect command of the combustion, that plan, although strongly pressed on public notice, was soon abandoned.

3. Then, again, many persons saw how strikingly the activity of the combustion of a common fire is under command where there is a blower or apron to the grate, or where the space between the fuel and the chimney throat is lessened by a lining of fire-brick, producing nearly the same effect as a blower; but not sufficiently aware that excessive action of these is completely preventible by the chimney throttle-valve, and believing erroneously that the hot smoke, while rising through a large open space over the fire, radiates much heat into the room, they did not contract that space nor use the blower, and so missed both the required control over the combustion, and allowed the true smoke to mix with and drag along with it a large quantity of the pure warm air about the fire.

4. Then, intelligent persons had noted the extraordinary powers of ventilating the room obtained by an opening made near the ceiling where the hot foul air is usually collected, into the flue of a strongly drawing chimney; but from not knowing that, by narrowing the space over the fire and the throat of the chimney, only very hot air is allowed to enter the flue,—and not reflecting that the chimney draught is strong in proportion to that heat,—and not aware that a balanced valve of metal placed in the ventilating opening would allow the foul air from the room to enter, but no smoke to escape,—such arrangement has been rarely adopted.

* Abstract of Report to the President of the Board of Trade on the Paris Universal Exhibition.

5. Then, lastly, persons have made channels for fresh air to enter the rooms, and spread from near the fire-place, but because the inner openings were either under the grate, so that the air blew the fire irregularly, and scattered the ash dust, or because the air was admitted to channels too close to the grate, in which it was overheated, and then ascended away to the ceiling, like a fire-balloon, doing little service below, the plan got little favour. By allowing the fresh air, however, to enter under a broad clean fender it is gently warmed by contact with that, and then spreads insensibly in the room, pure and tempered, preventing quite the cold draughts from windows or doors, so much complained of in ordinary cases.

In the new smokeless fire, these five objects are combined in fit manner and degrees, and other important objects, as the high or low position of the fire, are attended to.

A very important object exhibited in the Paris Exhibition was a prepared fuel, called the "charbon de Paris." The manufacturer takes fragments or dust of bituminous coal, or of anthracite, charcoal, or coke, and mixing these in certain proportions with coal-tar, he makes a soft mass, which, by moulds, he shapes into cylindrical pieces of about 4 inches long and 1¼ in diameter, and he afterwards hardens them by heat. These burn very like charcoal, free from smoke, and giving intense heat. There are now many makers of such fuel, seeming to believe the excellence of their product to depend chiefly on the proportions of the ingredients, and attributing too little to the uniform size and shape of the pieces, which allow that rightly proportioned approach of air to them on which perfect combustion so much depends.

There were in the Exhibition many specimens, both Continental and English, of artificial coal or fuel of kindred composition, in much larger masses. An obvious advantage of such over common coal is that the lumps, when put together, occupy less space than an equal weight of irregularly broken common coal, and therefore can be stored more advantageously in ships. And in the composition there may be of bitumen or pitchy matter just what aids the steady combustion without causing smoke, having, therefore, neither the excess nor the deficiency found in many natural coals.

The use of *coal-gas* as a fuel for cooking, and sometimes for warming rooms, is spreading over Europe, and well suited apparatus had been sent to the Exhibition from several countries. For the purpose of warming a room gas is a very expensive fuel, but for cooking, it may, in many cases, be both convenient and economical. Evident advantages are, that the fire has not to be lighted until the moment when the cooking begins, that it can easily, by the regulating clock, be rendered and maintained of exactly the requisite strength, and that it may be extinguished at once when the work is done.

In the Paris Exhibition there were open fire-grates, of variety almost endless, fitted for burning wood or coal. Many were very tasteful, and of perfect workmanship, but exhibiting no important novelty of principle. There were very ornamental and costly grates from England, as might be expected, from the open grate being there the universal fire-place, owing to the abundance and cheapness of the bituminous coal fitted for them. Several of the London manufacturers had sent specimens of the new smokeless grate.

Until recently the kinds of fuel burned in Paris were chiefly wood and charcoal, which, from their nature, produce very little smoke. Hence the remarkable clearness of the sky in Paris, and the unsoiled exterior and interior of the buildings, compared with the smoke-loaded atmosphere and the blackened walls of London, where bituminous coal almost alone is employed. Now, however, the use of bituminous coal is rapidly extending in Paris, and, unless precautions be taken, the same consequences will ollow as in London. There is no good reason why the legislatures in both cities should not interfere with respect to the smoke of domestic fires, as has already been done in London so usefully with respect to that of the furnaces of steam-engines and others. Thus all the evils from smoke, as set forth at the beginning of this report, would be much abated in London, and would never exist in Paris.

II.—*Of the Close Stove.*

This has been made hitherto nearly in the same ways in all countries. It encloses the fires, so that no air can enter it or can pass by the chimney, except what is wanted to support the combustion; and much of the heat of the smoke passing through the metallic or brick material of the construction remains in the room, as already mentioned. One portion of coal burned in such a stove warms a room as much as about four times the quantity burned in an open fire. Little smoke is produced in it.

Close stoves are very common in Paris, and are of great variety of form. They differ from English specimens, in having generally greater extent of exposed metallic chimney-tubes for giving out heat, arranged in tasteful ways.

Among the close stoves sent to the Paris Exhibition by English makers, were some for burning non-bituminous fuel, as coke, anthracite, or charcoal, showing the modifications devised by Dr. Arnott for obtaining important new qualities in that form of fireplace. The balanced valve regulator gives complete control over the entering air, causing the combustion to be as uniform as is that of a candle, and by a simple adjustment of it, the consumption of fuel may be increased or diminished at will, by a single pound in 24 hours. A receptacle to contain fuel enough for 24 or even 48 hours is placed with its open mouth immediately over the fire, and fresh fuel falls from above as the fuel below is consumed. The fire burns thus during a whole winter without being extinguished, and requires little more service than a kitchen clock. Such a stove as now described has performed in the dining-room of the writer for sixteen years, and during that time there has not been need to sweep the chimney.

The regulator of this stove is minutely described in the published treatise. It is of great simplicity, and costs only a few shillings. It is not easily hurt or deranged. Many forms of such regulator were devised by the inventor, when years ago he formed arrangements for maintaining an absolutely uniform temperature in chemical and other apparatus. Mons. M. E. Rolland, of Paris, has lately devised kindred forms of thermostat for his apparatus, called Torrefacteur, exhibited in the Exposition, without being aware that such arrangements had been made before.

III., IV.—*Self-regulating Fire for heating Water and for producing Steam.*

The stove above described may have its walls double, with water between them, and thus will maintain hot any desired quantity of water for the use of bedrooms, nurseries, &c.; and a larger fire or furnace so regulated may be used to heat boilers for the warming of large buildings, by circulation of water, or to produce steam for the same purpose.

Ventilation.

Ventilation of a single room in summer may be effected by windows open at the top. In winter it is supposed in general to be sufficiently secured by the stream of air passing up the chimney from the fireplace, and it may then be rendered perfect by a ventilating valve, properly managed. But where a spacious building is to be ventilated by night and by day, in summer and in winter, as a hospital or barrack, other means are required. Those, now for same years employed, are chiefly of two kinds.

1. A lofty shaft or chimney, heated by a fire or hot water pipes, and having communication with the places to be purified. In France such a shaft is called *cheminée d'appel.*

2. Air pumps or fan wheels driven by machinery, which may be used either to force air into the building through fit channels, or to draw air out, like the heated shaft; and by whichever of these means the vitiated air from the rooms is caused to leave them, it may issue either through openings near the ceilings, producing upward ventilation, or through openings near the floors, effecting downward ventilation.

In many English prisons ventilated by a hot shaft, the pure air, warmed or cooled, is caused to enter the cells near the top, and the impure air is withdrawn through openings near the bottom. This system has not given general satisfaction. With some desirable qualities, it has one which is decidedly bad. A good quality is, that it diffuses in a room the warmth of entering air more equably than when the source of heat is below; for warm air entering being lighter than the mass in the room, spreads itself all over that, and descends only as it cools and as more fresh warm air enters. The system is economical also, for the air which is passing away at the bottom, being the heaviest air in the room, is also the coldest, and therefore in departing carries away little heat. The heaviest air, however, is not the most impure air, as that should be which is departing, for the impure breath being warm always rises to mix with the entering fresh air, and so remains to be in part breathed again.

In France, for many hospitals, prisons, and large halls of assembly, this mode of descending ventilation, by departing currents at the floor drawn towards a heated shaft is adopted. In some the pure air enters below already heated, and in some it is heated in the room by contact with surfaces of what are called water stoves, containing circulating hot water. It is impossible after a little time that any person in such places can be breathing air perfectly pure, for unless the whole mass of air in the room be forced downwards to escape at the floor with greater speed than the hot breath is rising through the general mass, the breath must ascend and be diffused in the mass, and must soon descend again, although diluted, to enter more or less the chests of all persons present.

In the old House of Commons pure air, drawn from a high tower, and moderately warmed, was admitted through many apertures in the floor, and the impure foul air was drawn away through openings above to a lofty heated ventilating shaft. This plan, while under the direction of Dr. Reid, was found for years to answer very well.

In the House of Lords steam-engines of 20-horse power are used to impel air along channels among pipes heated by containing steam, and then into the great hall of the members. The impure air is by the entering pure air forced out of the chamber, chiefly through openings at the top towards a ventilating shaft or chimney. This system to act well requires constant skilled attendance, and in its first establishment is very costly.

The plans adopted in Paris for warming and ventilating certain large buildings by Messrs Leon Duvoir le Blanc, René Duvoir, Grouvelle, Thomas et Laurent, and others, in explanation of which there were models and drawings in the Exposition, are also examples of the systems above described. In those in which the heated shaft is used there is only the feeble and unsteady chimney force, which is too liable to failure.

M. Leon Duvoir le Blanc heats all the rooms of a building by circulation of hot water from a single boiler placed in the basement. The water is forced up from that to a high reservoir by the weight of the descending currents, from which reservoir tubes pass to every room, carrying the hot water to vessels there called water-stoves (*poêles d'eau*), from which, when cooled, it descends to be re-heated. The body of a water-stove is pierced by many passages or tubes open at both ends, through which passages the fresh air is caused to enter the room, and when warmed by the contact rises towards the ceiling. The heaviest, because coldest air of the room subsides to near the floor, and there, in proportion as fresh air enters, passes away by the ventilating openings. This system has the advantages of saving fuel as above described, and of causing uniform distribution of warmth, but it has the disadvantages of the impurity left, owing to the low exit of the air, and of the feeble and unsteady propelling power.

In the plan of M. René Duvoir, established at l'Ecole Polytechnique and elsewhere, hot water circulates from the boiler in larger tubes placed in channels formed in the walls and floors, along which also the fresh air moves towards the rooms. In other respects there is much resemblance to the plan of M. Duvoir le Blanc. It is some advantage that there cannot be warming of the rooms without ventilation, because warmth can be carried in only by the fresh air. Then the air in rising through warm channels becomes warm columns, aiding the action of the cheminée d'appel or shaft.

M. Grouvelle's system has also the shaft and central boiler with water stoves, but the water in the stoves is heated not always directly in the boiler, but by steam rising from the boiler to the stoves, or to distinct partial water circulations. There are cocks, as in all the other arrangements spoken of for regulating the distribution of heat according to the need.

Messrs. Thomas and Laurent, as exhibited at the hospital Lariboisière, use steam-engines of 20-horse power to force the air by fan-wheels through the building. The fresh air is heated by the steam of the engines after that has done its work in them. The injection of the fresh air drives the used air out of the wards by openings chiefly in the side walls, some of them being halfway up, some lower down. The expense of the first establishment of such apparatus is very great.

The evident desideratum, then, for the effectual ventilation of large buildings is a simple, and therefore cheap mechanical power, which can either force or draw air as desired, and which shall work with unfailing regularity according to requisite and clearly defined measure. It should take the place of the expensive and unsightly shafts, and of the steam-engines above described, or of steam-jets,— working uniformly through the nights as well as the days, and avoiding the necessity for fires, and for the watching of skilled attendants.

Such an air-moving apparatus, it is believed, exists in the ventilating pump devised by Dr. Arnott, of the body of which there was a model in the Paris Exhibition. The convenient mode of working one, however large, is not by a steam-engine, but by the ordinary supply of water to the house, delivered at first into a cistern placed high in the house, and made to move the pump as it gradually descends to lower levels for the domestic uses. By an easy arrangement every pint of water which descends 20 yards is caused to force 240 cubic feet of pure air into the house, through branching channels of distribution if desired, and the pump works by night as by day with the regularity of a clock, and stops only if the daily supply of water from the water company should fail.

The following extract from a Minute of the General Board of Health, dated October 4, 1850, relates to a trial of the apparatus made, while one intended for the new hospital at York was yet in the manufactory of the contractors, Messrs. Bailey, of High Holborn.

"The Board, accompanied by Mr. Austen, Dr. Sutherland, Mr. Rammell, having inspected the new engine and apparatus for the ventilation of the York Hospital, and having consulted their officers, were of opinion that the machine and arrangements were of a highly important character, as going far to solve the question of cheap and efficient ventilation. In this case the cost of the ventilation of a building to accommodate 1000 persons would probably not exceed one shilling per day. Considering the importance, in a sanitary point of view, of an apparatus capable at a small cost of regulating day and night, without superintendence, the quantity of air drawn in and out of dwelling and sleeping rooms, the Board deems it desirable to communicate with the directors of the York hospital, and to obtain from them the results of its pratical working."

After the apparatus had been in use at York for two years, the committee of management of the hospital reported to the Board of Health that the performance "was highly satisfactory."

REPORT ON THE WORKS OF THE METROPOLITAN WATER COMPANIES.*

By Henry Austin, William Ranger, and Alfred Dickens,
Superintending Inspectors of the General Board of Health.

Summary.

We beg to present in a tabulated form a concise view of the main features of the entire works of the metropolis water supply, already separately described.†

In bringing the chief works of the several Companies thus into juxtaposition, various anomalies and disproportions become apparent, which seem at first sight to be irreconcilable, such as the quantity of water supplied, the amount of steam power provided, the area of reservoirs and of filter beds, and the cost of the works as compared with the number of houses supplied by each of the Companies. But while, on the one hand, many of these seeming disproportions would doubtless be approximated by a full exposition of the various and special circumstances of each case, it must be borne in mind, on the other hand, that these works are for the most part the progressive growth of many years, under many professional advisers working independently, and under whom, with no uniform plan of action for guidance, very different views would be sure to find expression.

The only disproportion of the kind to which we consider it desirable to direct special attention, as probably affecting at times the quality of the supplies, is the very small amount of filtering area provided in some of these works as compared with that of others.

According to the return furnished by the several Water Companies in 1850, it appeared that 270,581 houses were then supplied with water, the gross daily quantity delivered having been 44,383,332 gallons. It will be observed from the preceding table that the supply of water to the metropolis has now reached the enormous quantity of upwards of 81 million gallons per day, *it having been nearly doubled in the short space of six years.* It is

* Report to the General Board of Health on the Metropolis Water Supply.

† For detailed Report, see *Journal*, ante p. 33.

Table of the entire Works of the Metropolis Water Supply.

List of Water Companies and Sources of Supply.	No. of Houses supplied.	Gross Quantity supplied per Day.	Aggregate Nominal Steam pr.	Length of Mains and Branches.	Area of Subsiding Reservoirs.	Area of Filter Beds.	Area of open reservoirs for filtered Water.	Area of covered reservoirs for filtered Water.	Cost of Works, as per former Return.	Cost of Alterations and of New Works.
		Gallons.	Horses.	Miles.	Acres.	Acres.	Acres.	Acres.	£	£
New River—Lea, Chalk Springs, etc.	95,083	25,000,000	1442	4 to 500	66·00	9·00	None.	3·76	1,421,717	566,084
East London—Lea	70,000	16,000,000	840	331	None.	12·00	None.	2·50	745,781	250,000
Southwark and Vauxhall—Thames at [Hampton	41,529	10,331,122	1065	432	7·88	4·40	None.	None.	435,247	214,010
Lambeth—Thames at Thames Ditton...	28,541	6,109,000	680	206	None.	0·73	1·25	3·00	307,352	301,633
West Middlesex—Thames at Hampton	25,732	6,895,368	480	178	16·00	4·50	None.	1·75	648,560	157,399
Chelsea—Thames at Seething Wells ...	25,030	5,323,000	700	198½	3·50	2·00	None.	2·50	455,712	472,324
Grand Junction—Thames at Hampton	17,221	6,714,292	1440	117	7·69	5·17	None.	1·07	522,295	211,128
Kent—Ravensbourne	16,077	3,500,000	500	124	5·20	2·65	1·55	None.	202,104	27,022
Hampstead—Ponds and Chalk Well ...	6,348	603,060	72	33½	35·00	0·14	None.	None.	81,231	33,224
Plumstead and Woolwich—Chalk well	3,000	550,000	35	16	0·19	None.	None.	0·32	None.	50,000
Totals	328,561	81,025,842	7254	2086	141·46	40·59	2·80	14·90	4,819,999	2,282,824

urnished to 328,561 of the 340,000 houses which now form the aggregate within the Registrar General's district. Thus, the average daily supply of water for all purposes, which in 1850 was 164 gallons per house, is now, in 1856, 246 gallons per house. The total nominal engine power employed and in reserve is equal to 7324 horses. The mains and branch pipes for bringing the water from the several sources, and distributing it in the districts exclusive of the private service pipes, form a total length of 2086 miles. The filter beds cover an area of upwards of 40 acres. Before the passing of the Metropolis Water Act of 1852, considerably more than half the supply was not filtered; subsiding reservoirs were in such case the only means of clearing the water of impurities in suspension; these are now for the most part employed as well as the filter beds, the total area of subsiding reservoirs in use being upwards of 141 acres in extent. The filtered water is stored in fourteen covered reservoirs comprising an area of nearly 15 acres, and in four uncovered reservoirs, of not quite 3 acres, which are beyond five miles distance from St. Paul's. The cost of the new works executed under the Metropolis Water Act, 1852, and the recent Acts of the several companies, has amounted to 2,282,824*l.*, making with the former expenditure as shown by the returns of 1850, the cost of the entire water works of the metropolis *upwards of seven millions sterling*. Even this amount, however, will fall short of the total expenditure; for the intermediate outlays between the former returns and the passing of the new Acts, and the cost of many works in hand, but not yet complete, are not included in this sum.

In presenting this summary of the establishments to which our inquiries have been directed, we desire to observe, in order to guard against misconception as to the omission of other valuable matter, that we have sought only, in fulfilment of our instructions, to give such a general description of the engineering features of the works of each company as would furnish a correct idea of the aggregate works of metropolitan water supply. Numberless points of details of construction, and information concerning the working of these establishments, would, no doubt, have been interesting in themselves, but they scarcely appeared to be necessary, keeping in view the main object of the inquiry with which we have had the honour to be intrusted, while such an extension would have involved a very elaborate and lengthened report, the preparation of which would have required much longer time than it appeared desirable to devote to the inquiry.

In conclusion, we desire to observe, as the result of our investigations into the present state of the metropolitan water supply:—

1st. That the requirements set forth in the commencement of our Report, comprising the 1st, 2nd, 3rd, 4th, 14th, and 17th clauses of the Metropolis Water Act, 1852, have in all essential respects, been fully and satisfactorily complied with by the several Companies, (the provisions for constant supply not coming into operation until the 1st July 1857). The new works have not, in fact, been limited to what a bare compliance with those provisions would have fulfilled. Measures have been adopted for the general improvement of the supplies, which evince a proper anxiety on the part of the companies in the discharge of the duties of their position towards the public.

2nd. That having regard to the serious state of contamination to which many of the rivers and streams of the country are being reduced by the drainage operations carried out in the neighbouring towns, and by the direct discharge of the sewage without any means adopted for the prevention of the pollution of the waters,—a condition which is evidenced to the inhabitants of the metropolis by the suddenly increased pollution of the Thames itself at the points whence their water supply has but recently been drawn,—we desire to reccommend that early attention be directed to the towns draining into the Thames and its tributaries, and into the Lea and Ravensbourne, above the present sources of supply, so that measures may be adopted with regard to the drainage of those places which will permanently preserve the supply of water to the metropolis in its utmost practicable state of purity.

EXAMINATION OF THE RIVER THAMES ABOVE THE NEW SOURCES OF SUPPLY.*

By Henry Austin, William Ranger, and Alfred Dickens, Superintending Inspectors of the General Board of Health.

In the course of our early examinations of the works of the water companies which derive their supplies from the river Thames, we could not fail to observe the very turbid and discoloured state of the water, an effect that is said to be for the most part due to the clay washed down by the heavy rains, and is found to be common also to the river Lea. But this fact, coupled with our observations in other places, of the injurious effects upon rivers and streams which have arisen from the drainage of the neighbouring towns into them, led us to consider it of importance to inquire as to the amount of deterioration to which the supplies of water furnished to the metropolis might be subject by the drainage of the towns situated above the newly adopted sources.

It is difficult to determine from what amount of population the Thames above Hampton may be said to receive the sewage either directly or by means of its tributaries, but at the smallest computation it is a very considerable number.

We were the more impressed with this point of inquiry from the fact, that the most urgent question which now presents itself in the progress of the sanitary improvement of many of the country towns, of which the drainage has been carried out without proper means for utilising or treating the sewage matter, is

* Report to the General Board of Health on the Metropolis Water Supply.

the serious pollution of the rivers and streams to which the outfalls are conducted.

The rapidly increased pollution of the Thames from the same cause within tidal influence, during the last few years, has been matter of surprise and comment for some time, and, looking at the evil consequences of such contamination of waters furnished for domestic use, it is matter for regret that the alteration of the sources of supply was not sooner commenced.

At the time of the outbreak of cholera in 1848, the state of the river at the point whence the Lambeth Company drew their supply was found to be so bad as to induce them to take measures at once for the alteration of their source. At that time the water delivered by the Southwark and Vauxhall Company, taken at ebb-tide and carefully filtered, enjoyed a comparative reputation for purity, and yet within the short period to the succeeding epidemic, the river at this higher point became so rapidly worse as to lead to the fearful increase of mortality which has been so conclusively deduced from a comparison of the death rate among the tenants of the two companies in the same district

It should be borne in mind that this source of danger in a water supply is scarcely removeable by any amount of care on the part of a company. It is not within the control of ordinary filtration. The poison being there in solution, there seems to be no cure but the abandonment of such a source of supply, and the works of the Southwark and Vauxhall Company, for this purpose, were in progress at the very time of the outbreak of cholera which is proved to have committed such increased ravages within this district.

Consideration of these facts led us, as we have said, to an examination of the river Thames above the new sources of supply. We commenced our inspection at Caversham-bridge, above Reading, about fifty miles beyond Hampton, now the highest point of supply on the river. We took seventeen samples of the water below the several towns and the tributary streams of the Thames.

The weather was dry during the whole of the time, and our examination satisfied us of a very perceptible increase of matters in suspension in the water in its progress downwards from one point to the other, and this increase was especially noticeable after passing Windsor and Eton, two towns of which the drainage has been latterly carried out to a great extent, without the adoption of any means for avoiding pollution of the river.

To what extent the danger of such pollution may be obviated by the action of the atmosphere, or by other causes, in so great a length of flow as there is between these places and the sources of metropolitan water supply, we do not suppose that anybody is capable of determining. We can only notify the considerable increase of matter in suspension which was perceptible in the water as we passed down the river, and which implied, to our minds, corresponding impurity in solution.

We regret that there has been no opportunity for analysing the samples obtained; but, looking at the result of chemical examination of waters of more decided differences of quality than could be conceived to exist in these samples, we should not expect to find much chemical variety noted in them from which any positive conclusions could be formed; for, turning to the 'Report of the Commissioners on the Chemical Quality of the Supply of Water to the Metropolis,' published in June 1851, we find, in the analyses of those waters in which we should have expected the most marked contrast—namely, those from Lambeth, from Battersea, and from Thames Ditton, the following figures:

	Grains in Imperial gallon. Organic Matter.	Ammonia.
Lambeth....................................	2·59	trace
Battersea	1·51	0·03
Thames Ditton	2·29	trace

From this extract it will be observed that the Lambeth water, which was then about to be voluntarily abandoned by the Company because of its polluted state, showed very little more organic impurity under chemical analysis than the Thames Ditton water which has been substituted for it. The Battersea water, supplied by the Southwark and Vauxhall Company, to the use of which a dire calamity was so soon to be traced, actually exhibited in this examination far less organic impurity than either of the others, or, indeed, than any of the Thames waters, and showed the minutest quantity only of ammonia.

The Battersea water no doubt had become worse at the time of the subsequent outbreak of cholera, but these are not differences from which the polluted state of the water at Lambeth and at Battersea even in 1851, as compared with that at Thames Ditton, could possibly have been inferred.

Turning also to the analyses contained in the 'Report of the Committee for Scientific Inquiries in relation to the Cholera Epidemic of 1854,' we find the following figures:

	Grains in Imperial gallon. Organic Matter.	Ammonia.
Lambeth Company—Thames Ditton	1·390	·064
Grand Junction Company—Kew ...	1·920	—
Chelsea Company—Chelsea............	5·410	—
Southwark and Vauxhall Company—Battersea	3·560	·840

From which it will be observed that although both the Chelsea and Battersea water have organic matter considerably in excess of the supply from Thames Ditton, the Battersea water has it not so much in excess of the Thames Ditton supply as the Chelsea water has it in excess of the Battersea; while the water from Kew, within the tidal influence, and receiving the drainage of a very large population from immediately above, approaches much more nearly to the quality of the Thames Ditton water. Add to this that the Southwark and Vauxhall water, which was condemned as the worst supply, and the Thames Ditton water, the new source of supply, at that time certainly the best, were the only two waters then furnished to the Metropolis in which any trace of ammonia was found, and the inference will naturally be drawn that chemical analysis does not at present convey an exact understanding of the danger to health which a particular water may occasion. Indeed, we understand it to be an admitted fact that it is a most difficult thing to discover, by any chemical process hitherto adopted, the precise amount of these poisonous ingredients which may produce such injury to the system; while, on the other hand, it is impossible to say how small a quantity of such matter might not, under certain circumstances, be injurious.

Neither can such ingredients be usually detected by the senses. It is true that we found the filtered water of the companies in every case bright to the eye, and pleasant to the taste, but neither eye nor palate will discover even a dangerous amount of impurity in a water when that water is in a fresh and cool state. The waters from the shallow wells of London, perfectly bright as they are, frequently present, under examination, evidence of impurities derived from the innumerable cesspools and sewers with which the metropolis is riddled and traversed; but those impurities may not be detected by the senses. The water always comes cold and sparkling from the pump, and, in ignorance of such dangerous impregnation, it has been almost universally preferred for drinking. The fatal consequences that may ensue from the use of such waters are strikingly evidenced in the report by a committee of the vestry of St. James's, Westminster, on the cholera outbreak in that parish.

We are induced to call special attention to the point under consideration, because, when the inquiries were instituted by the General Board of Health in 1850 into the water supply of the metropolis, great stress was laid, apparently with good reason, by the Southwark and Vauxhall Company, upon the analysis conducted by eminent chemists, in opposition to any change of source of that very supply to which such evil consequences have since been traced, and it is not a matter of surprise that, backed by such analyses and by the opinion expressed by three of the first chemists of the day, that this water was, "in the full sense of the term, wholesome and proper for the supply of a town," remonstrances should even more recently have been urged against any such change.

Such a test, now oftentimes repeated, having been found wanting, or at the least uncertain, we venture to warn against too much confidence being placed in the result, if analysis should fail to detect any serious difference of quality between the water of the Thames at Caversham-bridge, and that now supplied from Hampton or Thames Ditton.

We know from experience, at all events, that whatever amount of pollution the river may now derive from the towns along its banks, is as nothing to what it will be when the drainage works, for which some of those towns are already preparing, will have been carried out.

That the water companies themselves are fully alive to the importance of this question, is evident from the large expenses which the Lambeth and the East London Companies have already taken upon themselves, and the New River Company have proposed to take, to remove the more immediate contamination to which their sources of supply are subject from this cause; and, looking at the enormous outlays to which all have been compelled in seeking purer supplies, in justice to them, we consider that measures should be adopted for removing any preventible cause of contamination which, by future increase may tend to mar the efficiency of the works which have been so well carried out.

But, as a question of public health, how much more would it appear to be an imperative duty, especially keeping in view the lesson which has recently been taught from too long neglect of precautionary measures, to urge that no step be left untaken in a case which involves the purity of the supply of water to nearly the whole population of the metropolis, for although our remarks have been directed more especially to the Thames, they are equally applicable to the Lea and to the Ravensbourne,

In many country towns, complete works of water supply and drainage have been carried out within the last few years, and the authorities, probably conceiving that there the problem of sanitary reform would end, have been content to discharge the whole sewage of their districts into the nearest watercourses. The magnitude of the new evil which arises,— the complete poisoning of the streams,—will, it is hoped, soon work its own remedy, and enforce the application of means for the legitimate disposal of the refuse in the fertilisation of the lands. Already have several towns been compelled by legal proceedings, or by agreement with parties interested, to take measures for avoiding pollution of the streams, and there would appear to be no injustice, in any case, in urging upon all towns the adoption of a course which must ultimately tend to their own benefit and advantage.

We venture to hope that consideration of these facts may at least lead to the conclusion that a sufficient case is presented for further inquiry into the removable causes of contamination of the water supply of the metropolis above the present sources of supply.

Constant Supply.

The purer sources of water supply required by the Legislature having now been adopted, and the water filtered and preserved in covered reservoirs from local impurities and atmospheric deterioration, if measures be taken for preventing pollution of the rivers themselves, the only remaining serious cause of contamination will be the cisterns, water-butts, and other means employed for storing the supplies now furnished by the companies. Although considerable improvement has already taken place in the distribution, and the water formerly supplied only on alternate days is now for the most part given daily, except on Sundays, to every part of each Company's district, its storage even from day to day in the private butts and cisterns of most houses, and especially in those of the poorer classes, to a great extent destroys the advantages that so much pains have been taken to secure. The only complete remedy for this serious defect will be the constant supply, that is to say, a supply obtained at all times by direct communication of the house service pipes with the constantly charged mains of the companies, thus avoiding the necessity for any means of storage whatever on the private premises.

The constant supply would be the means of rectifying also another serious defect to which the public is not unfrequently liable in the present system, namely, the irregularities of the supply. Notwithstanding that the Companies have abundant means of furnishing any quantity of water that can be legitimately used throughout their district, loud complaints are too often heard of a want of water in certain localities. The deficiency would appear to arise not from actual lack of water, but from some irregularity from time to time in "*districting*" the service, which the constant supply would obviate. We would allude also to the great advantage of constantly charged mains, in case of fire, as no small consideration, but we refrain from entering at length upon this and other points involved in this important part of the question of a proper water supply as the provisions of the Metropolis Water Act, 1852, empowering the inhabitants under certain conditions to require the constant service, do not come into operation until five years after the passing of that act, namely, 1st July 1857. There appear however, to be no practical difficulties in the way of this boon to the public. It will involve, no doubt, considerable changes in the private works for the prevention of accident and waste, and the Act provides for the proper examination of these works by the Companies' officers.

EDUCATIONAL MUSEUM, SOUTH KENSINGTON.

The following regulations for the guidance of contributors to the Educational Museum, have just been issued by the Department of Science and Art.

1. The Museum will be open free to the Public, on Mondays, Tuesdays, and Saturdays; and on Wednesdays, Thursdays, and Fridays, to Students and the Public generally, on payment of 6*d.* each, or a subscription of ten shillings a year or five shillings a quarter, payable in advance.
2. Contributions forwarded for exhibition will be classified and arranged by the officers of the Museum.
3. Exhibitors will be requested to attach to their contributions descriptive labels giving the names, uses, &c.; the size and form of such label to be hereafter determined.
4. It is desirable that the usual retail price should be distinctly marked on all articles sent for Exhibition.
5. As it is the wish of the Committee on Education, and the evident interest of Exhibitors, that the Museum should at all times represent the then existing state of Educational appliances every facility will be given for the introduction of new Inventions, Books, Diagrams, &c., relative to Education.
6. Books, and other Educational appliances out of date, or the utility of which may have been superseded, or Articles that may have become injured, may be removed or replaced at the option of the Exhibitor.
7. To prevent confusion, and the possibility of Articles being removed by persons not properly authorised by the Exhibitor, due notice in writing of the intention to remove articles must be given, and no Book or object is to be removed until it has been exhibited at least twelve months.
8. In order to protect the property of Exhibitors, no Article will be allowed to be removed from the Museum without a written authority from the Superintendent.
9. On Wednesdays, Thursdays, and Fridays, the Books and other objects in the Museum, will be open to Students and to the Public for inspection and study, under such regulations as are usually found convenient in a Public Library.
10. A catalogue will from time to time be published, so as to keep pace as much as possible with the additions to the Museum, and the withdrawals from it.
11. Exhibitors desirous of advertising in the Catalogue, may send their Prospectuses, Illustrations, Price lists, &c., 1000 copies at a time, and *printed in demy 8vo.*, so that they may be bound up in the Catalogue. The binding will be free of cost to the Exhibitor; but Exhibitors will bear any depreciation in the value of the objects from their use by visitors.
12. All contributions forwarded to the Museum, to be addressed to the Secretary of the Department of Science and Art, Cromwell Gardens, South Kensington, care of Richard A. Thompson, Esq., Superintendent of the Museum.

WROUGHT IRON BEAMS AND JOISTS.*

By W. Fairbairn, F.R.S., C.E.

In the manufacture of wrought-iron beams and joists the French have taken an undoubted lead; and the specimens exhibited from the Forge et Fonderie de Montataire, and others at the late Paris Universal Exhibition, indicated a degree of perfection which has not as yet been attained in this country. Some of the joists, of the sectional dimensions shown in the annexed sketch (fig. 1, were rolled 60 feet long; and another specimen of still greater dimensions as at fig. 2, was rolled 40 feet long. These specimens, and several others of different sizes, showed how much has been done, and how much may yet be accomplished in this branch of manufacture; and we have yet to learn why the same facilities cannot be afforded for the introduction of this class of work direct from rolls by the iron-makers of England and Scotland. If this description of beams were properly rolled and manufactured, it would effect a great saving in mechanical construction, and would, at the same time, produce much greater certainty in the strength of beams, by dispensing with the present system of joints, and the riveted angle-iron, which constitute at the present moment our defective mode of constructions, as shown in the section fig. 3. It

* Abstract of Report to the President of the Board of Trade, on the Paris Universal Exhibition.

would introduce also into our present system of manufacture a new and greatly enlarged branch of industry, adapted to all the requirements of the architect, the builder, and the engineer.

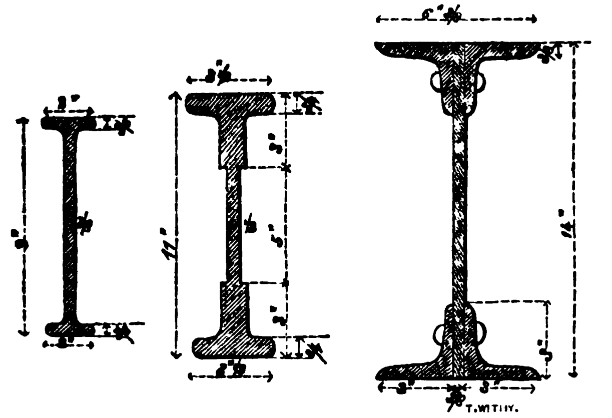


Fig. 1. Fig. 2. Fig. 3.

The introduction of this new description of beam, if properly prepared, would establish a new and important era in the history of constructive science, as it would supply architects and engineers with an article on which they might safely depend for durability and power of resistance to strain; which would not be liable to dry-rot, sap, or any of the destructive diseases to which timber is subject; and which would be free from oxidation when kept dry and imbedded in plaster. This is shown by the construction of floors in constant use in Paris. Besides, a building so constructed possesses the advantages of being fireproof, strong, and secure.

It may here be stated, that the floors of all the better class of houses in Paris are now built with iron joists, placed at distances varying from 2 feet to 2 ft. 6 in. assunder. Some of these floors supported on iron joists are 30 feet wide. At about every 3 ft. 6 in. cross tie-rods are placed, on which rest slender wrought-iron rods ½ inch square, three between each joist; these rods are run through perforated bricks of the annexed sectional form (fig. 4.) These bricks are built in a slightly arched

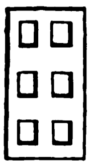


Fig. 4.

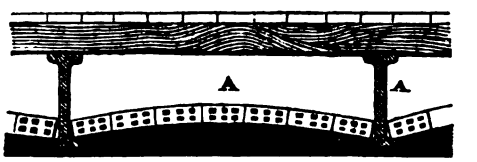


Fig. 5.

manner, and the space below them filled with plaster, forming a perfectly solid floor. Across these rods and arches wooden sleepers are placed to receive the boarding for the floors, leaving a hollow space between each joist, as at A A (fig. 5.) In this description of floors there is every security from fire, and the plaster being a bad conductor of heat, equalises the temperature of the room. The only objection is the open space A A (fig. 5), between the arches and the boarding, serving as a receptacle for vermin. This objection might be moved by divisions of plaster 6 inches thick carried across the floor, and in contact with the boards. This description of building is in general use in Paris and most other towns of France, and viewing it as a permanent fireproof structure, I should earnestly recommend its adoption in this country.

In the manufacture of malleable iron beams in France, sufficient attention has not been paid to form, in order to attain the section of greatest strength. The French philosophers and engineers are fully aware of the experiments made in the year 1845, for investigating the strength and form of iron beams, in order to establish the principle on which the Britannia and Conway tubular bridges should be constructed. The formulæ deduced from these experiments are well known in France, and up to the present time have been used for similar constructions. They proved that wrought-iron beams followed a totally different law in their resistance to strain, to cast-iron; that in wrought-iron beams the area of the bottom flange requires to be little more than one-half that of the top; while in cast-iron beams the area of the bottom flange should be *six times* that of the top flange. This difference arises from the great resistance which wrought-iron offers to a tensile strain, and its comparatively inferior resistance to compression. Cast-iron, on the other hand, possesses a high power of resistance to compression and defective resistance to tension.

The following table of resistances will show how the material should be distributed in order to obtain the maximum of strength with the minimum or least required quantity of material:

The resisting power of—

	To tension, in tons.	To compression, in tons.
Wrought-iron plates is	23	12
Copper "	16	3
Cast-iron "	8	51

From the above it is evident that to obtain the maximum strength in a wrought-iron beam from the least quantity of material, the area of the top flange should be nearly double that of the bottom; but as this is difficult in practice, I submit the annexed form (fig. 6) as the nearest approach to a maximum sectional strength. It is desirable to make the top flange as broad as possible, for the purpose of giving the beam lateral strength, and in this form the useless material now given to the bottom flange would be saved.

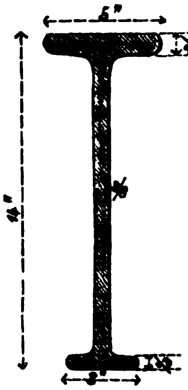
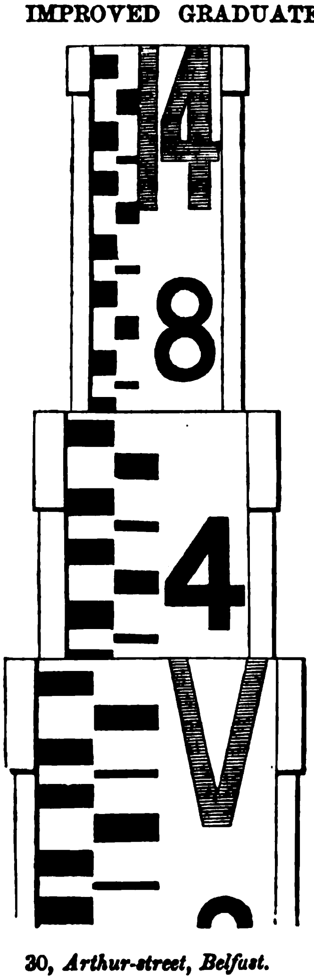


Fig. 6.

In other descriptions of manufacture, such as railway-bars, angle-iron, T-iron, and other varieties, we are in advance of other nations, though in beams and joists, like those so extensively used in France, we are far from perfect.

IMPROVED GRADUATED LEVELLING STAFF.



SIR—In the course of my practice in the execution of works, I have found great difficulty, when levelling on a very fine day, in reading the staff correctly, as at present graduated. Herewith is a pattern of one I have adopted; I am not aware of any similar. As it has given me so much satisfaction, and having been approved of by several engineers of standing, I am induced to make it public. The chief features are—the centre subdivision of the tenths are put prominently forward, thus greatly relieving the eye and diminishing the liability to error in the indication. The divisions are, respectively, two-hundredth and one-hundredth parts of a foot in height. You may also perceive at the conjunction of the tenths, that the line of separation is not drawn the full width across. By this arrangement the figures, tenths, and subdivisions are rendered so distinct, that the staff can be read at a glance, and at a much greater distance than at present. More space in breadth is also gained for the figures, without increasing the width of the staff which is of great importance.

I am, &c.,

30, *Arthur-street, Belfast.* GEO. SMITH, jun., C.E

REGISTER OF NEW PATENTS.

LOCOMOTIVE ENGINES.

J. E. M'CONNELL, Wolverton, *Patentee*, June 2, 1856.

This invention relates, first, to improvements in the fire boxes or furnaces of locomotive and high-pressure boilers, whereby an increased feed-water heating surface is obtained with the admission of heated air over or through the fuel, effecting a more perfect combustion of the smoke and gases than is at present the case in the ordinary locomotive fire boxes; and secondly, to an improved and simplified form of wrought-iron or steel piston and packing.

A fixed water space or partition is placed at or near the front of the fire box, and containing the feed water, which is pumped into it in the ordinary manner through the pipes leading from the tender. The feed water after being heated in this partition, is allowed to circulate through the boiler. This water space or partition is so arranged as to allow of a current of air to pass behind it from the ash-pan, and become heated during its passage, and in this heated state the air is directed over or through the burning fuel, for the purpose of obtaining a more perfect combustion. A number of tubular stays may be fitted into this water space for the heated air to pass through. A water space or bridge may be placed transversely, if found desirable, at or near the centre of the grate, and situated, or not, behind a transverse midfeather connected with the boiler. A number of tubular stays are also fitted into this bridge, for the purpose of directing streams or jets of heated air into or over the fuel. If found desirable, two fixed water partitions may be used, placed longitudinally one on each side of an ordinary midfeather, the air in all cases being heated, and directed over or through the fuel.

According to another modification the patentee proposes to use an air and water chamber or bridge, placed underneath and parallel to the ordinary longitudinal midfeather, a sufficient space or opening being left between the top of the bridge and the bottom of the midfeather to allow of the flames passing freely from one side of the furnace to the other. This bridge consists either of a double chamber to contain the water which is pumped into it in the ordinary manner from the tender, and is fitted with tubular stays to admit heated air from the ash-pan to the fuel as shown, or it may be made with one central air passage having a continuous water space all round it.

When an air and water bridge is employed in a locomotive fire box which is extended into the barrel of the boiler, it is proposed in some cases to have two valves or dampers in the extended portion of the fire box, one on each side of the midfeather, so that by closing one damper, the flame and gases will be compelled to pass from one side of the furnace over the bridge to the other side of the furnace, and vice versa, thereby effectually consuming the smoke and unburnt gases during their passage over the incandescent fuel in that side of the furnace wherein the damper has been left open.

Tke water in the tender has been described as being pumped in the ordinary manner through, and heated by water partitions or bridges inside the fire box; it is proposed also to heat such water by allowing it to circulate by suitable pipes through a heating chamber or water space placed inside the arch of the smoke box and surrounding the mouth or entrance to the chimney; or in place of simply allowing the water in the tender to circulate through this heating chamber, the feed water may be pumped from the tender or tank in the ordinary manner, and forced into the heating chamber in the smoke box through the ordinary clack valves, in which chamber it is heated before entering the boiler itself.

Another portion of the invention consists in making use of any convenient arrangement of apparatus for increasing or diminishing at pleasure the air spaces between the furnace bars.

According to another modification, this may be effected by a Venetian blind arrangement, the bars being made to turn partially or swivel on their lower edges, so as to be capable of being brought to a vertical position or edgewise when the air space will be greatest, or of being laid flat, or nearly so, when the admission of air will be stopped entirely or partially, according to the amount of inclination given to the fire bars. For the better supplying of heated air to the fuel, the patentee proposes to use a series of air tubes, extending from the fire box through the tube plate and smoke box, and opening into the atmosphere in the front of the smoke box, for the purpose of allowing a current or currents of fresh air to enter therein and become heated by its passage along the tubes. In this heated state the air is directed on to or over the fuel in the fire box and greatly assists combustion.

According to another modification, air pipes or vessels are contained in the smoke box and receive fresh air from outside the engine, which air is heated in such pipes or vessels, and is allowed to pass in a heated state to the fuel in the fire box by a pipe or pipes placed either outside or inside the boiler, and may be forced into the fire box either by a fan blower or pump.

The second portion of the invention consists in constructing wrought-iron or steel pistons in the form of a simple disc, forged in one piece with the piston rod, and having one or more annular grooves of greater or less width made round its periphery. In the annular grooves of the disc or body of the piston are inserted one or more steel or other metallic split rings, the inherent elasticity of which, in conjunction with steam pressure behind them as herein-after described, will tend to keep the packing tight without any other elastic media. Where a single ring only is used the joint therein may be kept steam-tight by the interposition of a tongue piece, but this tongue piece may be dispensed with when more than one packing ring is used, as in that case the joints may be so arranged as to intercept each other. Spiral springs to act on the packing may be used with or without steam, and the steam, if used, may be admitted behind the packing by slots, channels, or recesses, formed in the inner sides or flanges of the packing groove, and communicating with the annular chamber or space behind the packing ring or rings, or, in place of slots, channels or recesses, being made in the flanges of the grooves, such slots, channels, or recesses may be formed across the packing rings themselves.

Claims.—1. The application and use to, and in the fire boxes or furnaces of, locomotive or other high-pressure boilers, of water spaces or partitions placed transversely or longitudinally in such fire boxes or furnaces, and fitted with hollow stays for the passage of heated air to the fire.

2. The introduction of heated air from the smoke box to the fire in the fire box.

3. The heating of the feed water in an annular vessel on the top of the smoke box.

4. The application and use of adjustable fire bars for the purpose of regulating the admission of air to the fire.

5. The peculiar construction and arrangement of solid wrought-iron or steel pistons, in combination with the peculiar mode of admitting steam behind the packing ring or rings.

6. The application and use of wrought-iron or steel pistons consisting of a simple disc in one piece or solid with their piston rods, and circumferentially grooved to admit packing rings, such rings being kept tight by their own inherent elasticity, and also acted upon by springs or steam pressure, used either separately or in combination.

PURIFICATION OF GAS.

F. C. HILLS, Deptford, *Patentee*, May 27, 1856.

This invention relates to purifying coal-gas from ammonia, sulphuretted hydrogen, and other impurities after it leaves the retorts, by means of scrubbers or purifiers, or vessels partially filled with coke or charcoal, or sawdust, mixed or unmixed with hydrated or precipitated oxides of iron or lime, and kept damp by water or other purifying liquid, which is caused to spread over it and to percolate through it.

The improvements consist, first, in purifying the gas which escapes into the retort house or other gas work buildings. A scrubber, made preferably of thin wrought-iron, or other light material, is placed in the top of the roof, or in the upper part of the retort house, and all the apertures in the slates or tiles and upper part of the building are to be closed, so as to cause the gas in the building to escape through the scrubber. To damp the gases, a steam-pipe with holes or jets pointing upwards should be placed in the bottom of the scrubber, and to cause the gases to pass through the scrubber, the top of it should be covered airtight, either by dipping into a water lute, or otherwise, and a communication by means of a pipe be made to the chimney if there is share draught enough in it to draw the gas through the scrubber. Or, instead of the chimney, an exhauster may be used to draw the gas through the scrubber; or a steam jet will answer the purpose, placed in a tube or chimney fixed in the cover. The steam issuing upwards from the jet through the chimney or tube will rarify the air and make it lighter, and so draw the gases out of the building through the media contained in the scrubber, and which media for this purpose should consist of coke, charcoal, or sawdust, or such like material, into which hydrated oxides of iron are absorbed, or with which they are mixed, so as to form granulated or porous body sufficiently coarse to allow the smoky gas in the building to pass through it. Lime may be used instead of oxide of iron to mix with the charcoal, &c., but it is not so good. Peat or sawdust charcoal is perhaps the best to absorb or mix with the hydrated oxides of iron. The scrubber is to be furnished with gratings like a dry lime purifier, and the purifying material is to be laid on them in thin layers, and should be kept damp by an intermittent supply of water, which should be caused to pass through it as in an ordinary scrubber, which will to a great extent wash away the carbon of the smoke and dust which is deposited in the charcoal, and will keep it permeable by the gas. This scrubber may be of any convenient form, and there should be a bottom to it, turned up to the sides to catch any water that may run through the purifying media in the scrubber, and which water may be thence conveyed away. The sides of the scrubber should not touch the bottom, but only come down as far as the lowest grating, and between this grating and the bottom there should be left sufficient space for the gas to be drawn into the scrubber, and to pass up through the media therein contained. Ten or twelve inches depth of opening all round the sides will be in most cases sufficient for purifying the gas after it leaves the hydraulic main. The scrubber or purifier, through which the gas is to pass, is to be filled with coke, broken stoneware, or other such material, and which is to be kept damp by an intermittent supply of cold water or other purifying liquid. as in the ordinary way. This scrubber may be placed on the ground, and must have a closed bottom instead of an open one, as before described, and steam is to be introduced into the bottom of the scrubber below the bottom grating; or the steam may be passed into the pipe through which the gas passes to the scrubbers, so as to mix with the gas, and combine with the ammonia, and other condensable impurities it contains. The mixed vapour and gas will then pass upwards through the coke or other divided media contained in the scrubber, and meeting with the cold purifying liquid which is percolating down through it, the vapour will be condensed with the ammonia, &c. which it had taken up, and will fall to the bottom of the scrubber as ammoniacal liquor, and the gas will be more pure.

The second improvement consists in using warm water instead of cold for spreading over the materials contained in an ordinary scrubber. Cold water, especially in winter, is apt to cool the gas too quickly, and thereby occasion a deposition of napthaline; and the tar, also, which is contained in the gas becomes fixed, and occasionally stops up the interstices between the pieces of coke or other material, or coats them over, so as to obstruct the free passage of the gas through the scrubber; but when the water is warm, say 70 to 100° Fahrenheit, or thereabouts, the crystallisation and deposit of the napthaline by sudden cooling is to a great extent avoided, and the tar is also greatly prevented from stopping the action of the scrubber. When steam is used in conjunction with the purifying liquid, as already described, the cold liquid which is spread over the top of the media in the scrubber will become warm, by meeting the steam and gas which are passing up and coming in contact with it; therefore, when steam is used in conjunction with water or other purifying liquid, the liquid spread over the top of the scrubbing or purifying materials should be cold.

The third improvement consists in spreading water or other clear liquid over the materials contained in the scrubber by means of porous pipes, diaphragms, or filter stones, which, by allowing the water to filter through them, will present a dewy surface to the gas, and the water or other purifying liquid will be caused to drop equally over the surface of the materials contained in the scrubber; or a scrubber or condenser may be formed wholly of these porous filtering plates or diaphragms instead of being filled with coke or other greatly divided media, and the water being caused to filter through these plates or diaphragms, will present a damp surface to the gas, which will condense the ammonia it contains. The porous diaphragms here referred to are principally the artificial filtering plates as made by Ransome and Sims, of Westminster. Any convenient arrangement of the filter plates, which will allow the water to pass through them and present an extended damp or dewy surface to the gas, will answer the purpose. The top of an ordinary coke scrubber may be made of an iron frame, in compartments, having these filter plates cemented into them, so as to form a tank of a few inches deep to hold water for filtering through and supplying the scrubber, as described. A gas-tight cover should be fitted on the top of this water-tank that no gas may escape.

The fourth improvement consists in spreading water in a finely divided state in a vessel through which the gas which has escaped into the retort house mingled with air and smoke is caused to pass before entering the scrubber already described. This is effected by means of a steam jet, fixed in a small funnel-shaped or concave basin, and which basin is placed in the centre of the bottom part of the vessel, which may be of any convenient size or depth; and the orifice of the steam jet is to be a few inches above the bottom of the basin in the centre, and water is to be run at any required pace into the little conical or funnel-shaped basin, and when it comes to the bottom of the basin below the orifice of the steam jet, through which high-pressure steam is caused to issue, it will be partially converted into vapour, and will be dispersed in all directions, by which means the grosser or carbonaceous impurities of the gases passing through the vessel will be deposited or condensed before the gas passes into the scrubber containing the purifying material, already described. This vessel, in which the water is thus spread, should be made preferably of light wrought iron, and may be conveniently placed below the scrubber in the roof, before described, and may form an extension of it by making it so much deeper; or, if preferred, it may be connected by pipes to the scrubber in any convenient way.

Claims.—1. For purifying gas (whether escaping into the retort house or into the hydraulic main) combining the use of steam with the use of purifying liquids in scrubbers, or purifiers containing the purifying and divided media.

2. The employment in the scrubbers of a warm instead of a cold purifying liquid.

3. The distribution of the purifying liquid over the divided media in the scrubbers or purifiers by means of filtering plates or diaphragms; and also the forming the scrubbers or purifiers of a series of such filtering plates or diaphragms instead of coke or other divided media.

4. Spreading water by a jet of steam.

ARTIFICIAL STONE.

L. D. Owen, London, *Patentee*, May 28, 1856.

This invention consists in forming blocks of artificial stone, for building purposes, as a substitute for brick and stones. The basis of this improved building block are lime and silicious sand, articles which are old and well known materials for building purposes, and which have been used in a great variety of relative proportions, either as mortar to cement stones or bricks together, as concrete to make foundations, or for other purposes. The patentee states that although it is composed of such old and well-known material, yet these materials are so combined as to give to the block new properties and advantages essentially different from those possessed by any other known artificial building material.

A quantity of coarse silicious sand, as free as possible from admixture with clay or other earth is provided, together with a quantity of freshly slacked lime in powder. As much sand and lime as can be moulded into blocks during an hour are then to be thoroughly mixed together, in the proportion of about one part of lime to from six to twelve parts of sand, according to the nature of the sand or the quality of the lime, the lime being the dry powder hydrate produced when lumps of calcined limestone are freshly slacked, and the sand having that degree of moisture it ordinarily has when dug out of the earth. If preferred, the calcined limestone may be ground and mixed with the sand previous to being slacked, and then as much water added as is necessary for the process of slacking; this composition is then placed into the mould, of the required shape of a moulding press, similiar to those used for making bricks from pulverulent clay, and is there submitted to great pressure, which should be proportioned to the thickness required. A suitable pressure for a block of 3 inches thick would be about 3 tons to the square inch; blocks may be formed under less pressure, but it is evident that the compactness of the block increases with the pressure to a certain extent. After the block has been submitted to this pressure, it is carefully removed from the mould and laid upon a flat surface, with free access of air, where it should remain until sufficiently hardened or ripened, when it will be ready for use. For the purpose of facilitating the ripening of the block, it should if larger than a common brick, be perforated with one or more holes; these will admit the atmospheric air into the interior of the block, whereby the hydrate of lime will be converted into carbonate, a change which, if the blocks were large and solid, would require a considerable time.

The particles of sand in the composition are, by the heavy pressure to which it is subjected, forced into such close proximity, that it requires but very little cement to fill the interstices and agglomerate them together into a block of compact sandstone. The blocks thus made become indurated after a few months to such a degree that they are not readily distinguishable from natural sandstone. In the preparation of this material care must be taken not to employ wet sand, because if there is an excess of moisture, to such a degree as to exude water whilst the block is pressed, it would be impossible to give to the mass the requisite solidity, as the cohesion of the water to the sand and lime is so strong, and its incompressibility so great, that it could not be expressed in the very brief space of time during which the block is exposed to pressure. This excess of water would afterwards evaporate, leaving the block comparatively porous, light, and friable; it also would be much longer in hardening, crack in drying, and not maintain its shape. When sand is not readily obtainable, coarsely pulverised scoria from furnaces, bricks, or other pulverulent silicious matter may be employed in place of the sand; the lime and sand may be mixed with oxides of metal, or other colouring matter, to give the blocks any desired colour. These blocks dry without shrinking or warping, and hence possess great advantages over bricks which always shrink much and very unequally, and also warp in burning. Blocks may be made in any desirable form or shape, plain or ornamental, perforated or solid. For blocks intended for building in water, waterlime is used. These blocks are made in a similar manner to those above described, but when removed from the press and sufficiently set, it is well to submerge them in water for a time, by which means they will rapidly grow hard and fit for use.

Claim.—The manufacture of blocks of artificial stone from sand or other pulverulent silicious matter in combination with lime, and formed in moulds under great pressure.

PERMANENT WAY OF RAILWAYS.

F. P. Dimpfel, Philadelphia, U.S., *Patentee*, May 27, 1856.

This invention relates to a mode of connecting the rails of railways to the wooden sleepers, whereby the rails are more firmly held than by the ordinary plans of securing rails, and a rail of much lighter weight than is usually employed may be adopted. Instead of securing the rails by means of pins or spikes to the upper surface of a longitudinal sleeper, the patentee imbeds the foot of the rail in the sleeper, by cutting out grooves therein to receive the rail. A double T rail is preferred. To imbed the foot of the rail in the sleeper, the latter is cut longitudinally down the middle, and grooves or recesses are cut in the inner side of the two halves of the longitudinal sleeper of such a size and shape as to receive the foot of the rail when the two halves of the sleeper are brought together again. The greater portion of the rail is thus enclosed between the sleepers, and the foot of it rests half on one half of the sleeper and half on the other half of the sleeper. The whole is held together by bolts and nuts, the bolts passing through the rail and the two halves of the sleeper. The inner ends of the bolts or some of them may if required be provided with eyes to receive the rods for connecting the two rails of the track together, and thus preserving the gauge of the line.

The patentee observes, that in order to prevent as much as possible the lateral deflection of the rails, it may be desirable to give one-half of the sleeper a greater elevation than the other half, the lower half being at the highest elevation compatible with the flange of the traversing railway wheels, clearing it, but the other abutting against the head of the rail. A resisting medium is thus provided against the lateral pressure of the passing train. The several timbers forming the sleepers are arranged so that they shall break joint, not only with each other, but with the lengths of bar iron forming the rails; thus, where a joint in the rail occurs they will be supported on both sides by the longitudinal sleepers, and opposite a joint in the sleepers an unbroken length of rail will be presented.

Claim.—The mode described of obtaining a continuous bearing for the rails of railways, and of holding them in position without the aid of chairs or other analogous supports.

SEPULCHRAL MONUMENTS.

W. Potts, Handsworth, *Patentee*, June 4, 1856.

This invention relates to the construction of sepulchral monuments, combining economy with superior architectural and artistic design. The patentee makes covers for tombs by casting or moulding the covers in natural or artificial stone or metal, or by cutting the stone, marble or other material, with recesses or projections in the centre of the covers.

The inscription frame is formed at its lower part so as to fit accurately into a recess. Where the bases are formed of natural stone, iron bearers are placed underneath, instead of a stone flange.

The flanges are placed below the the level of the bases of the covers, and are made of a suitable width to sink or imbed in the unmoved earth between tombs. The flanges preserve the level of the monuments if the earth covering of the tomb should sink, avoiding the necessity for brickwork to sustain it. The inscription plates to be inserted in the inscription frame are supplied detached from the inscription frame, so as to provide the convenience of adding at a moderate cost a new and durable record of a recent death.

The plates are fastened by a flange at the lower end, being let into the inscription frame, and by a lock bolt into the frame at the top. In some sepulchral monuments, the inscription plates are all loose, and are held to the inscription frame by screws and nuts, and removeable at pleasure to be replaced by others containing new records of deaths.

The screws by which the inscription plates are secured to the monument pass through holes into the interior of the monument, access to which is gained for the purpose of screwing and unscrewing the inscription plates by the removal of the cover, which may be secured in its place by a lock.

Claim.—The casting or forming covers for tombs or graves with recesses or projections to receive the inscription frames at the centre of the covers, and also casting or forming the covers with flanges below the level of the bases or ground lines of the covers, to preserve the level of the covers if the grave itself sinks, and also supplying inscription plates composed in loose pieces, so as to readily affix a new record of a death.

FURNACES.

C. Desnos, Bedford-street, Strand, *Patentee*, June 16, 1856.

This invention consists in so enclosing the ash-box or pit of furnaces that the air necessary to combustion is impelled by the chimney draft to enter the furnace quickly, and in taking advantage of the low air pressure above the fuel in the furnace to draw the gases resulting from the distillation of the coals, and causing them to pass, together with the fresh air, through the carbonised fuel in the furnace.

The fuel rises above the upper level of the flue to the chimney, so that the draft thereto passes through the bulk of the fuel; a grated opening or panel forms the entrance to the chimney flue, against which the fuel rests; a metallic plate extends over the whole width of the furnace, dividing it in two parts, one of which remains free for the passage of smoke, and the entrance passage of the air into the ash-pit. The draft produced causes a current of air to enter rapidly, and to pass directly into the ash-pit, and up through the furnace bars. The current and direction of the air thus given causes the smoke resulting from the distillation of fresh fuel to pass over the partition down into the ash-pit, where it mixes with the fresh air, and is with it carried through the mass of incandescent fuel lying on the grate of the furnace, and so to the flue, whereby the smoke is consumed.

Claim.—The smoke-consuming furnace described, in which the chief feature is the return or conduct of the gases and smoke, or products of combustion arising from fresh fuel, at once into the ash-pit, and through the incandescent part of the fire, by the action of the draft.

RAILWAY CHAIRS.

W. H. BARLOW, Derby, and W. H. WOODHOUSE, Westminster, *Patentees*, June 16, 1856.

This invention proposes improvements in connecting and securing the ends of rails of railways. For these purposes the chairs employed are each made in two parts, which is not in itself new. The interior of the chair is formed to receive two "fish" plates in addition to the rail, and a screw bolt passes through the two jaws of the chair, through the rail, and through the two "fish" plates; where joint chairs are used, the chairs are made wide, and have two holes through each of the jaws for screw bolts, so that one bolt passes through the end of each rail as well as through the "fish" plates and the jaws of the chair. The "fish" plates are also bolted to the rails by other screw bolts passing through them. And it is found advantageous, when using "fish" plates in connecting the ends of rails of railways, to employ plates with two or more female screws therein, in place of separate nuts for each screw bolt used.

ON WINDING APPARATUS FOR MINES.*

By WARINGTON SMYTH.

IN earlier times barrels were used, and these now under the name of kibbles, were employed in our metalliferous mines; these were of various constructions and sizes, and it depended whether they were for winzes, horse or steam power. They would in general hold from 1 cwt. to ½ ton; sometimes they were made of wrought-iron, and at others of wood, strongly fastened with iron. Many of these had an oval construction. In general, in coal mining districts, this arrangement had been superseded, though it could occasionally be seen in Belgium and the Bristol and Somersetshire districts. In this locality, by the arrangement of a step, they were able to take the wagons to the side of the shaft, and then tilt the coal, and from thence it was drawn to the surface. In some cases, to strengthen the kibbles, and prevent accidents, there was a false bottom placed in them. If great care were not taken, any such tender mineral as coal was liable to break. In Hungary, instead of kibbles and barrels, he had seen strong bags of ox-hide used: a description of these would be found in the works of Agricola; they were merely two ox-hides sewn strongly together; and this was not at all undesireable or to be condemned where the ox-hides could be purchased at a cheap rate. He had seen, at Schemnitz, from 800 lb. to 1000 lb. of silver ore drawn to the surface in one of these bags. One of the great objections to the kibbles was their swinging backwards and forwards in the shaft, and this, where a shaft had to be timbered, often occasioned great expense: There was not only the wear and tear here, but likewise that of the rope and kibble, and it was long considered before adopted whether the kibbles could not be raised by the means of guides or rails. At the latter end of the last century baskets were employed, and they had not now fallen entirely into disuse, but could be seen in some of the smaller collieries in Lancashire, fortified by iron bands. The first place where guides were used, some 50 years ago, was in the Saxon mines: many of the shafts were on an underlie, and it was desireable to obviate the great friction. About the year 1827 they were first employed in the Radstock colliery district, in Somersetshire. A description of the guide was then given, accompanied with a diagram, and this preceded any attempts in the North of England. From 1835 to 1840 great attention was drawn to this in several of the coal districts, and during these years it came into general use in Northumberland and Devon. In some cases the guides were small, but they were of various descriptions, such as iron chains, iron rods, wire rope, and wood: wood was most generally considered to be superior. Those of iron were generally stretched from the bottom of the pit to the top. It was desirable they should have different substances, for it was well known that when two metals of the like nature were used there would be a great friction, and this, if possible, was always to be obviated. The old method had been found to be very destructive, as the constant re-loading of so friable a mineral was likely greatly to deteriorate its value. The question of economy was now greatly studied, so as to prevent, as far as possible, the various re-loadings. There was great skill required in laying out a shaft. Sometimes one rope would be sufficient, in other instances two would be found necessary, and there were cases where it was requisite that four should be employed. On account of the ventilation, it was advisable that the wagons should be made as small as possible, in comparison with the shaft. The cage should not weigh heavier than 4 or 5 cwt., but made of strong and durable materials, as the lighter the cage the greater quantity of mineral could be transported to the surface. A description of the ordinary cage was then given, accompanied with a diagram. Sometimes the cage was so constructed that it carried two wagons, side by side, in others the one was placed over the other. In a colliery that he knew, the Grand Hornu, near Mons, in Belgium, a great quantity of coal was drawn up at one time by a single steam-engine: the rope there used was of aloe fibre; the cage was divided into compartments, and protected by a bonnet; each compartment carried two wagons, which would hold about 6 cwt. each, and were loaded from the different levels. Great speed was there exercised: they ordinarily drew to the surface from 800 to 900 tons per diem, but if required could bring to grass as much as from 1000 to 1200 tons in twelve hours. The depth of this shaft was about 230 fms., and the raising was effected with great regularity and smoothness of method. In Lancashire and some of the northern districts, it was not uncommon for a weight of coal from 200 to 300 lb. to be brought to surface in ½ to ¾ of a minute. At a deep pit at Monkwearmouth, which was 286 fms. in depth, four wagons had been brought up in 1¾ minute. The average speed might be reckoned at from 10 to 20 miles per hour. It was slower when first descending, quicker in the middle of the shaft, and gentler when approaching the bottom. It was always necessary not only to calculate the weight of the rope or chain, but likewise to ascertain its strength and durability. Had it not been for the introduction of the wire-rope the deep mines in the Hartz would have been abandoned: this was largely used in collieries. The lecturer then described the various counterpoises required to be used, all of which were illustrated by models. In Belgium, in some mines, the men were forbidden to go down in the cages; in this country, however, they were allowed. He next described the safety-cage invented by Mr. Fourdrinier; there was another, which had been used at Anzin, in France, which had saved many lives: this had a pair of arms, which so soon as the rope broke clasped the guides. Another was that of Messrs. White and Grant, of Glasgow, which had likewise been found efficacious; he thought however desirable these inventions might be, when they considered the impurities they were likely to receive from coal dust, and sometimes acid water, that they would fail, unless there was a constant and diligent supervision exercised over them. By the late Act, colliery owners had been required to protect the mouths of abandoned shafts; this was a very salutary measure, and he trusted greater diligence and more extended control would be exercised than had been the case, so that many of the accidents that now occurred, if they could not be entirely avoided, would at least be materially remedied.

* Abstract of a lecture delivered at the Government School of Mines.

Australian Railways.—The legislature of New South Wales have passed an important act to enable the Governor, with the aid of the Executive Council, "from time to time to raise, by the sales of debentures secured upon the consolidated revenue fund of the colony, and bearing interest at a rate not exceeding 5 per cent. per annum, such sum or sums of money not exceeding 200,000*l.*, as may be required for carrying on of railway works." ——Contracts have been accepted for providing locomotives, rolling stock, &c., from England for the Melbourne and Williamstown railway, the successful tenderers being Messrs. De Pass, Brothers, and Co., at ½ per cent. upon the English prices. The same firm have also contracted for the supply of 18,000 tons of rails. Tenders have likewise been invited for the supply of 110,000 sleepers for the Melbourne, Mount Alexander, and Murray River railway, and the branch line to Williamstown; and for a three-rail fence on both sides of the main line for 20 miles from Melbourne. Tenders have been received for the supply of a large quantity of rolling stock of colonial manufacture, but have not been yet decided upon.——The railway from Melbourne to St. Kilda is being rapidly proceeded with, and the line from Melbourne to Geelong will be opened for traffic throughout, it is confidently asserted, in February.——The Geelong and Ballarat line is also in a forward state; and communication between these places will be established, it is expected, on or before the 1st of December.——The survey of the North-eastern line, to connect Melbourne, Kilmore, Seymour, Benalla, Beechworth, and Belvoir, is now in progress.

INSTITUTION OF CIVIL ENGINEERS.

Jan. 20 and 27.—I. K. Brunel, Esq., V. P., in the Chair.

The Discussion on Mr. F. R. Window's Paper "*On Submarine Telegraphs*," occupied both evenings.

A description was given of the two kinds of submarine cables employed,—the simple cable, composed of one wire in each non-conducting envelope, a certain number of them being laid down side by side, so that in case of a casualty occurring to one wire the others might be made use of;—and the compound cable, wherein a given number of wires were covered by one envelope of iron wire. The recent casualties occurring to these cables were quoted in support of the advantages offered by the simple cable: as, in consequence, the Calais cable, which was of the compound kind, being torn asunder by the anchor of a vessel during the late gales, there had ensued considerable inconvenience, until the transit of the messages could be arranged by another route, whereas the simple cables, although partially injured, had never ceased to be capable of conveying messages. It was not meant by this to assert, that the simple cable would be the best for the connecting link between the west point of Ireland and the United States; but the case was worth consideration, at the outset of so important an undertaking. It had not been the object of the author of the Paper to disparage the attempt to convey telegraphic messages to America, nor did he mean to assert that the speed would be so slow as to be a bar to profit; but he had given his impressions, derived from experiment, chiefly with the view of eliciting information, from those who had better opportunities of investigating the subject.

It was remarked, that some additions were necessary to render the Paper a complete report of the progress to the present time, and especially that the proportionate strength and weight of the different cables, and their construction, should have been given; the depth and character of the bottom at the various sites, and the manner of paying out, would have been interesting; as also some information as to the power used in the experiments recorded in the tables; the proportion between the power of the current and the different lengths and kinds of wire should have been examined. The chief point suggested for discussion was the difficulty of working, at a satisfactory rate, through such a length of cable as that now being constructed to connect Europe with America. There was reason to believe, that the effects of the phenomena of induction and retardation were exaggerated. The electrical conditions of an underground wire coincided with those of a submarine wire. The first English underground line of any importance, coated with gutta-percha, was that laid by the Magnetic Company, in 1851, between Liverpool and Manchester. The effect of induction manifested itself there, but Mr. Henley's instruments met the difficulty, and promised, with some modifications, to overcome any extension of it likely to arise in the longer lines then contemplated. They differed from the old plan in the use of reversed currents of equal duration, and of high proportionate intensity, compared with the ordinary galvanic current. This equality of time and force was a very important feature, for any difference was fatal to working through great lengths of wire affected by induction. In an instrument since contrived to work with reversed currents from a galvanic battery, in which the duration of the currents varied according as the signals, or pauses, were longer, or shorter, a short current was found not to be able to surmount the residual effects of a large one, and thus a proper neutralisation did not take place. The increase of induction by a current of great duration was self-evident, and might be practically seen by charging a well-insulated wire for some time; the return current, or discharge, had then more power than a brief current from the battery itself on short circuit. On the extension of the underground system, no cause for discouragement was found, as, with some alterations, the instruments worked admirably; and instead of being limited, circuits had frequently been worked at the rate of four hundred currents per minute, which would, from their length, only allow of ten currents being sent at the same time, if the theory advanced was sound. Some time since Mr. Charles Bright, in conjunction with Mr. Whitehouse, had made some experiments through two thousand miles of wire, connected so as to form a continuous circuit, terminating at both ends in the earth. Intermediate instruments were placed at each loop, to test the thorough action of the electrical waves through the entire length, and signals were clearly defined at a rate of ten to twelve words per minute. Two large induction coils, three feet in length, excited by a powerful 'Grove' battery of fifty pint cells, but connected for quantity in sets of ten, were used to generate the currents, which were very powerful. From all that had been shown in the Paper, it was contended, that no difficulty was likely to arise, in working from Ireland to Newfoundland, that could not be effectually dealt with.

Portions were exhibited of the submarine cables leading to Calais and to Ostend, which had been ruptured during the recent gales by a vessel dragging her anchor, and hanging upon those cables consecutively. It was remarked, that though such force had been used as ruptured the iron wire and twisted it in a remarkable manner, the gutta percha covering of the copper wire was but little injured, and only exhibited a simple and clean section, all the rest of the covering being in as good a state as when it was first laid down, five years and a half previously.

It was observed, that although Mr. Crampton's name had been prominently mentioned, in connection with the first successful and permanent application of submarine cables, he did not in any way claim the merit of the invention, and was most anxious to bring forward the legitimate claims to priority of all those who had made the investigations upon which the system was based, and to give their share of merit to all who had co-operated with him, in the actual operation of laying down the first working cable. The invention, or discovery, resulted in fact from the combined investigations and experiments of several gentlemen, as had been observed in the Paper; and in corroboration of this, a tracing was exhibited of a drawing made for Professor Wheatstone in 1840, showing the submarine cable in its details of construction, insulated by tarred yarn and covered with iron wire; and the mode of laying down and picking up was also shown. There could not be any doubt of the authenticity of the drawing, and it was known that Lutwiche, who made it, went to Australia in 1841, and had not since been in this country. It was always said of him that he had aided Professor Wheatstone in working out the mechanical details of the proposed system of submarine telegraphs, stated by the Professor, before a Parliamentary Committee, to be praticable.

The names of Mr. Wallaston, an early labourer in the field,—of Messrs. Wilkins and Weatherly, who attended to the machinery for constructing the cable,—of Mr. Newall, who made the cable,—of Mr. Statham, who effected the gutta percha insulation,—of Messrs. Davis and Campbell, solicitors, to whose energy and confidence the ultimate success was so greatly due,—and of Mr. Brett, whose indomitable perseverance had kept the subject constantly before the public, were successively mentioned, and their respective shares in the merit of the Submarine Telegraph duly apportioned.

It was shown, that the experiments on the velocity of electric currents on long submerged wires, made by Mr. Latimer Clark, and referred to in the Paper, formed the subject of a lecture given at the Royal Institution by Professor Faraday, on the 20th of January, 1854, and that the battery used consisted of 360 pairs of plates (4 by 3 inches). It was nowhere mentioned in the Paper, that "by no appliance could and wire above a certain length be worked through," but "that although the difficulties of induction could be lessened, they could by no appliance be entirely avoided." Though allusion had been made to the fact of overcoming to a certain point the effects of charge and discharge, due to induction, the mechanical appliances by which this was accomplished were not described in the Paper, as they would be much more easily understood by a *viva voce* explanation. The first fact noticed was the necessity for an increased intensity in the current employed; and the magneto-electric telegraph, which gave currents of great intensity, and each current in a reverse direction to the last, appeared to be very suited to submarine work, as the reverse current assisted the discharge of the wire. An instrument invented to effect the same thing, with a galvanic battery, was shown and described. A key, upon being alternately pressed down and released, sent currents, first in one, then in the other direction, which, acting upon an electro-magnet at the other end of the line, caused a needle to deflect to the right or left, in the one case making contact with the local battery, and in the other breaking it. Other instruments for the same purpose were also described. It was noticed that the inferences drawn from experiments where several wires in one cable were looped up into a single length, might be fallacious, because there would, in that case, be currents flowing in opposite directions, in immediate proximity to each other, and the induced currents would also be of an opposite nature, and thus neutralise each other; and the effect of induction would, therefore, be very different to that upon a single insulated wire, of the same length, extended in a straight line.

The question as to induction from wire to wire, in the experiment upon a length of two thousand miles, required some explanation. The greatest care and the most delicate apparatus were employed to ascertain if any error could arise from this cause, and the result was quite satisfactory.

The tables from which arguments had been extracted against the successful working of long lines of submarine wire showed, forcibly, the weakness of those arguments. It had been stated, that Professor Wheatstone proved the passage of an electric current to reach the enormous speed of 288,000 miles per second, and the table gradually descended to only 18,000 miles, with other experiments on the same class of conductors. If the nature of the existing powers had been recorded, the statement would have clearly demonstrated, that different portions of power produced very different results. The first experiments were made with high tension electricity, the last with currents of greater quantity, and hence the difference. A statement by Professor Thompson, of Glasgow, showed that the reasoning from theory, without regard to practical results, taught that a very much greater rate than that named in the Paper would be attained in the line from Ireland to Newfoundland.

This statement by Professor Thompson, recalled the fact of the experiments of Mr. Wildman Whitehouse having exhibited the transmission of distinct signals, at the rate of four per second, through a greater length of underground wire than would be required of submarine wire to connect Ireland with Newfoundland, for the United States line. It was remarked, that in the Proceedings of the Royal Society (May 1855), and in the Report of the Proceedings of the British Association, at

Glasgow, in the same year, the theoretical objections now brought forward had been urged against the scheme, and satisfactory answers were given in the *Athenæum* of November 1856, and in a Paper read before the Royal Society in December 1856, all the reasonings being derived from actual experiment.

From these investigations it appeared, that without any direct trial in long subterranean, or submarine wires, but by reasoning on the known facts and measurements regarding electric conduction through copper, and electric induction across solid insulators, there were strong grounds for confidence, in expecting that a message of twenty words would not require more than seven minutes for its delivery, and that two hundred such messages could be sent during the day of twenty-four hours, through such a cable as was proposed to be laid across the Atlantic. There was even reason to think that rate might be ultimately exceeded, by the perfecting of the system introduced by Mr. Whitehouse.

In some experiments through a length of 1600 miles of wire, made with varying battery powers, gradually increased, by successive additions, from 31 cells to sixteen times 31 cells, there was no sensible variation in the velocity of the currents, which was found on an average to be about 1000 miles per second. There was, however, no constant velocity, as this depended upon the quantity of the battery, the thickness of the coating, and the size of the copper wire, and the consequent induction that was going on between it and the earth. Subsequently, experiments through similar wires had been made, first with the voltaic battery, and then with the current induced by an electro-magnet, and a difference in the velocity obtained by the two means was indicated. The system of employing alternate currents, or waves, of positive and negative electricity, which had been first accomplished by means of Mr. Henley's instrument, enabled greater speed to be obtained through underground and submarine wires, and was the only one in use at the present day. By it, two, or three signals might be made to leave the hand of the operator before the first had been indicated on the distant instruments.

It was explained, that the difference in the observed speeds of electricity arose from the circumstance, that the arrival of the electric wave towards its maximum power only was noticed, and not its commencement, and that this was dependent upon the power employed, as well as upon the peculiar conditions of the conductor at the time. The passage of an electric current was in reality instantaneous, for electricity having no momentum, or inertia, and being incompressible into a conductor, and capable of travelling through any length of line, it must begin to flow out of the one end simultaneously with the application of the battery at the other.

It was observed, that the statement of Professor Faraday that different and distinct waves of electricity might co-exist in any long submarine conductor, at the same instant of time, was fully borne out by the recent researches of Mr. Whitehouse. In a length of wire of 1020 miles, three signals of a signal stroke bell had been distinctly heard after the hand had ceased to transmit; and in a length of 498 miles, two such signals in arrear had been heard. From some experiments which had been made, with a view of arriving at the laws affecting the transmission of electric signals in submarine conductors, it had been found, that the law of the squares, as hitherto held, was totally inapplicable to the phenomena in question, and that the tendency was to approach much more nearly to the simple arithmetical ratio. With an amount of electric force, inadequate as compared with the length of wire to be filled up, it was seen that the retardation, occurring in the later portions of the transit, would follow a gradually augmenting ratio, in proportion to the increasingly exhausted condition of the enfeebled current; whilst if the amount of electro-motive force was greater, and more fairly related to the length of wire to be excited, then a more uniform rate of propagation of the electric wave would obtain, on the several portions of any given length of wire. With magneto-electric currents a rate of transmission two-and-a-half to three times greater than that of any voltaic impulse had been obtained; and there was this further advantage attending such currents, that the wire could never be overcharged from an inequality in the due succession of positive and negative currents. With regard to the subject of lateral induction from wire to wire, it was stated that a current whose magnetic lifting power was equal to 18,000 grains, when set into a wire 166 miles in length, produced in an adjacent parallel wire, of equal length, a transient current of only 1½ grains, by lateral induction, or 1 in 10,000, a proportion insignificant in amount when compared with the full current under examination; and it was further proved by experiment to exert no influence on the rate of propagation.

It was remarked that the subject under discussion involved two principal questions, which should be discussed separately, namely, the mechanical one of insulating, shielding, and submerging the metallic conductor, and the electrical question of transmitting messages through the same when laid. With regard to the first, it was shown, that Mr. Werner Siemens, of Berlin, discovered the non-conducting property of gutta-percha in 1846; and that in the spring of 1847, he proposed to the Prussian Government, the establishment of underground line wires, coated with that material. In the autumn of that year an experimental line of 20 miles in length, from Gros Beren to Berlin, was completed, and was found to work so successfully, that in the years 1848-9, about 3000 miles were laid on this system. In March 1848, several miles of copper wire coated with gutta-percha, by means of the cylinder machine, were submerged in the harbour of Kiel, for the purpose of establishing an electric communication between the shore and several points in the deep channel, and this was asserted to be the first attempt ever made to establish submarine communications. With regard to the law of the retardation of electric waves, the theory had been advanced, that the retardation increased as the square of the distance; whilst, more recently, another experimenter had maintained that it increased only as the length. It was believed that if all the circumstances of the later experiments had been taken into account, they would tend to corroborate the previous theory. It had been supposed, that the increasing resistance in long conductors might be overcome by proportionately increasing the electro-motive force, but it was contended, that if this force became excessive, the discharge would no longer pass through the length of the cable, and back through the earth, but would cross the insulating medium in the form of a spark, and disable the cable. It had also been proposed to send a considerable number of waves simultaneously through the cable, but it was urged, that the number which could follow, without destroying each other, was limited to three or four, and that in the Atlantic cable it would not be possible to send more than one word per minute. It was suggested, that the passage of an electric wave through a cable might be accelerated to nearly four times its natural velocity, by simply returning the current through a second insulated wire within the cable, instead of through the earth. The two wires being simultaneously charged, the one with positive and the other with negative electricity, completely neutralised the electric charge of the metallic covering of the wire. Other disturbing causes, such as the magnetisation of the surrounding iron covering, which exercised a considerable retarding effect upon the electric wave, would also be removed. The positive and negative waves in the two enclosed wires would likewise mutually accelerate each other, by voltaic induction.

It was observed, that the Paper before the meeting did not give any account of the losses or failures of several submarine electro-telegraphic cables, attempted to be laid down, but from which more might be learnt than from a whole catalogue of successful operations; neither had any mention been made of telegraphing through water, without wires, or any other metallic conductor. The present successful submarine cables were a combination of a perfectly insulated wire, contained within exterior strong iron wires, running in a longitudinally spiral direction. The invention of this kind of cable was claimed for Mr. Edward Highton, on the authority of a judgment stated to have been given in the Cour Imperiale de Paris, and it was asserted that the Solicitor-General for England concurred in this opinion. Although gutta-percha, when buried in the earth, and acted upon under peculiar circumstances, was subject to decay, yet as far as past experience had gone, sea-water seemed to be a preservative of that gum. It was suggested, that the conducting wire of a subterranean, or submarine telegraph, might be protected from oxidation, or decay at any point of leakage, by means of an electric current.

Reference was made to the following formula of Professor Ohm, for determining the velocity of the passage of a current of electricity:—

$$F = \frac{n E}{\frac{n DR}{S} + \frac{l r}{s}}$$

in which E was the electro-motive force; n the number of plates; D the distance of plates; R the specific resistance of fluid; s the section of wire; S the area of plates; l the length of circuit; and r the specific resistance of wire.

The effects produced many years ago with two batteries, the one not exceeding the $\frac{1}{40}$th of a cubic inch, and the other the $\frac{1}{10000}$th part of a cubic inch, were also alluded to, as was likewise the application of frictional or hydro electricity, for telegraphic purposes. The importance of a good system of code signals, where the cost of the intervening wire between two very distant stations was great, was next remarked on, and a code was exhibited by which an almost infinite number of signals could be transmitted with very few currents of electricity. A method was described of sending messages simultaneously through the same intervening wire in each direction, without interference with each other; and the opinion was expressed, that if a thoroughly insulated wire could be obtained and maintained between England and America, there could be no doubt that a much greater number of messages could be transmitted than had been predicted in the Paper.

Incidental to the discussion, it was mentioned that an ingenious instrument, invented by Mr. Window, the author of the Paper, had been submitted by him to the Telegraph Company, and by order of the Directors given to one of their officers, who had reported adversely to it; but within a short time the identical instrument was patented by the officer who had reported against it, and it was now almost universally employed for working the submarine telegraphs.

To this it was replied, that the patented instrument in question was imagined to be antecedent to the introduction of a similar instrument by Mr. Window, and that it had been the result of a long series of observations; for so early as the year 1848, the effects of induction were noticed in the underground wires through London, which were insulated in leaden pipes by pitch and cotton; and this induced charge was used as a severe test of the perfection of the insulation, as being more delicate than the galvanometers then in use. Again, in 1851-2, when the connection of London with Manchester and Liverpool, by means of wires insulated by gutta-percha was contemplated, the inference was drawn that it would not be possible to work at a commercial speed with the printing instruments in use at that period, and it was to obviate this that the instrument had been invented.

It was also stated that in 1850 Mr. Henley, the patentee of the Magnetic Telegraph, had submitted his ideas to Sir Charles Fox, after having shown the instrument to some acknowledged authorities, by whom he was told that it was a pretty toy, but of no practical utility. Sir Charles Fox, however, happening to entertain a different opinion, took it to Professor Faraday, who confirmed his views, and thus encouraged Mr. Henley to persevere until the present result was attained. These instances were named to encourage perseverance, and to prevent the discouragement attendant upon the first want of success.

Towards the close of the discussion it was remarked, that it would have been desirable if some further information had been afforded, as to the means proposed to be adopted in laying the Atlantic cable; neither had its construction, nor the materials to be employed, nor its strength, been satisfactorily explained. Doubtless many contingencies would arise in carrying out this great undertaking—and it had not been stated how these were proposed to be overcome. The great depth at which the cable was to be laid would cause un unsupported length of upwards of 2½ miles to be presented to the action of currents, and to the shocks imparted during heavy seas. It was just possible that the strains so brought upon the cable might be partially expended throughout the whole unsupported length, and operate in straightening the curve it would assume; but, on the other hand, they might be more limited in their range, and then the question arose, whether the cable was sufficiently strong to meet these strains. It was true, that the Mediterranean cable had been laid at as great a depth, and was said to have failed only from a deficiency in the length; but, from whatever cause, it was a fact that that communication had not been made. Everyone must feel a deep interest in the progress of an undertaking, which could not fail to exercise so important an influence on civilisation and on commerce, and the hope was expressed that all would willingly contribute suggestions, which might have the effect of lessening the chances of failure, and of so ensuring its probable success.

Feb. 3.—G. P. BIDDER, Esq., V. P., in the Chair.

The first Paper read was *"On the Varieties of Permanent Way, praticallly in use on Railways."* By W. BRIDGES ADAMS.

The Paper commenced by stating, that the calculations of Engineers, as to the strength and duration of "permanent way,' had been baffled by the unforseen increase of traffic, and that the proportions of the road to the heavy engines required to be reconsidered. It then described the principles involved—lateral and vertical strength of rails and firm joints,—ample bearing surface of the rails on the sleepers, and of the sleepers on the ballast,—chemical durability of the materials,—the porous ballast for drainage,—and the buoyant principle for boggy ground.

The importance of the depth of the rail, to prevent too great flexure under the rolling load, was then dwelt on, combined with the principle of supporting the rail, by the upper portion, as closely as possible to the surface, to prevent displacement.

The chronological sequence of the various forms of rails, was the single T, the double I, the bridge, and the contractor's rail; then the chair serving as an extended base to keep the rail from tilting sideways.

The process of fish-jointing was then considered, with regard to its effect in converting each rail into "a beam fixed at the two ends," and thus practically adding to the vertical strength. It was shown, that the strongest form of the double-headed rail, in which the shoulders formed an obtuse angle with the vertical web, was the worst form for fishing, and that the fishes were only kept tight by an intense strain on the bolts, which commonly worked loose, so that if neglected, the suspended fish joint was less perfect than an ordinary joint chair. The practice of rolling rails with squared side channels, to get better hold on the rails, was a great evil, for the edges were thus exposed to be sheared off by the action of the engine wheels. A remedy for this was shown to be practically, by stamping the ends of the rails, whilst hot, in dies, so as to square the channels to the length of the fishes, and thus to compress the metal in the heads, and to prove its quality at that part where it was usually the least sound. Thus the seats for the fishes would be square indents and fac-similes. An improvement in the form of the fish itself was to roll it as an angle iron, with a horizontal rib below, which, while adding to the horizontal strength, afforded the means of securing a lighter class of bolts from getting loose, by keying them between the rails and the bevelled sides of the nuts and bolt heads. A mode of keying ordinary fish bolts was also shown, by driving thin plate wedges between the bevelled edges of adjoining bolts. A description followed of various other joints: Mr. Fowler's three wedge chair; Mr. Samuel's fish chair; Mr. P. W. Barlow's double chair, bolted below the rail; Mr. McConochie's wedge chair; Mr. Mansel's wood pile-chair; Mr. Adams' bracket, or knee joint and intermediate fastenings, used on the Great Northern and South Western lines, applicable equally to the double headed and to the foot, or contractor's rail; Mr. W. H. Barlow's double wedge key chairs; Mr. Parsons' fish key and wood lined joint chair; Mr. Burleigh's joint chair and long key, without wood lining; Mr Wright's vice-joint chair; and Mr. Barningham's long double chair, on two sleepers. Split rails, in two parts, breaking joint longitudinally, were then described, and also a system of wooden chairs and struts used in France.

The fishing and jointing of foot and bridge rails were then treated seriatim, and the truss joint for bridge rails, concluding the series, was described. Then followed the series of iron sleeper way,—Mr. Reynolds' "hog-trough metals," Mr. Greaves' spheroidal sleepers, Mr. P. W. Barlow's cast-iron way, Mr. Samuel's wood lined cast-iron sleepers, and Mr. De Bergue's cast-iron sleepers.

Wrought-iron way and sleepers, without timber, were then examined, beginning with Mr. G. W. Buck, in 1845, who produced a plan very similar to that introduced by Mr. W. H. Barlow, in 1849, the various sections of which were criticised. Then followed the girder rail, first propounded by Mr. Adams in 1851, and now modified and successfully tested and extending in use. A sample of this rail 7 inches in vertical depth was shown, with angle brackets spreading to a width of 13 inches, breaking joint, and bolted beneath the horizontal webs. Plans of the same kind were also exhibited, applicable to the ordinary double T rail; a rail of 65 lb., and a bracket of 28 lb., with bolts bearing on shoes or on external edges; the bearing surface on the ballast being equal to a cross sleeper road with the sleepers at intervals of 3 feet. These wrought-iron girder rails were, practically, beams; but were sufficiently elastic to prevent destruction by blows—a quality always insisted on by Mr. Robert Stephenson. Experimental results were given; and a description of Mr. Spencer's corrugated permanent way completed the series.

Sixteen diagrams of varieties of permanent way, beginning with the stone-block system and ending with the girder rail, were exhibited, showing the various heights above the bearing surface on the ballast, from 18 inches down to 2½ inches.

Specimens were shown of Mr. Adams' double-headed girder rail, as used on the Great Northern Railway; of the bridge and truss joint, as used on the Great Northern and Western of Ireland, the Belfast and Ballymena, the South Coast, the South Western, and other railways the bracket joint, as used on the Great Northern and South Western; and models of the bracket joint and intermediate brackets with two bolts, and of the mode of keying fish bolts.

The second Paper read was *"On some Recent Improvements in the Permanent Way of Railways."* By P. M. PARSONS, Assoc. Inst. C.E.

The improvements described in this Paper had reference particularly to the form of the chair and to the nature of the fastenings. As laid on the East Kent Railway, the joint chairs weighed about 54 lb. each, and, with the exception of being somewhat longer, were in general appearance similar to ordinary chairs. They were 12 inches in length, and the sole, or bottom, was provided at the underside with a cross rib at each end, overhanging the sleeper on each side, and forming with it an inverted trough girder, of which the ribs were the webs, and the sole, or bottom of the chair, was the flange. One jaw of the chair was made to fit the shoulders of the rails, and the other was provided with two recesses, which received two thin creosoted elm blocks, cut across the grain, acting as cushions,—a wrought-iron wedge, provided with jags, or barbs, being driven between the rails and the wooden cushions. In the intermediate chairs, one jaw was of such a form that the upper part pressed against the web, and the lower part against the side of the table. The other jaw had an inward inclination of about one in three, and was provided with a dovetail recess, to hold the wooden cushion,—a cast-iron wedge being introduced between it and the rail. This wedge, instead of fitting against both shoulders of the rail, was made to bear against the web, and the upper part of its lower shoulder, by which the rail was forced down upon the seat, and was held firmly in a lateral direction. A short length of way on this system was laid in 1854, on the Great Northern Railway, under the direction of the Engineer-in-Chief, Mr. Cubitt, and the results were considered to be very satisfactory.

Specimens of these chairs and fastenings were exhibited, and the subject was generally fully illustrated by a large series of models furnished by the Permanent Way Company.

Feb. 10 and 17.—J. LOCKE, Esq., M.P., V. P., in the Chair.

The discussion upon the "Permanent Way of Railways" occupied both evenings. It was remarked that the Paper omitted all notice of the class of fastenings employed previous to the introduction of the wooden key. This class consisted either of iron pins, small iron wedges, or screw bolts, all embodying the same principle of small metal surfaces bearing upon small points of contact. The fit was generally very imperfect, and the fastenings rapidly deteriorated. When, from any irregularity of fit, an undue strain came upon the bolt, the thread of the screw was stripped, or the nut took a particular set, to which it always returned when screwed up. These fastenings were abandoned simultaneously by all Engineers in favour of the wooden key, which presented an elastic medium to compensate for inaccuracies, and brought comparatively large surfaces into contact.

A recent examination of some brackets, and fish plates, which had been laid down about twelve months, and were secured by bolts and nuts, showed that in 125 pairs of joints, each pair having 8 bolts, 261 bolts were loose, and 6 were out altogether, though they had been tightened up within 48 hours. The number of loose bolts at each joint varied from 1 to 8. It was contended, therefore, that bolts and nuts, such as were ordinarily used, were unsafe, inefficient, and expensive fastenings, for connecting together the parts of a permanent way, and that they were not to be relied on.

It was argued that a simpler system, for binding the different parts together was to employ wedges, which were always capable of performing their office, and were tightened up by a blow of a hammer.

With regard to the "girder" rail, it was contended, that experience had proved its rigidity and want of elasticity to be so great, that the heavy weights now carried on railways would soon destroy its upper surface, and cause it to laminate. The effect, too, of reducing the thickness of the middle web, would be to increase the cost of the rails per ton—and though credit had been taken for a saving in the item of ballast on this system, it was thought that Engineers generally would not like to diminish the amount of ballast on a railway.

It was observed, that an essential principle in a permanent way was to form the various lengths of rails into continuous bars, by fixing them firmly at their ends, either by chairs, or brackets, or fishes (keyed, or bolted), or by break-joint angle plates. With a view to prevent the bolts from getting loose, a system had been devised for locking both heads and nuts, so as to prevent them from turning round. This was proposed to be accomplished by bevilling the edges of the bolts and nuts where in contact with the fishes, so as to form grooves in which to drive plate wedges between contiguous bolts, and then to fix them by turning up the corners. It was mentioned that the original "fish" was keyed into the chairs and not bolted; and it was believed that this was firmer than the subsequent modification of the "fish-joint" with bolts, suspended between chairs. To compress the ends of the rails, and at the same time to form square channels for the fishes to lie at rest, without strain on the bolts, it was proposed to squeeze the ends of the rails whilst hot, between a pair of dies.

With reference to the comparative weights of the cast-iron sleepers used on the Londonderry and Enniskillen and the South-Eastern Lines, it was stated that the lightest portion of the latter was 5 per cent. heavier than the heaviest portion of the Enniskillen permanent way, whilst the general average was 18 per cent. heavier. Altogether about 225 miles of these cast-iron sleepers had been laid, on different railways in England and Ireland during the last five years, and only about 1 per cent. per annum had required to be replaced from all causes. Experiments had recently been made to test the strength of different forms of cast-iron sleepers, for which purpose a falling ram, weighing 12 cwt., was employed. Twenty-three forms were experimented upon, and the result was that an ordinary 80 lb rail, with 3 feet bearings, was destroyed, by bending, with a fall of 2 feet, whilst the South-Eastern sleeper bore a fall of 4 ft. 6 in. being 1 foot more than any other which was tried.

A trial of a short length of De Bergue's cast-iron sleeper way on the Great Northern Railway was stated to have shown that the plate sleepers required a less amount of attention as to packing and lifting, than the ordinary transverse wood sleepers. The chief defect of this system was asserted to be the method of fixing the rail to the sleeper. It might possess some advantages of cost in some situations, and with some modifications would probably be made to answer well for light traffic. Adams's suspended girder rail had also been subject to a similar trial, and the result was, in some respects very satisfactory. It was nearly equally rigid in all its parts, possessed a certain amount of elasticity, derived from the wings, and but little vertical deflection. It presented great facilities for packing, and could be lifted in less than half the time required by the wood sleeper system. It might be advantageous for the future to increase the width of the tread of the rail.

It was stated, that there were now about 800 miles of single line laid with the Barlow rail, and that though in the first instance transverse wooden sleepers had been used, yet this method had now been abandoned, the rail being laid down without sleepers. The difficulties were the manufacture of a sound rail, and the rigidity of the way when made. The wrought-iron way was more rigid than that of cast-iron. The rigidity of the latter might be overcome, it was believed, by the adoption of Samuel's trough sleeper with wooden fastenings. It was remarked that there were now more than 1000 miles of single line of iron permanent way laid and in operation. The practicability of the use of that material had, therefore, been proved, though, probably, the best form might not yet have been devised. It was considered singular, that a country abounding in iron should annually expend hundreds of thousands of pounds in bringing timber from foreign countries, to lay and rot on the railways of the kingdom.

It was stated that a recent examination of some portions of the South Western Railway demonstrated the solidity of the permanent way laid with fish joints; very few, if any, of the bolts and nuts were loose, and the line generally was in a very good state. The same might be said of Samuel's fish chairs, and of Greaves' system, which had been so extensively and satisfactorily used on the Egyptian railways. Where bad bolts and nuts had been used they were loose and had caused much trouble, but if the company would permit a due expenditure, it was not at all difficult to make such a way as would be really permanent; indeed, as was subsequently remarked, wherever good materials of sufficient weight and well put together, were employed, it was difficult to make a bad permanent way. Nothing but undue economy induced such a result. The compressed wooden keys were first tried on the Liverpool and Manchester Railway in 1835, and the improvements in their manufacture introduced by Messrs. Ransome and May, had materially extended their use. The double-headed rail was first rolled under the direction and from the designs of Mr. Locke, and it was asserted, in contradiction of some statements relative to their not being reversed, that there were few, if any, rails of that description finally rejected as being worn out before they had been reversed in the chairs. As to the assumed rigidity of cast-iron permanent way, it was shown, that the specimens of Greaves' and of De Bergue's iron way demonstrated the fallacy of such an assumption, as they were both found to be, after many years' hard usage, in an excellent state of preservation, and had not produced any injurious effects on the rolling stock.

It was admitted, that in many of the experiments on fishing joints, indifferent materials had been used and with corresponding results; they had been first adapted to railways in a bad condition, where the ends of the rails were injured, and the fishes did not fit; the pins were thus broken and the results were disastrous; but when they had been adapted to new or uninjured rails, the results were invariably good.

It was objected to the Paper, that it had overlooked many of the most salient improvements, such as the bridge rail, and Ransome's and May's cast-iron chairs, which latter were, with the compressed keys and trenails, now used on nearly six thousand miles of single line of permanent way. Also, that the Barlow rails did not, as had been asserted, suck up the water beneath them; but that the ballast, when duly packed, was solid and remained for a long period without failing.

The compressed wood trenails and keys, with cast-iron chairs of uniform construction and good form, and a rail not exceeding 82 lb. per yard, fixed at the joints, made a very firm and good way.

It was asserted, with respect to the fish joint, that Mr. Richardson was the real inventor, he being at the time an assistant engineer on the Eastern Union Railway, where the fishes were first used by Mr. Bruff to tie together and stiffen the ends of the rails, and render them, in fact, a girder across a weak bridge on that line. To this it was replied, that Mr. Richardson's first idea was not a fished joint at all, but merely a scarfed joint rail, which was not adopted, because it was not considered effective. Mr. Adams then produced a joint having the same object as the operation of fishing a spar, an operation so well known to seamen; it was patented in the names of Adams and Richardson, the former gentleman drawing the specification and making the models at his works, where they were seen and approved of by Mr. Peter Ashcroft, before the period of the competition for the prize offered by the Eastern Counties Railway Company for an effectual method of securing the joints of rails. This was believed to be the correct version of the invention of the fished joint. It was at the same time stated, that upwards of twenty years ago, several hundred tons of these fishes had been rolled, and been exported from Liverpool, by Mr Edwin Mawe, to America and to Germany, and that there was not any novelty in their subsequent introduction on the English railways.

It was urged, that the method of depreciating all previous systems for the purpose of advocating a new introduction, was unwise. The Engineers would judge for themselves as to the merits of new inventions, and were much better able to judge of them than the inventors themselves. It was very prejudicial to the profession, that Engineers, having the control of railways, should become patentees, and band themselves together for the purchase of other inventions to be used on the lines upon which any of them were employed; it laid them open to suspicions to which professional men should not be subjected, and gave a colour to the statements, that contractors were obliged to pay for the use of these patents, in order to prevent their tenders from being rejected, on other occasions, when submitted to engineers so placed.

It had been attempted to be shown, that it was advantageous for a company to become possessed of a number of patents, in order to facilitate dealing with them; but it was contended, that when there were numerous inventors whose claims were nearly balanced, it was more propable, that engineers would be able to arrive at equitable and reasonable arrangements for the use of the inventions, on better terms for the railway companies.

It was stated, that the permanent way adopted for the lines of railway in the East Indies, was of the simplest character, consisting of the ordinary double-headed rail, laid with chairs on transverse wood sleepers, and connected with fished joints; explanations were also given of certain points in the design and construction that had been carefully attended to, in order to ensure a successful result.

The fallacy of asserting, that a flat country admitted of the use of smaller engines and lighter permanent way, was demonstrated. The precautions necessary for constructing railways in Norway, Denmark, Canada, and all countries where the cold was intense, were explained, and it was shown, that the engineer must adapt the system of permanent way to the circumstances of the country and climate.

It was admitted, that it was desirable to separate as much as possible, the commercial from the technical questions, avoiding the former, in discussions at the Institution, but it was difficult at all times to do so.

In addition to the systems previously mentioned, specimens and drawings were exhibited of cast-iron chairs used on the East Lancashire Railway by Mr. J. S. Perring; of Spencer's corrugated sleeper road; of a new rail by Mr. Bagot; and of a solid chilled crossing by Messrs. Ransome and Biddle.

Feb. 24.—G. P. BIDDER, Esq., V. P. in the chair.

The Paper read, was "*On Chain Cable and Timber Testing Machines.*" By T. DUNN.

The hydraulic press machines, for testing chain cables, had been generally so costly in construction, and required such expensive foundations, that few of the chain manufacturers had on their premises any means of testing their chains. Messrs. Dunn, Hattersley, and Co., of the Windsor Bridge Iron Works, Manchester, having had their attention directed to this want, designed the simplified testing machine, the description of which formed the subject of the Paper, and which could be produced for 200*l.* to 300*l.*, instead of 1100*l.* to 1600*l.*, the cost of the government and corporation testing machines. The bed of the new machine consisted of a trough of cast-iron, with a slot throughout its length (30 yards), to contain the portion of cable under proof; this trough was laid on guntrees of wood as a foundation, and a few cross bars were placed over the slot, to prevent the end of the chain from rising, in case of fracture. This arrangement precluded the possibility of accident to the workmen when testing chains, as the ends were retained within the trough instead of sweeping across laterally, as frequently occured when the chains were laid upon a bench for testing. The arrangements for the main hydraulic cylinder, the valves, and the levers, were very simple and effective, and the results of very numerous series of experiments, which were given, demonstrated the power and uniform action of these machines—one of which was used at the Paris Universal Exhibition in 1855, for making a long series of experiments on the strengths of colonial and other timber, under the direction of Captain Fowke, R.E., part of whose report was quoted.

In the course of the discussion it was remarked, that the broken links showed, in almost every instance, that the fractures had arisen from an imperfect union of the iron of the links in welding. It was considered that sufficient force and rapidity of blows could not be obtained by hand labour, and that tilt hammers with the requisite speed had not yet been employed; neither had steam hammers, which were merely lifted by steam and fell by their own gravity, sufficient speed for heavy chain making.

A description was given of Naylor's single, or double-acting steam hammer, which could be changed at pleasure, by merely moving a lever, and by which any amount of steam, from a mere breathing upon the piston, to that of the full pressure of the boiler could be applied, and be varied whilst the hammer was in full work.

Two of these hammers were employed in the workshops of the Eastern Counties Railway at Stratford, and one at Norwich. They were somewhat like the "Nasmyth" hammer, but comprised several modifications having reference particularly to the valves and the valve gearing. The hammers weighed 10 cwt. each, and when worked with a length of stroke of 12 inches, and double acting, 252 blows per minute could be obtained, or more than twice the number that could be given by an ordinary hammer lifted by steam, and falling by its own unaided gravity. The same principle was said to be applicable for rivetting iron plates for ship building—also for boilers, tanks, wrought-iron bridges, rivet making, &c.

Some calculations which had been made to discover the law which regulated the size of the chain cable and the weight of anchor for a given ship, showed that

$$\tfrac{1}{2}\sqrt[3]{\text{Load displacement}}$$

gave the diameter of the chain cable usually emplowed by screw-steamers of the present form.

ROYAL SCOTTISH SOCIETY OF ARTS.

On the Application of Iron and Steel Wire to the Strengthening of Cast Iron. By WILLIAM BAIN, Edinburgh.—The author stated, that in order to accomplish this, advantage is taken of wrought iron manufactured into wire being, by many degrees, the strongest form in which it can be produced. But owing to the unavoidable limit of its dimensions, and, consequently, its want of rigidity, except by tension, which cannot be accomplished without consuming a proportion of its strength, it is, without the assistance of some other material, inapplicable in many cases where great strength is required. The wire being cut into desired lengths, and well cleaned and freed from oxide, and also any grease or other matter which might tend to generate gases, is introduced into the mould prepared to receive the molten iron, and laid in approved directions. A small quantity thus mechanically combined with cast iron, moulded into beams or other castings, was stated to add greatly to their strength; in proof of which, he stated that the following experiment was made by him in order to afford a practical test of his method of imparting strength to cast iron:—Three iron bars of one inch square section, and one of the same size, containing a wire, whose sectional area was about one twenty-third of an inch, were cast from the same ladle, and, after being placed upon supports four feet apart, were subjected to weights suspended from their centres; the three former, which were *sound*, broke with 504 lbs., 504 lbs., and 508 lbs., respectively, and the latter, notwithstanding the occurrence of a bubble at its point of fracture, sustained 574 lbs. before breaking. That the result, therefore, approached by this experiment, even when interfered with by the bubble already noticed, went to prove that by the introduction of the wire the strength of the bar was increased by about a seventh.

On several proposed Improvements in Small Syphons; with remarks on the advantageous employment of Large Syphons for purposes for which they are not commonly used. By JAMES ELLIOT, late V.P.—The object of the proposed improvements is to facilitate the filling of the syphon in all cases, but especially in those in which it is employed for drawing off acids or other liquids with which manual contact is undesirable. This object is effected in various ways, more or less simple, according to the circumstances of the case, but in every instance by means of an additional tube attached either to the curved part of the syphon, or near an extremity. In three of the proposed forms of the instrument, the outer end of the additional tube opens into a hollow elastic ball, with which it has an air-tight connection. In using these, the ball is first compressed with the hand, then the syphon is immersed with one or both extremities in the liquid, and the ball relaxed. The syphon immediately fills. If both ends are immersed, the syphon is lifted out full; but if one end only is immersed, the finger is placed upon the other, and after relaxing the ball the finger is withdrawn, without any contact with the liquid, and the liquid instantly flows. The employment of large syphons was recommended in certain cases of draining ponds and mosses temporarily—as, for instance, to obtain deposits of marl from their beds, instead of the common process of deep cuttings or tunnels, and also in such cases as exhausting the water from coffer-dams in rapid streams, instead of the usual method by pumping.

Improvements in Stone-cutting Machinery. By P. K. HUNTER, Gorton Foundry, Manchester.—The object of the machine was stated to be to cut freestone of any sort into sizes suitable for building or other purposes, by means of hardened tools or cutters fixed in the periphery of a revolving disc, on the principle of a circular saw, and to supersede the slow and ordinary method of cutting by friction with iron plates and sand. That, by this new method, a common grindstone of any thickness can be cut through with very little waste of steel, and fed forward to the machine at the rate of 7 inches per minute. The tools are of round bar steel, and are made hollow up the stem (trumpet-shaped) to facilitate the sharpening of their edge, which is thinned out upon the horn of the anvil, and then driven into a mould made for the purpose, after which they are slightly ground. The thickness of cut taken with an 11 feet disc is $1\frac{3}{8}$ inches; thinner cuts may be taken with smaller sized discs. It was stated that a number of these machines are at work in different parts of Scotland; and in Dean Forest, Gloucestershire, one with disc 11 feet diameter is used for cutting up freestone blocks into flags for paving, and is able to turn off 250 superficial feet in ten hours—the force required to drive it being about one-horse power. Two labourers are required to attend the machine, and a smith to sharpen the tools, one set of which, twenty-four in number, being able to cut 80 or 90 feet of ordinary stone, and from 40 to 50 feet of common grindstone, the total waste of steel being at the rate of six ounces per 100 feet of stone cut. The advantages of the machine were stated to be, that it requires no skilled person to work it, as any labourer can turn or replace the tools, they being completely self-adjusting; and that it can cut at least ten times more stone than any other machine with the same amount of horse-power.

Self-acting Ventilator for Private Rooms, Offices, Halls, &c. By ROBERT TROTTER, Edinburgh.—This ventilator may be made entirely of wood, or of zinc, or partly of zinc and of glass. It is placed in the upper part of one or more of the windows of the room to be ventilated, according to its size and other circumstances; and the principle on which the ventilator acts is that of allowing a free escape from the room of heated and polluted air; while, at the same time, it prevents all access into it by the window in which it is fitted up of cold air from without, in consequence of the opening left by the ventilator for the escape of the polluted air being temporarily shut up by any current of air from without attempting to flow into the room. The advantages of this ventilator were stated to be—1st, That from its being self-acting, the ventilation of the room does not, in any degree, depend on care or attention on the part of servants or others. 2dly, From its construction and action, no current of cold air is introduced by means of it into the room; and 3dly, Free ventilation is secured by it at a very small expense. This system of ventilation has been for some time past, and is now, in successful operation in five large institutions of this city, and is about to be made use of in a sixth. Into several of the buildings it was introduced with the sanction and approval of experienced and able architects, who, after careful inquiry and personal examination, confirm the favourable report made by the officials of all of them of the successful working of the ventilators, without producing the slightest inconvenience of any kind.

ARCHITECTURAL IMPROVEMENTS OF LONDON.

No VIII.—Our Streets.

In our previous notices we have principally confined our remarks to individual buildings; we shall now refer to some of our street improvements. In doing this we may briefly advert to what the late Mr. Nash accomplished in Regent-street and Waterloo-place, in brick, compo, and mastic, which at the time were considered very extraordinary productions. Since that period, however, a new spirit seems to have presided over our architectural dreams, which are now realised to a large extent in stone and brick, the latter material in many instances being allowed to show its own beautiful and durable face, instead of being covered with cement that requires to be coloured or painted every two or three years, to make it look anything like respectable. In reverting to the street improvements of London in our own day, we must begin with New Caunon-street, our present *beau ideal par excellence*. In this street very great things have been done, if we cannot produce that long straight sweep of perspective beauty, to be observed in the Rue de Rivoli at Paris, assisted as it is so materially on a large portion of one of its sides by the façades of the Palaces of the Louvre and the Tuileries. New Cannon-street, we need scarcely observe will, in its external appearance be in a great measure marred by its northern side, which is now being rebuilt piece-meal, without much regard to either general or individual effect. On the southern side of the street, however, we have some very fair samples of the class of buildings which come under the head of wholesale warehouses, insurance offices, and other business premises, which may fairly vie with some of the palaces of Venice, Florence, and Verona, and, as far as size is concerned, outdo many of them. We shall enter New Cannon-street at its western end, which opens upon St. Paul's Churchyard, and before doing so shall pause to observe that if the Corporation of the City of London wish to immortalise their names, now is the time to do so. This is to be effected by removing that portion of the block of old street buildings, which abut against the Cordwainers' Hall, so as to lay open the view of St. Paul's, from one end of its parapet to the other, from Watling-street to Ludgate-hill, and also effect a peep of its eastern end. This being done, there should be a monument to its great architect, Wren, erected on the triangular plot of ground which has lain waste so long, opposite to Messrs. Cook's warehouses in St. Paul's Churchyard. This being accomplished, we should have a most splendid perspective view of the second best Christian temple of the Christian world, and a memorial to the memory of one of the greatest architects of either ancient or modern times. We have confidence in believing, if a monument of this description were proposed to be erected by public subscription, that one would be produced at once honourable to Wren, and a great embellishment to this part of the City. On entering New Cannon-street from the west, the first important structure that meets the eye is the block built for Messrs. Berens and Blumberg, from the designs of Professor Hoskings, the main features of which partake of Italian characteristics. It is carried up to the great height of 68 feet from the level of the foot pavement, above which are attics in the roof, hidden by a parapet, having on the piers vases cut in Bath stone. Unlike any others in the same range, this building contains a sub-basement of two stories, below the street level, the lower one of which is 8 ft. 6 in. in height, and affords large additional space for the purpose of packing goods. The ground-floor portion of the elevation, which is rusticated in a peculiar manner worthy of notice, is faced with Portland stone, and the upper stories to the level of the principal cornice at the eaves are faced with Beart's patent bricks, with Portland cement dressings to the windows, the principal cornice being of the same materials. The building possesses some peculiarities of detail. It is constructed in the most substantial manner, the whole of the supporting timbers of the floors being of oak, some of the main beams 10 inches square, and others 10 inches by 9. The depth of the edifice is 100 feet, and as a whole it forms the entire block from Old Change to Distaff-lane. Beyond this, on the same side, and extending to Friday-street, are the extensive premises of Messrs. Kerr and Scott, also embellished with Italian details, and the interior elegantly fitted-up, having what is technically termed a well in the centre, lighted from the roof. Around this well, on each floor, the goods are exhibited. Proceeding further to the right, east of Friday-street, is another large block, the ground story of which is distinguished by a series of stilted arches, not in very good taste, and an extremely heavy cornice at the eaves of the roof. From this stretches another group to the end of Earl-street, much plainer, but in better taste. Nearly opposite to Messrs. Scott and Kerr's premises, and close to the Cordwainer's Hall, a building is being erected from the designs of Mr. Roberts, of Lawrence Pountney-lane, and is constructed of Portland stone, malm, and red bricks. In this structure the architect has departed from the set rules of Italian design, and produced a structure possessing considerable novelty. Its windows have some peculiarities of Lombardic design, being semi-circular headed, with labels around them resting upon corbels, and their jambs and soffits being hollowed instead of either square or splayed. This building has a frontage of 57 feet in Cannon-street, and 45 feet in Friday-street. The height of its elevation from the curb level is upwards of 80 feet. Portland stone is employed for the facing of the whole of the ground story. On the upper part of the piers, on each side of the entrance, is a profusion of carving of fruit, flowers, and lions' heads, admirably executed. The plain facings of the walls are yellow malm bricks, and the stringcourses and arched heads of the upper windows are red. The interior is constructed in the most sound and substantial manner, most of the brickwork being set in cement, and it has the same arrangement as Messrs. Scott and Kerr's warehouses, having a well, 20 feet by 10 feet, which extends from the basement to the roof, and is supported by a series of iron columns, which will be cradled out and adorned with Corinthian capitals and enriched entablatures. Six of the stories in the building will be entirely occupied as general warehouses, each containing an area of 57 feet by 43 feet. Taken as a whole, this edifice will be one of the most complete of its kind in London.

REVIEWS.

A Practical Treatise on Cast and Wrought Iron Bridges and Girders, as applied to Railway Structures and to Bridges generally, with numerous examples drawn to a large scale, selected from the public works of the most eminent engineers. By W. Humber. London: Spon. Parts 1 to 7. Folio.

Notwithstanding the extent and variety of theoretical information respecting the strength of beams, which the scientific engineer may resort to for his guidance in the construction of girder bridges, a vast number of the details of those structures must be designed by his own experience and ingenuity, irrespectively of theoretical knowledge. The mathematical principles of the strength of materials involve considerations so difficult that they can rarely be applied to any but simple cases, and it is obvious that various complexities of construction must frequently occur in practice, which are beyond the reach of strict theoretical investigation. It is the duty of the engineer to ascertain assuredly, in every instance, whether the variations from the simplest forms of girders which he is compelled to adopt do not materially affect known laws of strength and stability; but this assurance is not always easily arrived at. We have seen instances in which apparently trifling deviations from standard forms have been attended by most disastrous results. For example, the combination of oblique tension rods of wrought-iron with cast-iron beams appeared some years ago to very eminent engineers to secure an amount of strength which the experience of a fatal accident showed to be erroneously estimated. It is clear that when so great a departure from established modes of construction, as that here alluded to, was contemplated, the new construction ought to have been preliminarily tested either by actual experiment, or by most conclusive theoretical reasoning. There are, of course, minor novelties of construction, which may be safely adopted without exact computation of their effects, where the engineer is sufficiently guided by that general power of perception of the statical efficiency of structural details, which is acquired by comprehensive experience, and a sound knowledge of mechanics. To this limited extent only are empirical rules admissible in designing structures of which the security is so important as is that of railway bridges.

A well selected and well arranged collection of examples of girder bridges cannot therefore fail to be of great value to the modern engineer. Such a series ought to show the means which have been successfully adopted in overcoming local and exceptional exigencies by special contrivances. Of such a series, too, the value would be greatly increased by a system of progressive advance from the simplest forms of girders to the most complex, and by a comparison of different modes of dealing with each distinct class of variations. The work before us contains a considerable number of valuable examples, but lacks the system and method which appear to us so desirable. The plates in the different parts of this work are given without any apparent system, are irregularly numbered, and do not correspond to the accompanying description in the letter-press. Perhaps as the work advances this defect will be to some extent rectified, but at present there are no traces of system in the selection of examples. The introduction does not appear to us written with a clear knowledge of the laws of the strength of girders. For instance, we find it stated (page 3) that the deflection of a girder ought not to exceed 1 in 500, whereas, it is certain that the amount of deflection which a girder will bear depends among other things on the relation of its depth to its length. A girder may be so deep that a deflection of 1 in 500 would strain it beyond the limit of rupture, or the depth may be so small, and its flexibility consequently so great, that a far greater deflection would not sensibly impair the elasticity. Again, we find in the same paragraph, that "a girder will be deflected more by a load running rapidly over it, than if the same is carried over it slowly. Experiments have been made, and the results have proved that there is an increase of about one-seventh in the former instance." We suppose the experiments here alluded to are those made some years ago under the authority of the Royal Commission of Inquiry respecting iron structures. It would appear from the sentence just quoted, that the increase of deflection is the same in all cases; but in truth that increase depends on the velocity of the load and its weight. We have made these objections to the publication before us because we should gladly see it improve as it progresses. The works selected for illustration are most of them valuable examples of engravings, and the plates are very clear and appear to be executed with great attention to accuracy.

Examples of Antient Domestick Architecture. Part II., Royal 4to. 10 Plates. By F. T. Dollman, Architect. London: Bell and Daldy.

This part of Mr. Dollman's valuable work is wholly devoted to the Hospital of St. Cross, one of the most ancient, interesting, and charitable foundations in the kingdom, and one perhaps which retains more of its original intention and character than any similar remnant of ancient piety in the island. The hospital stands at Sparkford, on the banks of the Itchin river, about one mile west from Winchester, and owes its existence* to Bishop Henry de Blois, who founded it about 1132† for the health of his own soul, and the souls of his predecessors and those of the Kings of England, and for the maintenance and residence of 13 poor men, so decayed in health and fortune, that without charitable assistance they cannot maintain themselves; and for the relief of one hundred other indigent persons of the city, of devout and modest character. The daily allowance for the poor brethren consisted of a loaf of good wheat bread of 2 lb. 10 oz. weight; six quarts of good small beer, a sufficient quantity of pottage, and three messes for dinner, one called "mortrell," made of milk and wastell bread; one of fish, and one of flesh; and one mess for supper, the value of which amounted to 17d. worth per week. The daily dole for the hundred men was dispensed at dinner-time, in the place called "Hundredmenshall;" this portion of the building still exists, and is so named in the ground plan of the building by Mr. Dollman. It consisted of a loaf of coarser bread of 2 lb. 10 oz. weight, three quarts of small beer, a sufficient quantity of pottage or a mess of pulse, one herring, or two pilchards, or two eggs, or one farthing's worth of cheese, value 3d. Thirteen of the poorer students of the grammar school formed part of the one hundred recipients of this bounty. After dinner was done, the fragments of the meal of each was allowed to be taken away by those it belonged to. On several holidays throughout the year, and particularly on the anniversary of the founder's obit, great additions were made to the rations of the brethren, as well as the hundred poor, which number on these occasions was trebled.

Besides the support for the poor here mentioned, there was originally an endowment for a master, a steward, four chaplains, thirteen clerks, and seven choristers.

In 1157, the guardians and administrators were constituted by the founder to be the master and brethren of St. John of Jerusalem, saving to himself his canonical jurisdiction. In the time of Bishop Toclive, a quarrel arose between him and the master and brethren, which grew to such a height that Henry II. was compelled to mediate between them, and an agreement was made that the administration should be ceded to the Bishop of Winchester, upon his undertaking to give them the impropriation of the churches of Mordon and Hanuiton for the payment of fifty-three marks per annum, and giving them a discharge for a pension of ten marks, two wax candles, and ten pounds of wax for the House of St. Cross.

The end and purport of this charity, before the prelacy of the munificent William of Wykeham, had been so diverted by abuses from the intention of the founder, that he determined, and succeeded, after long and tedious litigation, to restore its revenues to their original use; re-establishing it securely, every attention was bestowed by him upon the well ordering of its arrangements, so that those who were to enjoy the advantages of the charity should fully be so enabled. The good effects arising from the attention to its interests, by William of Wykeham, were so evident to his successor, Cardinal Beaufort, that he determined to enlarge it by giving it additional and permanent means to support two priests and thirty-five more brethren, chosen from decayed gentlemen, who were to reside in the hospital; these were to be attended upon in sickness and infirmity by three hospital nuns. Indeed, so vast was the Cardinal's benefaction towards it, that he may be regarded as the second founder of St. Cross,‡ which he was desirous should be called "The Almshouse of Noble Poverty," from the grade of such occupants as he had destined it to be the support of.

Through the spoliation and fleecing the hospital underwent at the time of the Reformation, and since, the establishment has become only the shadow of the two original institutions; instead of its seventy resident clergy and laity who were here supported, besides the 100 out-members who received their meat and drink, the charity now only supports ten resident brethren, and three out pensioners, exclusive of the master and chaplain.

Here may be seen something like the conventual customs of ancient times, though the hospital never was a monastery, but merely a noble charitable foundation for "ancient and infirm men, to live together in a regular and devout manner." The inmates reside in separate dwellings, which are remarkable for their neatness, and they wear a black flowing dress, having a large silver cross upon the breast, and salute each other with the conventual appellation of "Brother."

From the sketch of the ancient and present foundation we have given of this once important place, we will now turn to a consideration of the plates which Mr. Dollman has furnished to show the architecture and arrangements of St. Cross, taking them in their order. The first plates in the part are two half-sheets, which show the ground and first-floor plans of the entire hospital; these restore those parts which are not in existence, and are deserving of being well studied for admirable arrangement and separate completeness. Plate 15 comprises the north and south elevation of the handsome tower gate-house, built by Cardinal Beaufort, who is represented in one of the three elegant niches in the upper part; the other two have been despoiled by time of their statues. Plate 16 is devoted to the refectory, which is shown well in transverse and longitudinal sections, both of which display the construction of its open timbered roof of Irish oak; in addition to these sections, the plate is filled up with details of windows, gateway-porch, and string-courses. Plate 17 contains elevations of the brethrens' dwellings, back and front, with several entire sections through the dwellings, taken at different parts. Plate 18 gives the complete arrangement of the retired ambulatory, which may be considered most remarkably picturesque in its arrangement. Plate 19 is filled with plans and details of the deep bayed windows, the studded oaken doors and fireplaces, and the iron-work, consisting of knockers, closing-rings, and key-plates; and the last Plate (20) is occupied with a perspective of the buildings around the principal quadrangle, with its trimmed internal

* According to some statements an hospital existed here before Bishop Henry's foundation, which was destroyed by the Danes.

† The revenues which formed the founder's munificent donation to support the hospital were derived from manors, rectories, tythes, rents and lands belonging to the diocese, and in the Bishop's patronage, and produced, according to an estimate of William of Wykeham, 300*l.* per annum; and, according to an existing ancient steward at the same period, above 400*l.* per annum.

‡ The additional revenue arising from the donations of the cardinal amounted in yearly value to 188*l.* towards supporting his extension of the foundation of St. Cross' Hospital.

grass-plats and well-kept walks. Beneath the view is a block plan of the entire hospital; its church and walled gardens, and large details of the spandrils in the dexter and sinister sides of the entrance gateway in the north side of the gate-house.

Mr. Dollman has now performed half his task, and we should think to the entire satisfaction of his patrons and subscribers. The plates are superior to those in his first part, and are deserving of every praise for clearness and beauty of execution. We should think those architects who are engaged in buildings for charitable and educational purposes, and who have not seen or subscribed to this work, will do well to add it to their office libraries. 'Antient Domestick Architecture' in every way may be considered as worthy of being placed by the side of the labours of Mr. Dollman's master, the elder Pugin.

Adcock's Engineer's Pocket Book for the year 1857, *containing numerous and extensive Tables and Formulæ; together with an Almanack and Diary.* London: SIMPKINS and Co. pp. 353.

In the present edition of this standard and useful work, several new papers have been introduced. From one of these, upon "Acoustics," we extract the following:—

"In a hall ventilated on the plenum principle—forcing in the pure air, and letting it drive out the impure, a speaker should be better heard than in one ventilated on the vacuum principle—drawing off the impure air, and leaving the pure to find access.

"As to the form of enclosed spaces for acoustical purposes, two persons in the respective foci of an enclosed ellipse, and beyond what elsewhere would be hearing distance, will be audible to each other if the distances from either to any point in the periphery, and thence to the other, are severally within such hearing distance. Could the position for the speaker be a fixed point, his end of the place of assembly should be a parabola, to direct the reflected rays in parallel lines, or a wider curve, to direct them divergently. The writer has successfully applied the hollow parti-paraboloid as an acoustic canopy to a pulpit, the focus being situated in the average position of the minister's mouth, and the base next the audience. The relative distances of equal-hearing in front—at either side—and in the rear, when the speaker is looking straight forward, Wren states, respectively, as 50, 30, and 20. These proportions will give an isocoustic egg-oval; and they may with advantage be borne in mind in the placing of a central pulpit or rostrum.

"From the pulpit, sound has been laid on with gutta-percha tubes to the pews of persons afflicted with imperfect audition. A main, commencing in the pulpit with a capacious trumpet-mouth, might be regarded as an essential in a large church, affording the opportunity of attaching a branch ear-tube where wanted."

There is also an excellent paper on "Contour Levels," and a paper on "Ferro-Metallurgy" embraces a good description of Bessemer's process. An interesting paper on "Measuring Instruments" is also added to this edition.

The compensating principle is explained that has been applied in the formation of measuring rods for the trigonometrical survey in Ireland. The apparatus used by Col. Colby was two 10-feet bars of brass and iron jointed together, and so adjusted that two minute points near the ends were maintained equi-distant. These were devised by Troughton and Simms.—Three methods are given for setting out a circle or circular arc where the centre is inaccessible, or the radius is so great as to preclude the possibility of striking the curve from a fixed centre.

Laxton's Builders' Price Book for 1857; *containing upwards of* 8000 *Prices, carefully corrected from the present Price of Materials and Labour,* 3000 *Useful and Important Memoranda; together with Tables for Purchasing Leases, Estates and Annuities; Area and Circumferences of Circles, Scantlings of Timber, Weights of Iron, Timber, &c.* By WILLIAM LAXTON, Architect. *And the whole of the Metropolis Building Act, with Notes of Cases, the Unrepealed Sections of the* 8th *Vict.*, c. 84, *and List of District Surveyors.* Thirty-fourth Edition. By FRED. W. LAXTON, Barrister-at-Law, F.S.A. London: John Knott, Civil Engineer and Architect's Journal-office, 19, Arundel-street, Strand.

To the present edition is added an Appendix with illustrations, containing several new inventions and materials adapted for building purposes; also, the description of eighty building stones, with their cost per foot at quarry and in London, mineral designation, colour of the stone, where known or reported to have been employed, and general remarks, the quarries being classified into districts and counties. The Index has been re-written, and an Index added to the Building Act.

WESTMINSTER IMPROVEMENTS.

Sir Benjamin Hall has in part stated in the House of Commons the prospects of the Westminster improvement plans. As many as 1791 specifications have been sent out, inviting designs for the War and Foreign Offices, block plans for a concentration of the public offices on the land between St. James's-park and the river, and the site of a new bridge in lieu of Westminster-bridge. There is a growing opinion in favour of the plan originally suggested by Sir Howard Douglas for placing the bridge somewhere nearer Charing-cross, which is in the direct line from most of the great highways on the other side of the river. Sir Howard also suggested another bridge at Lambeth ferry; in the meanwhile Sir Benjamin Hall has caused a survey to be made of the bed of the Thames, which is very greatly altered since the last survey by Mr. Telford in 1826. There has been a great demand for the specifications from professional men in our own country, and in all parts of the world—America, Italy, France, Denmark, Spain, Sweden, and many States of Germany. The plans, whether on the flat or in the round, will occupy a very considerable space, and it is even calculated that they cannot all be got into Westminster-hall, but that some supplemental building in the neighbourhood will be required. The exhibition will be opened at Easter to the whole public.

RAILWAY CROSSINGS.

At a recent meeting of the Institution of Civil Engineers, a model of an improved railway crossing, by Mr. Henry C. Hurry, was exhibited. The objects sought to be attained were to make a perfect continuity of the main line rail through all crossings, without "point and wing" (or "elbow") rails, and to effect a saving in the expense of the permanent way of railways. By perfect continuity of the main line rail through crossings, the extra wear and tear which at present took place at crossings, both to the permanent way and to the rolling stock, was prevented, and the danger of wheels getting off the rail, or on to the wrong rail, particularly in "elbow" crossings, was removed. The steeled "point and wing and elbow" rails used in the construction of crossings, parts involving considerable wear and expense, were removed. In this improvement, where a main line was crossed, the rail crossing, in approaching the point of crossing, was raised to about 1¼ inch above the level of the main line rail. The crossing rail, both inside and outside the main line rail, was cut at such a distance as to allow of the free passage of wheels upon the main line, and both ends of the rail were bent down for about one foot, so that the extreme points were on the same level as the main line rail. Between the end of the rail and the outside of the main line rail was laid a packing at the same level as the main line, and in the line that the flanges of wheels traversing the crossing would take, of a sufficient width to allow for deviations of gauge. Between the inside of the main line, and the end of the crossing rail was placed a movable packing, or wedge, which rested upon inclines in such a way that it might be raised to the level of the main line, or lowered sufficiently to allow the flanges of wheels upon the main line to clear. This movement was produced by the action that reversed the points leading to the crossing. By these means a level and continuous way was made for wheels to pass along (upon their flanges) for the distance between the ends of the cut rails of the crossing line. The gauge was maintained by a check rail. In the crossing of a siding rail with a siding rail, the movable packing was not required, as it was not necessary to keep the continuity of either rail. In this case both rails were cast in the same way as the crossing rail before described, and they were laid down on the same level, their ends being bent down as described, to the level of a packing laid 1¼ inch below their general level, and so placed as to carry wheels when traversing either line, over the distance between the rails, the gauge being kept by check rails.

Sir Charles Eastlake's hint at the Academy dinner has been taken by Lord Palmerston, who says the artists *must* have more room; and the government architects have prepared plans for an alteration in the entrance-hall of the Gallery in Trafalgar-square, meant to provide a larger room, better lighted, for the ever-enlarging school of English sculpture. The present back room is to be thrown into the hall; a new dome is to rise on the roof, and light the new room.

APPLICATION OF RAILS FOR HORSE TRANSIT IN THE STREETS AND ENVIRONS OF LONDON, AND ALSO FOR RAILWAY BRANCHES.*

By W. Bridges Adams.

The earliest roads were the simple surface of the earth. When worn into ruts, a new and parallel track was taken, and then another and another. What are called wheel roads in the pampas of La Plata and the steppes of Russia, are examples of this. But this kind of accommodation was only available on broad plains, with land of little or no value. On valuable land, or in mineral districts or rocky valleys, it was needful to repair the tracks when worn. Where stone existed, the obvious method was to break it into small pieces, and throw it into the ruts, as was the case in Derbyshire and elsewhere, and this no doubt was the earliest kind of macadam.

In the coal districts of the North, where land was valuable, it became the practice in opening a coal-pit to hire a "way leave," or right of way, or leave a way open which, if the pit worked out, could again be used for cultivation or grazing. If the ordinary ground was used to travel on, a horse could only draw about 17 cwt. of coals, and to amend this the earliest railways were devised, viz., a system of cross sleepers, placed two or three feet apart, and on these were trenailed down longitudinal wooden rails, squared to a section of six inches broad by five inches deep, the guage of way being four feet. On these wooden rails, which formed a substructure, were trenailed down other pieces of timber, which could be taken away and replaced when worn. On this kind of railway a horse could draw 42 cwt., or two-and-a-half times the load of the ordinary road. The introduction of these roads took place about the year 1600. It was, of course, necessary to level the ground beneath and around the timbers for the horses' feet, and this therefore constituted the first invention of railways, an invention forced on by the absolute necessity of a continuous stream of traffic which ordinary roads were unequal to.

The wear of the timber begot the practice of covering it in parts with plates of iron, in strakes like the tyre of a wheel. Subsequently cast-iron plates were used, of an angular form, stretching from sleeper to sleeper, an elevated rib rising from a flat plate fastened down to the sleepers, the ribs being either inside the wheels or outside. This kind of rail was called the tramway, either from the name of the engineer who first used it, Mr. Outram, or from the fact of its trammelling the wheels to their path. The objection to it was the facility of dirt lying on it, impeding the path of the wheels. This is shown by fig. 1.

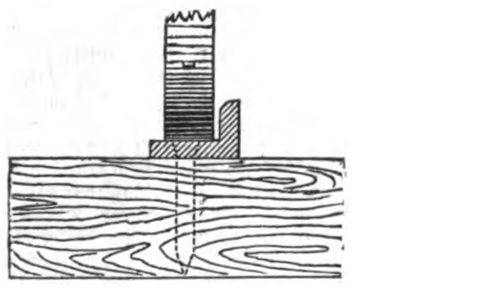


Fig. 1.

This ultimately gave rise to the invention of the edge-rail, *i.e.*, the rail projecting above the surface of the ground, and without a guiding flange, which was applied to the wheel instead. The forms of the rail were various. Fig. 2

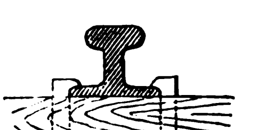


Fig. 2.

Fig. 3.

shows a section of rail, with a broad flat base, spiked down upon sleepers, commonly used in the United States. Fig. 3 a bridge rail, usually screwed down upon sleepers. Fig. 4 a rail with a broad head but narrow base, to provide for which a cast-iron chair is used. Fig. 5 shows the double-headed rail, also used with a chair, and intended for reversal upside down when worn.

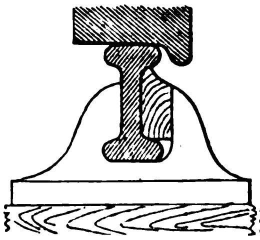


Fig. 5.

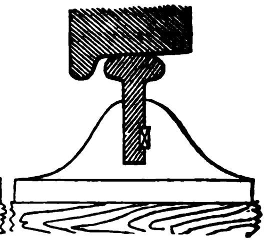


Fig. 4.

All these systems of rails, whether tramways or edge rails, project above the surface, and the wheels are guided by both rails, and cannot be guided by one rail only, or they would run off. This fact involves a very complicated arrangement of what are called switches and points and crossings, when it is required to move a train from one line of rails to another, a system which involves also great expense in repairs and considerable risk of getting off the line, in case of any irregularity at high speeds.

The fact of projection above the surface, and the speeds used, led to a general impression that railroads must be distinct roads from highways, and that it would be impossible to use the same road for both purposes. Yet even upon the railways the fact was practically demonstrated to be otherwise, for at what are called level crossings the spaces between and outside the rails are boarded over to the level, to allow ordinary vehicles to pass over them. It is true that this involves a greatly increased expense.

In years past before edge railways existed, I was familiar with many of the locomotists who advocated and practised the use of steam-carriages on common roads, and who, considering the difficulties they had to contend with, practically accomplished great results. Mr. Walter Hancock was one of the most untiring, and I frequently pointed out to him that his chief difficulty was the want of solidity to sustain the load of his wheels, and that he must take either to stone curbs or iron rails before he could succeed. He could not accomplish this; for although the law allowed him to run his steam-carriage on the road, it did not allow him to repair, and still less to improve the road. The law allowed the road trustees to dictate the width of tyres in proportion to load, or to charge accordingly, yet, notwithstanding, permitting dished wheels, with coned peripheries, to scoop out the road while rolling, without regard to damage, but giving no specific instructions as to the hardening of the road itself, so that the injudicious application of road metal could, at their will, prevent traffic altogether.

Still, my own conviction remained that iron tracks were the true solution of the problem. In proportion to the smoothness and hardness of the surface is the facility of draught and the saving in wear and tear of vehicles. A railway is better than a highway, in virtue of its hard and smooth surface, its self-guidance for the vehicles, and its better level. But if the vehicles running on a railway be greatly in excess of its strength, they may involve more resistance than an omnibus running on a hard modern road which does not yield under the wheels.

A rail should be—having regard to the load on it—so wide as to prevent lateral deflection, and so deep as to prevent vertical deflection in itself, and it should have so much surface-bearing as to prevent it from sinking in the ballast.

But it is not necessary in all cases that the haulage on rails should be performed by steam, though in most cases that is the cheapest mode of traction. The steam railways in the United States have given rise to horse railways through cities and towns. They began in a peculiar manner.

The American railways, it is well known, were made to run to and through towns and cities, instead of to them only. The inhabitants were rarely anxious, as in England, to keep the rail away from them, but the contrary. It was deemed necessary to run round street corners. The first engine was ordered in England, and was built by Messrs. Robert Stephenson and Co., at Newcastle-on-Tyne, with the requirement of going round a sharp curve. It was, therefore, constructed as a two-wheel engine, with a swivelling truck on four low wheels in front. This kind of truck, used in the work-shop to carry large castings, was known under the euphonious name of a "bogy." The engine was, there-

* Paper read at the Society of Arts, London.

fore, shipped and invoiced as a bogy-engine. From that sprung up the whole race of American bogy-engines and carriages upon two bogies, or eight wheels, and Brother Jonathan claimed it as his invention; but that is all—in his own quaint phraseology—"bogus."

When the first railways began to work, the town authorities stipulated that the engines should be unhooked, and horses used to draw the trains through the streets; though subsequently this was compounded for by working the engine slowly, under a large maple slab, on which was painted—"Look out for the engine when the bell rings."

Once familiarised with railway carriages drawn by horses, the observant American mind was not slow to perceive that the arrangement was very superior to omnibuses for town transit. St eet after street in New York and other cities was laid down with rails, and on streets of great traffic many lines of rails were laid down side by side. Broadway is one of the few streets without them, and even that has been the subject of a law-suit betwen *pro* and *con* railers.

A Frenchman imported the plan to Paris, and it is probable that it will become an universal Continental practice.

But it has not been done in England, not done in London, in Manchester, or other great towns, where the amount of traffic seems imperatively to call for the introduction of the system.—Why has it not been done?

The answer is plain. The whole thing is so simple and easy, and the outlay needed so small, that there is no scope for either lawyers or engineers. There are neither bridges nor works to execute, nor, if managed rightly, any act of parliament to obtain, and no large number of persons to be interested.

In December, 1850, I read a paper advocating the system, before the Society of Arts, in which I stated:—"It would be easy to convert the turnpike roads into a system of practical railways, by inserting rails level with the surface, to travel on at stage-coach speed by steam. This arrangement would place the whole of the agricultural districts of England in a rapidly improving condition, the farms at one end of the line and the markets at the other. The ordinary traffic would not be interfered with by this plan of rails, as vehicles could cross and recross them."

In 1851 an attempt was made by Mr. Thomas Wright to get up a company to make street railways, but without success.

Even supposing the street railway, *i.e.*, the permanent way, to cost as much as the steam permament way, *i.e.*, about 2000*l.* per mile single way, still it would be a source of great economy to make it. A notion prevails that as on common roads the vehicles are comparatively light, very light rails will suffice, but this is not the fact. The rails on common roads would be subjected to side blows and diagonal blows from heavy coal waggons and other vehicles, and therefore they need be heavy and tough. Wrought-iron only can be used, for cast-iron always crumbles away at the joints, even when made strong enough not to break by blows. If wrought-iron be used, it may be used with or without timber sleepers. In most cases it will be an advantage to use no timber whatever, on account of its rapid destruction, but if used it should be merely as a packing below the rails, and not as a part of the structure.

The structural detail is a matter of great importance. The requisite conditions are:—First. Strength to resist violence. Secondly. Simplicity of structure and fewness of parts. Thirdly. Sufficiency of depth and width to give vertical and lateral resistance, and continuous strength at the joints. Fourthly. Facility in laying down, maintaining, and replacing. Fifthly. Non-interference with access to drains and sewers, and water-pipes below. Lastly. Economy in cost.

I have had many plans of structures with rails made on purpose, but it has for some time past occurred to me that the existing rails of railways worn out by the locomotive, are perfectly well adapted to street use. They therefore afford us the means of great strength of iron at low cost.

There are two considerations—either to adapt the street rails to the wheels of the ordinary omnibuses and cabs, or to adapt them to a special form of wheel tyre.

For ordinary wheels, my plan is as follows:—The common double T rail used on the narrow guage railways is as fig. 6, 5 inches in height, and 2½ inches in width. It is connected together at the joints by a patented invention of mine, called the fished joint, iron fishes fitting in the internal channels, bolted by four cross bolts.

In practice the wheels of the locomotive with six tons dead weight on them, abrade the upper surface, while the lower surface is damaged in the chairs. But the side channels remain intact. I therefore take the rails and lay them down flat, bolting them at the joints to a block of cast-iron through the fish-bolt

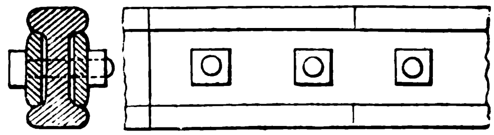


FIG. 6.

holes, the same block being provided with a horizontal hole, in which is received a tie or guage bar, connecting the two opposite rails together, as shown in fig. 7.

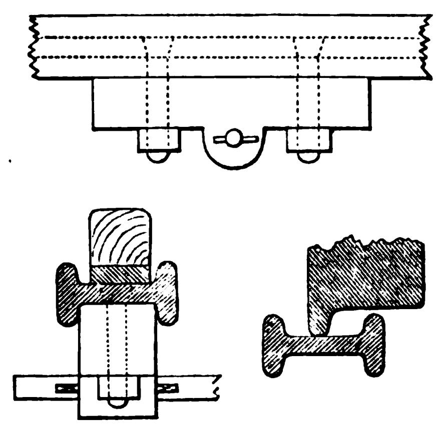


FIG. 7.

These rails, 15 feet long, are laid in the ground flat with the surface, and the tie-bar buried below, keys them down. As the greatest load that can come upon them is one ton per wheel, instead of six tons per wheel in the vertical position, the strength will be more than ample.

There is another consideration—their bearing surface on the ground to prevent the rails from crushing in. As usually laid on railways, the bearing surface is formed by the sleepers. In a first-class cross sleeper road the sleepers are laid three feet apart; the practical bearing surface of each sleeper is about six feet, which is about two feet per foot run of the two rails. The two rails laid flatwise give a bearing surface of 10 inches per foot run. If therefore two feet be equivalent to 12 tons on two wheels, 10 inches will be more than ample for two tons on two wheels. In the case of the locomotive, the bearing is 2 inches per ton; in the case of the street traffic it is 5 inches per ton; and the lateral strength of each rail is compressed from 2½ inches to 5 inches. They would be competent to engines with not more than two tons on each wheel.

In the channels of these rails the ordinary omnibus wheels can run, and, supposing the gauge the same, ordinary railway waggons could run equally well, the wheels running on their flanges instead of their tracks.

In the tramway, Fig. 1, and the edge railway, Fig. 2, it will be seen that both rails are essential to keep the waggon in track. But it is worthy of remark that in these channel rails one rail only will serve for guidance, and the opposite rail may be a simple plane surface, as in Fig. 11. Considerable lateral friction may be avoided by this arrangement, as it will permit of slight inaccuracies of guage in the omnibus wheels.

There is one disadvantage in the channel rail—dirt may get into it, which will not rest on the edge rail. This may be obviated in two ways; a spring scraper may be attached to the vehicle, and smart lads from the red or blue Shoe Brigade might be selected and provided with a crooked stick each, to patrol the line.

It is obvious that ordinary omnibuses running on these rails would be in no difficulty; if requiring to turn off and run on ordinary roads, they can easily be turned out of the rail channels, without any necessity for points and crossings, or any of the expensive paraphernalia needed on railways by reason of the great weights.

The junctions for ramifications are easily made by connecting two lines side by side with a double casting and cutting away the rib between them.

On ordinary roads it will be found sufficient to use a macadam surface between and at the sides of the rails. In streets it would be desirable to pave next the rails, if not all over the surface, and my plan of paving would be different from the ordinary road.

For the passage of wheels, it is desirable to have the surface as smooth as possible, but for foot hold for horses' feet it is desirable to have a certain amount of roughness. The earliest stone paving was with boulders, gradually replaced by cut granite, in pieces of greater horizontal width than vertical depth. The present practice is to use these deep stones laid in parallel lines, and to connect them by hot lime grouting. When new the surface is rough, and suited to the horses' feet, and the interlocking of the groutings makes the stones a continuous body. But the surface wears smooth, the grouting cracks, and the stones sink in detail, being vertical and each depending only on its own base when the bond breaks.

I propose to lay the stones at an angle of about 45 deg. one upon another. Thus in the case of vertical blows every stone is supported by the others, and there is less tendency to crack the grouting. Moreover, one of the upper edges of the stones is an acute angle, which instantly breaks away as it is worn thin, and a surface adapted to the horses' feet is thus maintained to the last.

In the railway wheels which are fast on the axles as shown at Figs. 4 and 5, the cone form of the peripheries, as before described, is supposed to compensate for curves and irregularities. If it does this, it is clear it ought to be run as it were on knife-edges. If the profile of the wheel corresponds to the profile of the rail it is clear that a large amount of friction must ensue analogous to that produced by broad waggon wheels, which are dished and curved on their peripheries. The vertical wheel is in all cases best, and with a cylindrical tread, but it is essential also in such case that every wheel should run loose on its axle.

It is essential also that brakes should be used for the purpose of stoppage or for retardation on inclines, and very simple mechanical means may be rendered available to facilitate the transit up inclines.

Supposing single lines to be used in the first instance, it will be desirable at intervals to make turns out, as shown by Fig 8.

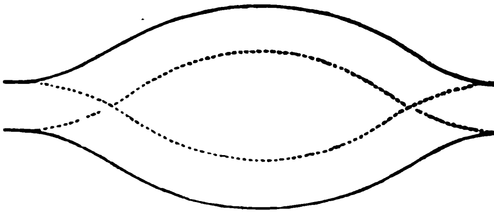


Fig. 8.

For the purpose of returning, the rail may be of a horseshoe form, so that the carriage, guided by the wheels on one side, will turn round in a circle. The diagram, Fig. 9 shows this arrangement, with one rail and a flat surface. Fig. 10 shows a turn-out.

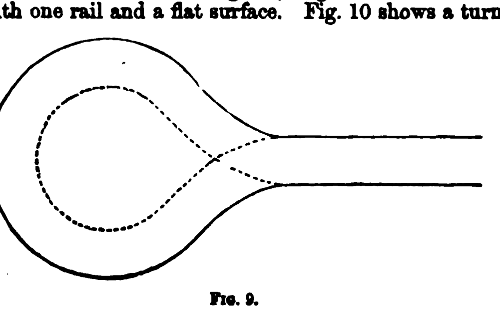


Fig. 9.

This system offers peculiar advantages to railway companies for communicating with towns and villages at a cheap rate. They have abundance of iron rails, and the cost beyond the rails scarcely exceeds two to three hundred pounds per mile. There are many localities where railway communication is very desireable, but the cost of works, bridges, permanent way, stations, and act of parliament, is an absolute prohibition. In most cases there is a highway or turnpike, or occupation road, skirting the rail and communicating with the town. With the old rails laid on the road on the plan just shown no stations are required, for the rails can carry vehicles to the doors of the existing inns along the existing streets, and if horses be not sufficient, small engines, with wheels of small diameter, and not more than two tons on each wheel, can be used on them, a class of engines adapted to the makers of the portable farm engines.

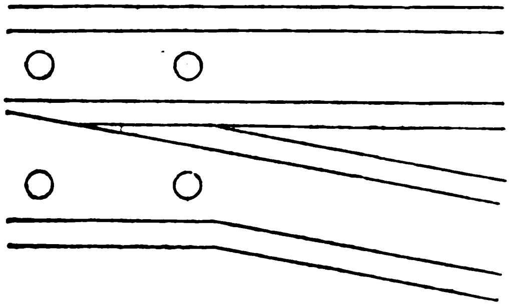


Fig. 10.

So far as regards the conversion of the ordinary double T rail to streets and roads; but there is another rail also well adapted to the same purpose, and possessing greater lateral and vertical strength for this purpose—the bridge rail, Fig. 3. The form of the bridge rail is a hollow, and it is applied as shown at fig. 3 upon railways. For street and road purposes it is reversed, with the grooves above, resting on the bottom and the side flanges, as shown at fig. 11. At the joints, the connection is made by a channel-formed iron casting, bearing beneath the flanges and bolted through the crown of the rail. A tie-bar passing horizontally through the casting connects the two opposite rails together.

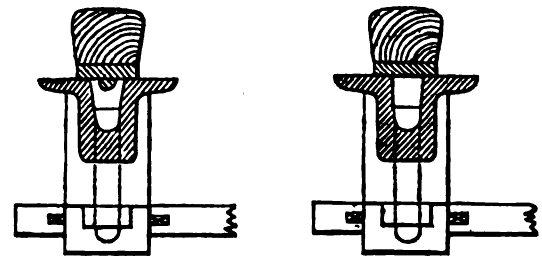


Fig. 11.

The wheels to run on this kind of rail will require flanges in the centre of the breadth of the tyre, as shown. But it is not necessary to have flanges except on one side of the carriage; the opposite side may be plain tyres. A spring scraper will keep the grooves clean, or a boy can be employed. All the other arrangements will be the same as before described with the double T rail. These rails are 6 inches wide each, and about 3½ deep; therefore the bearing surface of 12 inches should be equivalent to six tons, or three tons per wheel.

This system of rails through the streets affords a facility for carrying on the traffic, when access is required to the water-pipes, drains, or sewers, which is not the case with the ordinary paving, as most people know to their very great vexation. With the rails, if there be need to excavate below them, the operation would be to open up horizontal trenches transversely at three to four feet apart, in which to lay sleepers for the rails to rest on, much in the same mode that is used to suspend the water-pipes. On the sleepers are laid planks for the horses, and thus the excavation can go on below without any interruption.

Ordinary wheels could not run on these bridge rails, but light engines could, in suburban districts, or on railway branches.

It is obvious that convenient carriages, similar in construction to railway carriages, could be used on these lines, but without the necessity for their great dead weight. Frames and wheels might all be of the lightest construction, as there is no longitudinal concussion to apprehend.

This paper relates to the streets and suburbs of London in particular, but the result would be extension to communicate between railways and turnpike roads.

NOTES OF THE MONTH.

At a recent meeting of the Institution of Civil Engineers, Messrs. Scheutz's Calculating Machine was exhibited, and was explained by Mr. Babbage and Mr. Gravatt. There was also shown a portion of a table of logarithms, which had been composed, calculated, and printed entirely by its aid, and without the use of types. It was estimated that these compound operations could be accomplished in less than half the time which a compositor would take to set the types; and at the same time all liability of error was avoided. The machine had been recently purchased by Mr. J. F. Rathbone, of Albany, U.S., for presentation to the Dudley Observatory, U.S. America.

At the Monthly Ballot of the Institution of Civil Engineers, the following candidates were balloted for and duly elected:—Messrs. T. F. Chappé, J. F. Fairbank, H. E. Fortescue, R. W. Graham, W. Weallens, and T. A. Yarrow, as members; and Colonel Gordon, R.E., Major Jervois, R.E., Captain Collingwood, M.A., and Messrs. W. Binns, J. Brunton, E. Byrne, W. R. Coulthard, G. Dyson, L. Epstein, J. England, jun., H. C. Forde, C. H. Grant, W. B. Hall, C. E. Heinke, G. Knight, J. Newton, G. Robertson, B. W. Thurston, G. T. Selby, and J. Withers, as Associates.

The new Art-Treasures Palace at Manchester, the shell of which has only just been completed, was thrown open for promenade a few days since, previous to receiving the internal fittings and decorations.

Besides the usual annual prizes offered by the Academy of Sciences at Paris for memoirs on various scientific subjects, an extraordinary prize of six thousand francs is offered this year for an essay on the Application of Steam to the Navy. The essays must be sent to the Institute on or before the 1st of November next.

English cultivators of science have been favoured candidates of late for the honours conferred by the French Academy of Sciences. At the annual meeting of that body, held recently, M. Geoffroy St. Hilaire presiding, a prize for astronomy was bestowed on Mr. Pogson, of Oxford, for the discovery of the planet Isis. One of the Monthyon prizes for discoveries in medicine and surgery was granted to Mr. Simpson for his successful use of chloroform in surgical operations and accouchements. The Cuvier prize was accorded to Professor Owen, for having, by his labours during twenty years, so greatly enlarged the field of comparative anatomy and of palæontology.

Mr. M'Dowall has received a commission to execute the Turner monument for St. Paul's. The painter left 1000*l.*, by will, for the memorial; and the competition for its execution was confined to Royal Academicians.

The Emperor of Japan intends to have the mines of his realm worked in a scientific way, and to that end has requested the Dutch government in India to send him a trustworthy European engineer. In consequence of this request, Herr Otto Hugunin, a pupil of the Academy of Delft, has set out for Jeddo.

Mr. Davis, who has been for the last two months excavating among the ruins of Carthage, under the auspices of the British government and Museum, has discovered the remains of an ancient temple, which is believed to be that of Dido. After cutting through two layers of flooring, which must have been laid down at lengthened intervals, he came on a most splendid piece of mosaic many square yards in area, and in which were delineated two heads, each three feet high, supposed to be those of Dido and Juno, besides several graceful Eastern figures, and a number of highly elegant devices and ornaments, equal, it is alleged, to the most beautiful specimens of the art yet brought to light. Mr. Davis has taken every precaution to guard the mosaic from the influence of the weather. It is supposed that the British government will despatch a vessel to convey it to England, as well as other objects of interest which he has discovered.

The Commissioners under the Llandudno Local Improvement Act have entered into a contract with Mr. Knight, of Manchester, for the drainage of the town. The plans and specifications have been prepared by Mr. T. M. Smith, of London, C.E. They have been commenced, and are to be completed by August next.

Mr. Joseph Tucker, of the firm of Hoskins and Tucker, of Bristol, has invented a safety poop for ships, which is adapted to both ordinary and steam vessels. In case of foundering or fire, the poop is capable of being immediately detached and converted into a raft, and provision is made for steering it.

An Auctioneers' and Land Agents' Subscription-room and Exchange has been established in Princes-street, opposite the Bank of England. The rules and regulations agreed to fix the annual subscriptions from January to January, at 3*l.* 3*s.* for individuals, and 4*l.* 4*s.* for firms, payable in advance. Mr. C. C. Roberts is the secretary. One of the chief objects of this new association is to supply a perfect system of registration, to enable the members more readily to find purchasers for what they may have to sell and obtain investments for those wishing to buy. Another object is the raising of the position and public standing of the profession. The bringing of buyer and seller to one central point is itself an important object for the facilitation of business.

The Corporation of Glasgow have purchased ground on the south of the river for an additional park, at the sum of 30,000*l.*

The Government have decided on the erection of a large prison at Norfolk Island, for the reception of convicts under sentence of transportation.

The works of the Plymouth Great Western Docks having been sufficiently completed, the screw steamship *Elba* entered the basin on the 11th ult., and was placed in the graving dock. The basin, or inner dock, which is now for the first time available for mercantile purposes, has an area of 14 acres, with a depth of 22 feet, and is entered by iron gates 80 feet wide in the clear. The wharfs which surround it are most extensive, and suitable stores are in course of erection. Inside the basin is the graving dock, 379 feet long, and 96 wide, and capable of affording ample accommodation to vessels as large or larger than the steamship *Himalaya*. The outer harbour being protected by Mill Bay-pier and by the other works of the company, the *Elba* was enabled with great facility to steam through the entrance and into her berth alongside the basin wharf without requiring a warp to check her. She is 223 feet long, registers 448 tons, and carries 800 gross.

The Bradford branch of the Great Western railway from the main line at Bath to the Wilts, Somerset, and Weymouth railway at Trowbridge, has just been opened for passenger traffic. The new line is about eight miles in length, and, although short, it is of considerable importance by cutting off an acute angle, and forming with the Wilts, Somerset, and Weymouth branch, nearly a direct line of railway on the broad gauge from Bath and Bristol to Salisbury, Southampton, and Weymouth.

On the authority of Mr. Neill, the Consul-General for Honduras, it is stated that the works of the Pernambuco railway are progressing favourably under the superintendence of Mr. J. Bayliss, C.E., the representative in Brazil of Mr. Furness, the contractor; that Mr. Penniston, the company's chief engineer, reports most encouragingly as to the solidity of the execution of the works; and that they will be completed before the time originally contemplated; and, from the interest displayed by the people of the country in the undertaking, that the traffic is likely to considerably exceed the prospective estimate.

The projected railway from the Mediterranean to the Euphrates will commence on the coast of Syria. The place chosen for the head of the line is near a deep and well-sheltered bay, about two miles from the left bank of the Orontes. A port will be constructed at this spot, which appears to have been designed by nature for such an undertaking. On quitting the coast the road will be directed towards Killis, a commercial town in Syria, numbering about 11,000 inhabitants. From Killis the railway will be continued to Antioch on the Orontes, and from Antioch to Aleppo, the chief town of the pashalik of that name. Aleppo is the most important town in all Syria in respect to commerce. The inhabitants addressed a petition to the Sultan, praying that the railway might pass near their town, and their request was granted. After passing Aleppo the road will run nearly parallel with the Euphrates to a place called the Castle of Ja' Ber, situate below Babylon, between Hilla and Semaouns on the Euphrates. There will terminate the first section of the great trunk. The line will afterwards be directed from Ja' Ber to Bussorah. It will enter on the Persian territory by turning the left bank of the Persian Gulf as far as Shiraz; will cross the Beloochistan, and reach British India by Hyderabad in the Deccan. Such is the plan of the railway, which will bring passengers from the coast of Syria to the heart of India without quitting the line—a distance of 4000 miles.

Captain Galton, R.E., has presented to the Board of Trade a valuable report on the Railways of the United States, with their geographical peculiarities, mode of construction, management, &c. We shall give some extracts next month.

COMPETITIONS.

Plans, Designs, and Estimates are invited for laying out and embellishing the new burial ground for the city of Worcester; two chapels, lodges, and other buildings, fences, roads, and drainage of the land being provided fo·. The author of the plans adopted is to carry out the works. Premiums, 20*l.* and 10*l.* for the second and third best plans. Information may be had of Mr. John Hill, Town-clerk, Guildhall, Worcester. Plans to be sent in by the 14th inst.

Plans and Estimates are invited for the Erection of Baths and Wash-houses in the Full-street, Derby. Particulars may be known on application to Mr. Pratt, Chamberlain, Town-hall, Derby. Premium 20*l.* for the approved plan, and 10*l.* for the second best. Plans to be sent to Mr. Pratt by the 14th inst.

The Corporation of Cardiff, acting as the Burial Board, are desirous of receiving Designs, Specification, and Estimates for Fencing and Draining 40 acres of land at Maindy, near Cardiff; for erecting Two Chapels, Lodge, and Reception-room; and for Laying out the land as a Burial Ground; with roads and pathways, and marking every grave space. The Board will not bind themselves to employ the person whose design may be approved; but in case he should not be employed, the Board will pay him the sum of Twenty Guineas for his design. A plan of the land, with levels and sections, may be obtained on application to the Town-clerk. Designs to be sent to Mr. E. P. Richards, Town-clerk, Cardiff, by the 14th inst.

The Commissioners of Her Majesty's Works and Public Buildings invite architects of all countries to furnish them with designs for Offices for the Secretary of State for Foreign Affairs, for the Secretary of State for War, and for laying out the ground between the Thames and St. James's-park, adjoining Great George-street. The drawings to be made to a scale of 16 feet to the inch. General specifications of the materials proposed to be used in the buildings must accompany each design. A block-plan showing how the site may be so appropriated that the two buildings proposed to be erected may form part of a large and comprehensive scheme for concentrating the principal public offices, and for the improvement of the leading thoroughfares, including Westminster-bridge, whether as regards its present or any other site. Seven premiums for the best designs for the War Office of 800*l.*, 500*l.*, 300*l.*, 200*l.*, 100*l.*, 100*l.*, and 100*l.* Seven premiums for the best designs for the Foreign Office, of 800*l.*, 500*l.*, 300*l.*, 200*l.*, 100*l.*, 100*l.*, and 100*l.* For the best design for a block plan, three premiums of 500*l.*, 200*l.*, 100*l.* Plans of the ground, and other particulars will be forwarded on application to Mr. Alfred Austin, Office of Works, Whitehall. Designs to be sent in by the 20th of March.

Plans, Designs, and Estimates are required for enlarging the Dorset County Lunatic Asylum, Forston. The plans to provide increased accommodation for 140 patients and their attendants, with offices; also gas-works, weigh-bridges, and a chapel. Premiums, 80*l.* and 20*l.* Particulars may be had of Mr. Evans, County Surveyor, Wimborne. Plans to be sent in by the 21st inst.

The Burial Board for the Parish of St. Mary, Warwick, wish to receive Plans and Suggestions for erecting Two Chapels and a Lodge upon the Burial Ground. Particulars may be known on application to Mr. Thomas Nicks, Clerk to the Board, to whom Plans are to be delivered by the 21st inst. No premium is offered.

Designs are invited for a New Mechanics' Institution at North Shields, to include a library or lecture-room, reading-room, class-room, rooms for the residence of the librarian, &c. Premium, 30*l.* Information may be obtained of Mr. T. Fenwick, Borough Surveyor, North Shields. Designs to be sent in by the 22nd inst.

The Committee for rebuilding the Parish Church of Bramcote, Nottinghamshire, are desirous of receiving Plans and Estimates. Every information will be given as to the accommodation required, and the funds at the disposal of the Committee, on application to the Rev. W. H. Cantrell, Bramcote. Plans to be delivered by the 25th inst.

Designs are invited from artists of all countries for a Monument to be erected in St. Paul's Cathedral, to the memory of the late Duke of Wellington. The cost, with all expenses, not to exceed 20,000*l.* Premiums of 700*l*, 500*l.*, 300*l.*, 200*l.*, and five of 100*l.* A ground-plan of the cathedral, and the site of the proposed monument, &c., will be forwarded, on application to Mr. Alfred Austin, Office of Works, Whitehall. Designs from artists residing in the United Kingdom to June 1st, 1857; from artists residing abroad to the 25th of the same month.

Plans, Specifications, and Estimates are invited for cottages suited for agricultural labourers in Somersetshire. Premiums, 7*l.* 7*s.* for the best pair of cottages with three bed-rooms each, and 5*l.* 5*s.* for the best plan for a pair of cottages with two bed-rooms each. Particulars may be had of the Honorary Secretaries of the Chard, Crewkerne, and Ilminster Labourers' Friend Society; the Rev. J. S. Coles, of Shepton Beauchamp, near Ilminster; the Rev. G Ware, Winsham, near Chard; and Mr. W. Sparks, Crewkerne. Plans to be sent in by the 25th inst.

The Directors of the Dundalk Exchange and Market Company are prepared to receive Plans and Estimates for the erection of Exchange, News room, Assembly Room, and General Markets: for the approved plan of which they will give a premium of 30*l.*, and for the next approved of 15*l.* Plans to be submitted before the 2nd of April. Further particulars will be given upon application to the Honorary Secretaries, Peter Russell and James Shekerton.

Designs are invited for a statue in marble of the late Lord Plunket, to be placed in the Hall of the Four Courts, Dublin. Information of Colman M. O'Loghlen, 20, Merrion-square South, or Robert Johnston, 3, Henrietta-street, Dublin, Secretaries.

Designs for a church to be erected at Berne are invited from architects of all countries by members of the "Catholic parish of the city of Berne." The cost not to exceed 6000*l.* The first prize is 60*l.*; four medals, gold and silver, are also offered.

The Designs of Mr. William Hill, architect, Leeds, have been selected for the Methodist New Connexion Chapel, to be erected in that city. The estimated cost is 3000*l.*

The Designs of Mr. Matthew Thompson, architect, of Newcastle and Sunderland, have been selected by the Sunderland Cemetery Committee for laying out the ground and erecting the chapels and lodges

The Town-hall Company, Rugby, have selected the Designs of Mr. Murray, architect, for the New Town-hall to be erected there. The estimated cost is 2800*l.*

The Trustees of the White Horse Estate, Norwood, have awarded the First Premium of 150 Guineas, to Messrs. Morgan and Phipson, of 3, Danes-inn, Strand; the Second of 100 Guineas to Mr. J. H. Bone, of Maidstone; and the Third Premium of 50 Guineas to Messrs. Coe and Beetholme, of Danes-inn, Strand, for the best designs for laying out this estate

The Committee for the Memorial Church at Constantinople have selected Thirteen Designs out of the forty-six submitted, as possessing claims for distinction, and have thus placed them:

Prizemen.—1st, W. Burges; 2nd, G. E. Street; 3rd, G. S. Bodley.

Proxime Accessit, recommended for extra Prize.—W. Slater.

Especially Mentioned (alphabetically,)—C. Gray, "In te Domine Speravi," R. P Pullan, G. Truefitt, Weightman, Hadfield, and Goldie.

Honourably Mentioned (alphabetically).—A. Bell, F. Francke (Meiningen), Howell and Budd, Prichard and Seddon.

NEW PATENTS.

PROVISIONAL PROTECTIONS GRANTED UNDER THE PATENT LAWS AMENDMENT ACT.

Dated November 8.

2580. E. N. Cadet, Rue Folie Mericourt, Paris—Improvements in the construction of cocks and taps

Dated November 19.

2735. T. Hindle, Blackburn—Improvements in the manufacture of textile fabrics

Dated November 21.

2756. C. H. J. W. M. Liebmann, Fartown, Huddersfield—Improvements in the purification of water, and in the reparation of materials employed therein. (Communication)

Dated November 26.

2802. F. N. Clerk, Birmingham—Improvements in metallic roofing for buildings, and in appendages to roofs

Dated December 9.

2916. T. Peake, Abbey-street-mill, Derby—Improvements in the manufacture of chenille and other piled fabrics

Dated December 11.

2932. J. Chatwin, Birmingham—An expanding compensating slide for sustaining gas and other lights, also applicable for other similar purposes

Dated December 17.

2993. G. M. P. Swift, Viscount Carlingford, Swiftsseath, Kilkenny—An aërial chariot or apparatus for navigating the air

Dated December 19.

3011. J. Murdoch, Dundee—An improved ships-main pump, applicable to other purposes also

Dated December 20.

3012. H. Moorhouse, Denton, Manchester—Improvements in self-acting signals for railways

Dated December 23.

3046. A. Ross, J. Vallentine, A. Murray, and A. Don, Fettercairn, Kincardineshire, Improvements in the purification of coal-gas, the residum of such purifying process being applicable either as a manure or for manufacturing gas from

Dated January 2.

17. J. Wilson, St. Helen's, Lancaster—Improvements in the manufacture of steel

Dated January 8.

64. J. Goodman, A. Myers, and L. Goodman, King David-lane, Shadwell—Improvements in the manufacture of caps or coverings for the head

Dated January 9.

83. J. Bagshaw and J. P. Harris, Belstead, Suffolk—Improved medicinal mixtures, adapted for curing diseases of cattle

Dated January 10.

92. J. F. Porter, Park-street, Westminster—Improvements in the manufacture of bricks and other articles of clay and brickearth, or of the like material

Dated January 12.

98. G. F. Wilson, Belmont, Vauxhall—Improvements in treating Burmese and such like petroleum, and their products

100. J. B. Howell, Sheffield, and N. Harvey, Haymarket—Improvements in the manufacture of steam boilers

102. G. Eskholme and H. Wilkes, Rotherham—Improvements in apparatus for preventing waste of water from service pipes and cisterns

Dated January 13.

104. A. Bower, Liverpool—Improvements in or applicable to the keels of navigable vessels

108. D. Cheetham, Rochdale—Improvements in apparatus applicable to steam and other boilers

110. R. C. Galton, Ham Common, Surrey—An apparatus for giving alarm to the inmates of dwelling-houses in cases of burglary.

112. J. Barsham, Albert Road, Kingston-upon-Thames—An improvement in the manufacture of mats or fabrics used for packing

Dated January 14.

114. Sir J. Murray, Dublin—Abating the smells and increasing the fertilizing usefulness of liquid manures, sewage, gas, or other liquors, and for means of raising or propelling such mixtures and other solids or fluids to convenient heights or distances

116. J. C. Haddan, Canon-row, Westminster—Improvements in smelting ores and in roasting and extracting products therefrom. (Communication)

117. W. E. Newton, Chancery-lane—An improved steam engine. (A communication)

118. W. E. Newton, Chancery-lane—An improvement in rollers employed for calendering, mangling, and other processes of analogous character. (A communication)

119. G. A. Blittkowski, New-street, United States of America—Improvements in breech-loading fire-arms

Dated January 15.

120. A. C. Hobbs, Cheapside—An improvement in locks and latches

121. D. H. Fowler, New Orleans, Louisiana—An improvement in steam boilers

122. G. Parker and W. Martin, Manchester—Improvements in machinery for opening, cleaning, and preparing cotton

123. J. Higham, Manchester—Improvements in valve musical instruments

124. C. W. Williams, Liverpool—Improvements in furnace grates and fire-bars

125. T. F. Henley, Bromley, Middlesex—Improvements in the preparation or manufacture of certain beverages or liquors of the nature and character of home-made wines, and in the means of obtaining the same.

126. F. Watkins, Summerfield Cottage, Birmingham—Improvements in machinery for manufacturing bolts, spikes, and rivets

127. A. V. Newton, Chancery-lane—Improvement in steam-engines. (Communication)

128. J. Homan, Milk-street, Cheapside—Improved machinery for folding cloth into lengths

129. G. Bedson, Manchester—Improvements in coating and insulating wire

130. M. A. Muir, and J. Mollwham, Glasgow—Improvements in moulding or shaping metals

131. R. Adamson, and R. Holland, Preston—Improvements in looms for weaving

Dated January 17.

140. P. A. T. Pichon, Dijon, France—An improved process for accelerating tanning without the assistance of acids foreign to the bark

141. C. F. Vasserot, Essex-street, Strand—A new beverage. (Communication from E. Marchand, Fecamp, France)

142. C. F. Vasserot, Essex-street, Strand—Covering all description of grain with a fertile substance or manure and the apparatus employed for the same. (Communication from L M. P. M. d'Illiers, Orleans, France)

143. J. Dennison and H. Hurst, Halifax—Improvements in looms for weaving

144. P. Walker Warrington, Lancaster—Improvements in apparatus employed in distilling and in the manufacture of vinegar

145. A. L. Autran, Rue de l'Echiquier, Paris—Improvements in the wicks of candles and lamps

146. J. Cooke and W. Cooke, Shrewsbury—A new or improved rotatory machine, to be used as a steam-engine, water-wheel, fire-engine, or pump

147. A. Steinmetz, Middle Temple—The improvement of circular gas burners and their chimnies (to be called the Steinmetz Burner and Steinmetz Chimney)
148. R. Reeves and J. Reeves, Bratton, Westbury—Improvements in machinery for delivering manure for agricultural purposes
149. W. Warne, Tottenham—Improvements in the manufacture of deckle straps
150. J. Long, Tiverton—Improvements in the fastenings of brooches and other articles of jewellery

Dated January 19.

151. N. Fortune, Paris—Improvements in the manufacture of knife handles
152. H. Vesnoy, Rue du Faubourg du Temple, Paris—Improvements in heating foot-stoves, beds, and applicable to various other similar purposes
153. T. Sagar and C. Turner, Burnley, Lancaster—Improvements in power looms for weaving
155. W. H. Mitchell, Brooklyn, New York, U. S.—Improvements in means for distributing and composing types
157. E. Clark, Great George-street, Westminster—Improvements in floating docks
158. J. Bird, Brick Works, near Dudley—Improvements in the manufacture of articles suitable to be used as window heads and sills, lintels, and other similar parts of buildings
159. E. Clark, Great George-street, Westminster—Improvements in machinery or apparatus for raising ships out of the water for the purpose of examination and repair

Dated January 20.

161. T. Edwards and D. Rowley, Brierley-hill, Stafford—New or improved machinery for rolling taper bars
162. W. E. Newton, Chancery-lane—Improvements in sewing machines. (Communication)
164. F. C. Calvert, Manchester—The use or application of certain substances in stiffening, sizing, or otherwise preparing textile fabrics and paper
165. R. A. Brooman, Fleet-street—Improvements in the manufacture of petticoats and other knitted fabrics on circular looms or frames. (Communication from M. Lucevilliard)
166. V. A. Kleatzy, Paris—Improvements in machinery to be worked by steam or other power, for clearing and ploughing land
167. T. Johnson, Runcorn—An improvement in purifying alkaline lees
168. R. Quin, Poland-street—Improvements in stereoscopes
169. W. H. Barlow, Derby, and H. Woodhouse, Parliament-street—Improvements in the permanent way of railways
170. T. Boyle, Pilgrim-street, Ludgate-hill — Improvements in outside reflecting lanterns
171. J. H. Johnson, Lincoln's-inn-fields—Improvements in apparatus for the preservation of life and property at sea. (Communication from J. T. Garlick, New York, U.S.)
172. J. H. Johnson, Lincoln's-inn-fields—Improvements in apparatus for the preservation of money, books, paper, and other property, in case of disaster to ships and other vessels. (Communication from J. T. Garlick, New York, U. S.)

Dated January 21.

173. L. D. Jackson, Underwood, Nottingham—An improved beer engine or syphon and vent peg, to be used for the purpose of drawing or pumping ales, beer, and other fluids
174. J. Massey and J. Hargreaves, jun., Burnley—Improvements in machinery or apparatus employed in the preparation or cotton and other fibrous materials for spinning
175. H. Chamberlin, jun., Narborough, Norfolk—Improvements in implements or apparatus for ploughing, tilling, or cultivating land
176. R. J. B. Ledure, Paris—An improved railway-break
177. W. C. Scott, Waltham Cottages, Camberwell—Improvements in apparatus for separating coin
178. R. K. Aitchison, London—Improved apparatus for the amalgamation of precious metals
179. S. Dyer, Bristol—Improvements in ships' fittings, such as mast-hoops, jib hanks, and jib and other travellers
181. R. A. Brooman, Fleet-street—Improvements in the manufacture of lubricating compositions. (Communication)
182. S. Neville, Gateshead—Improvements in machinery or apparatus employed in the annealing of glass and the firing of pottery ware
183. T. Harris, Regent's-park—Improvements in apparatus for refrigerating or cooling, and regulating the temperature in worts and beer, which may also be employed as condensers in distilling
184. A. V. Newton, Chancery-lane—Improved means of transmitting messages by audible signals. (Communication)
185. H. Cater, Anchor-terrace, Southwark—Improvements in steam-boilers
186. H. Medlock, Great Marlborough-street, Westminster—An improved method of purifying water

Dated January 22.

187. L. Bower, Birmingham—An improvement or improvements in the manufacture of bolts, rivets, spikes, screw-blanks, nuts for screws, and washers
188. F. A. N. Delsarte and E. Valin, Paris—Improvements in pianos and other stringed musical instruments
189. J. Warne, Weymouth-place, New Kent-road—A new combination of metals applicable to decorative and useful purposes, part of which invention is applicable also to the method of combining metals and alloys of metals
191. E. Mander and W. Morgan, Birmingham—Improvements in the manufacture of photographic, jewellers' and other cases having wood or papier mâché foundations, and where raised regular or irregular forms are required in such cases, and the machinery for carrying out such improvements, parts of which are applicable to other purposes where sawing or shaping is required
192. C. C. Engström, Stockholm—Improvements in the construction of projectiles for rifled guns and mortars
193. J. Ebery, Birmingham—Improvements in runners, tap notches, and other parts of umbrellas and parasols
194. G. P. di Termini, Friday-street—Improvements in the construction of artificial hands
196. G. H. Hickman and A. Hickman, Bilston—An improvement in the method of manufacturing strip and hoop iron used for making wrought-iron tubes and other purposes
198. E. Luedeke, Raglan-terrace, Robin-hood-street, Nottingham—Improvements in obtaining power when steam, gas, or air is used
197. R. Johnstone, Cambridge-place, Agar-town, St. Pancras—Improvements in the manufacture of firewood for lighting fires
198. W. Roberts, Millwall—Improvements in arranging ships' and other similar pumps
199. H. W. Wimshurst, St. John's-wood—An improved mode of manufacturing sheet metal
200. J. G. Marshall, Leeds—Improvements in preparing flax, hemp, China grass, and other vegetable fibrous substances
201. F. Sadgrove, Union-court, Old Broad-street—Improvements in the construction of window or other sashes or shutters and frames

Dated January 23.

202. A. Hemingway and T. Wheatley, Openshaw, Manchester—Improvements in slide valves for steam-engines and other purposes
203. G. Bedson, Manchester—Improvements in coating iron and other metal with metals or metallic compounds.
204. C. F. Vasserot, Essex-street, Strand—An improved gasogene. (Communication)
205. C. F. Vasserot, Essex-street, Strand—A hydrostatic bellows. (Communication from E. A. L. d'Argy, Batignolles, Seine, France)
206. C. F. Vasserot, Essex-street, Strand—An improved phosphoric fuse or tinder-box and lighter. (Communication from E. A. L. d'Argy, Batignolles, Seine, France)
207. G. Eskholme, and H. Wilkes, Rotherham—Improvements in ball or other cocks
208. P. A. le Comte de Fontainemoreau, South-street, Finsbury—Improvements in fire-arms, and in the bullets to be used therewith. (Communication)
209. J. F. Powell, Albion-place, Hyde-park—Improvements in reverberatory and other furnaces
210. G. F. Wilson, Belmont, Vauxhall—An improvement in the manufacture of night-lights
211. P. A. Balestrini, Brescia, Italy—Improvements in electric telegraphs
212. G. F. Wilson, Belmont, Vauxhall—Improvements in the manufacture of candles

Dated January 28.

242. C. Hunter, Burnside, Antrim, Ireland—Improvements in bleaching or cleansing textile fabrics or materials and materials used for making paper
243. J. Elce and J. Hewitt, Manchester—Improvements in mules and other machines for spinning and doubling
244. R. Harlow, Stockport—Improvements in apparatus to be applied to steam boilers
245. C. Whowell, Two Brooks, Tottington, Lancaster—Improvements in machinery for stretching, drying, and finishing woven fabrics
246. J. Harris, Bolton, Lancaster—Improvements in lighting gas for illumination
247. G. C. T. Cranstoun, Chirnside Bridge, Berwick, N. B., G. Young, Dunse, and J. Lovell, Chirnside Bridge—Improvements in generating steam
248. T. Cooke, New-street, Portland-town—Improvements in ventilators for omnibuses, and in apparatus for actuating the same
249. W. H. Sisterson, Southwark—An improvement in cranes
250. R. A. Brooman, Fleet-street—An improved protective matting or fabric for sheltering plants, shrubs, and other vegetable productions, pits, frames, and other similar structures, together with machinery for manufacturing the same, and the mode of supporting it when in use. (Communication from J. Guyot)
251. A. P. How, Mark-lane—An improved anti-garotte cravat
252. R. A. Brooman, Fleet-street—An improved method of elevating water and other liquids. (Communication from J. Ramar)
253. J. L. Norton, Imperial Works, Bromley, Middlesex—Improvements in steeping or washing and rinsing machines
254. W. Grant, Newnham-street, Edgware-road—Improvements in the manufacture of hurdles and gates
255. J. L. Norton, Imperial Works, Bromley, Middlesex—Improvements in separating animal from vegetable fibres
256. A. Clark, High-street, Southampton—Improvements in signal lamps
257. G. F. Wilson, Belmont, Vauxhall—Improvements in treating Burmese and such like petroleum
258. G. E. Deering, Lockleys, Herts—Improvements in lighting and warming trains of railway carriages
259. H. Chamberlin, Narborough, Norfolk—Improvements in paving or covering the surfaces of roads, streets, or ways

Dated January 29.

260. C. E. Symonds, Stones End, Southwark—Improvements in the manufacture of oxide of lead and its salts
261. W. Heywood, Manchester—Improvements in boilers for generating steam
262. A. Malins, Birmingham—A new or improved method of ornamenting castors for furniture, lamps, chandeliers, cornices, and cornice ends, curtain-bands, and curtain-pins
263. G. Sampson and J. Sampson, Gordon-street, Bradford, and E. Ledger, Lofthouse, near Wakefield—Improvements in apparatus for effecting the folding or rigging of woven fabrics
264. S. Jay and G. Smith. Regent-street—An improved hood or covering for the head, capable of being used either separate from, or in combination with, other garments, such as cloaks, mantles, capes, dressing-gowns, and other entire or partial coverings for the human body
265. C. De Bussy, Mornington-road—The reduction of zinc ores
266. J. R. Macdonald, Hamburg—Improvements in the manufacture of india-rubber overshoes. (Communication from N. Hayward)
267. W. Weild, Manchester—Improvements in looms for weaving pile fabrics, part of which improvements are applicable to looms for weaving other fabrics

Dated January 30.

268. P. E. L. de Lavigerie, Rue de l'Echiquier, Paris—Improvements in the manufacture of comforters, scarfs, and other like coverings for the neck
269. J. Farrar, Bury, Lancaster—Improvements in apparatus for regulating the pressure and flow of gas
270. J. T. Pitman, Gracechurch-street—An improvement of the better organisation of the instrumental music scale. (Communication)
271. J. Thom, Lambeth—Improvements in the construction and mode of fixing artificial teeth
272. S. Montagu, Cornhill—Improvements in packing cases
273. J. R. Chibnall, Westminster—An improved method of burning or consuming smoke
274. C. Lenz, Fenchurch-street—An improvement in the manufacture of cast steel
275. T. Ellis, Ty Mawr, Pontypridd, Glamorganshire—Improvements in the preparation of india-rubber and gutta-percha by combining therewith other materials
276. A. Wright, Newcastle, Stafford—An improved manufacture of malt
277. F. W. Campin, Strand—The manufacture of a certain textile fabric, termed by the inventor "tissu courroie." (Communication)
278. I. Holden, St. Denis, near Paris—Improvements in washing and drying wool and other fibres, part of which improvements is applicable when connecting together lengths of leather for other purposes
279. I. Holden, St. Denis, near Paris—Improvements in combing wool and other fibres
280. I. Holden, St. Denis, near Paris—Improvements in preparing and combing wool and other fibres
281. I. Holden, St. Denis, near Paris—Improvements in carding wool and other fibres
282. H. Smith, Little Hampton-street, Birmingham—Improvements in window price tickets, and which said improvements are also applicable to the ornamenting and pricing the wrappers or paper boxes for holding fancy and other goods, also in the mode of attaching or suspending window tickets
283. T. Affleck, Ceylon—Improvements in machinery or apparatus for pulping coffee
284. J. Owen, Worsley, Lancaster—Improvements in machinery or apparatus for the prevention of accidents in ascending and descending shafts of mines, which said improvements are also applicable to hoisting and other lifting machines
285. J. A. Williams, Baydon, Wilts—Improvements in machinery or apparatus for ploughing or tilling land by steam power

Dated January 31.

286. A. Hensel, Stafford-place, Pimlico—Making compressed yeast
287. R. Appleby, Newcastle-on-Tyne—Improvements in washing machines
289. W. Hargreaves, Bradford—Improvements in machinery for preparing and combing wool, hair, silk, cotton, flax, and other fibrous substances

292. J. M. Worrall, Salford, Lancaster—An improvement in finishing certain descriptions of fustians called "cords" and "thicksets"
293. D. Cooper and T. Wood, Manchester, and T. L. Langshaw, Salford—An improved apparatus applicable to the purposes of ventilation
294. D. Howarth, Manchester—The application of a substance, substances, or composition, not hitherto used for sizing or preparing woollen or worsted yarns or warps for weaving
295. A. P. Price, Margate, Kent—Improvements in the separation of gold from certain auriferous mixtures, compounds, and products
296. W. Dray, Swan-lane, London—An improvement in ploughs

Dated February 2.

297. W. H. Holding and J. R. Casbay, Chatham—Improvements in the manufacture of soap
298. C. Symonds, Liverpool—Improvements in ships' night signals
299. J. Middleton, Calais—Improvements in consuming the smoke of furnaces
300. R. Robinson, Salford—Improvements in machinery or apparatus for finishing yarns or threads
301. J. F. Dudebout, South-street, Finsbury—Improvements in looms for weaving
302. B. Hodgson and J. Carter, Halifax—Improvements in apparatus for introducing the pile wires used in weaving Brussels carpets and other piled fabrics
303. J. H. Johnson, Lincoln's-inn-fields—Improvements in heating the feed-water of steam-boilers. (Communication from Messrs. Baudouim, Taniturier, and Richard)
304. M. A. Muir and J. McIlwham, Glasgow—Improvements in moulding or shaping metals
305. R. Morrison, Newcastle-upon-Tyne—Improvements in steam-boilers

Dated February 3.

306. T. Cowburn, Manchester, J. Preston, Pendleton, and J. Shetlock, Salford—Improvements in apparatus for regulating and indicating the pressure of steam and other fluids
307. T. W. Rayner, Saint-George's-East—Improvements in cocks and valves
308. J. Hunt, TheBrades, Stafford—Improvements in shovels and spades for general use
309. F. Garand, Essex-street, Strand—Improvements in transmitting motion and means of stopping it immediately
310. W. Lund, Fleet-street—Improvements in securing cases containing bullion and other valuable property, parts of which are applicable to the securing of bales and other packages
311. R. Laming, Hayward's Heath, Cuckfield—Improvements in purifying gas, in obtaining materials useful for that purpose, and in working up into useful products certain ammoniacal and phosphatic substances obtainable as residues in the purifying of gas
312. J. Taylor, Middlesbro'-on-Tees—Improvements in the governors for the engines of screw-steamers, and other vessels propelled from the stern
313. J. Taylor, Middlesbro'-on-Tees—A compensating crane
314. G. White, Laurence Pountney-lane—Improvements in dyeing and printing textile fibres and fabrics. (Communication from C. Lanth, Mulhouse, France)
315. C. Cochrane, Ormesby Iron-works, Middlesbro'-on-Tees—An improvement in heating blast for blast furnaces and cupolas
317. H. Unwin, Sheffield—Improvements in the application of waste heat from coke ovens

Dated February 4.

318. A. Steinments, Middle Temple—A method, mode, contrivance, or management to check the honesty of omnibus conductors and other receivers of money under similar circumstances, to be accounted for to their employers, without machine or mechanical appliance
319. J. Hamsher, Elizabeth-street-south, Pimlico—Improvements in the manufacture of blacking for polishing, softening, and preserving boots and shoes, and other leathern articles
320. O. Gandine, Newman-street, Oxford-street—An indicating target
321. E. Lewis and G. Böhm, Coleman-street—Improvements in printing in colours, called an improved photogalvanographic chromographic process
323. S. Hart, Portland-street, Liverpool—Improvements in apparatus for raising and forcing water
324. C. De Bergue, Dowgate-hill—Improvements in the method of, or apparatus for, laying the permanent way of railways
325. W. E. Newton, Chancery-lane—Improvements in piano-fortes. (Communication)
326. A. V. Newton, Chancery-lane—An improvement in machinery for polishing flat surfaces of glass and other substances. (Communication)
327. J. Burrows, Wigan—Improvements in steam-engines
328. J. H. Johnson, Lincoln's-inn-fields—Improvements in the treatment of flax and similar textile materials. (Communication from J. Lefebure, Brussels)
329. R. H. Houlston, Greenock—Improvements in effecting general conveyance or transport on water

Dated February 5.

30. T. Summers, Northern Iron-works, Southampton—Improvements in guages for indicating pressure and vacuum
331. P. Schäfer and F. Schäfer, Brewer-street—Improvements in travelling bags or cases, and an apparatus for carrying fittings therein
332. A. V. Newton, Chancery-lane—An improvement in casting metallic articles. (Communication)
333. C. Brasil and W. Crummack, Chorley, Lancaster—Improvements in looms for weaving
334. H. Smith, Stamford—Improvements in haymaking machinery
335. W. E. Newton, Chancery-lane—Improvements in breech loading fire-arms. (Communication)
336. G. Chowen, James-street, Covent-garden—Preventing further casualties on the Goodwin Sands

Dated February 6.

337. T. Stott, Sabden, near Whalley, Lancaster—Improvements in pickers
339. W. Green, Pembroke Cottages, Caledonian-road, Islington—Improvements in manufacturing or producing substitutes for leather for boots, shoes, and other uses, and in machinery or apparatus for effecting the same
340. R. A. Brooman, Fleet-street—Improvements in preparing or dressing threads and and other fibrous materials, and in the machinery employed therein. (Communication from E. C. T. Croutelle)
341. J. Gilroy, Auldhousefield, near Pollockshaws, Renfrew—Improvements in applying starch or other semifluid matter by machinery to woven fabrics
342. J. M. Worrall, Salford—An improvement in finishing a certain description of fustians called "diagonals"
343. G. Wright, Sheffield—Improvements in stove-grates or fireplaces
344. T. Newton, Walsall, Stafford—Improvements in the construction of Stockmen's saddles and appendages thereto. (Partly a communication)
345. A. Dècle and F. A. Drault, Paris—Improvements in the manufacture of bracelets
346. P. Poisson, Paris—Improvements in preparing and applying surfaces for painting

Dated February 7.

347. H. Heald and A. Heald, Sabden Whalley, Lancaster—Improvements in looms and in pickers used for weaving
348. N. Nozalco, Manchester, and G. Heyes, Bury—Improvements in looms
349. J. A. Limbert—Improvements in marine steam engines
350. J. C. Haddan, Cannon-row, Westminster—Improvements in marine steam engines (Communication)
351. C. Crickmay, Guildford-place, Lower Kennington-lane—Improvements in breech loading guns or pistols for military and other purposes, and which said improvements are applicable, and will admit of being applied, to guns or pistols now in use
352. F. Wrigley, Manchester—An improved apparatus for cutting tobacco
353. J. H. Johnson, Lincoln's-inn-fields—Improvements in casting metals. (Communication from Jackson Brothers, Petin, Gaudet, and Co., Rivé de Gier, France)
354. J. N. V. Cadiat, Paris—The application of centrifugal force in purifying minerals, or any other similar hard substances, by washing
355. J. Skertchley, Culford-road, De Beauvoir-square—Improvements in, and in the manufacture of saggers
356. W. Greenslade, Bristol, and J. Wood, St. Pancras, Middlesex—Improvements in brushes, especially applicable to painters' brushes
357. J. Taylor, Upper-street, Islington, and E. Owen, Aberdeen-terrace, Blackheath—Improvements in the manufacture of yellow prussiate of potass
358. F. L. Bauwens, Ranelagh-road—An improved mode of treating and distilling fatty matters, and in the apparatus employed therein.
359. T. Brown and G. Parry, Ebbw Vale, Monmouth—Improvements in the manufacture of iron
360. R. A. Brooman, Fleet-street—An improved method of obtaining motive power (Communication from G. Russo)
361. R. A. Brooman, Fleet-street—Improvements in measuring the capacity and contents of casks and other similar vessels, and in instruments or apparatus employed therein. (Communication)
362. G. T. Bousfield, Sussex-place, Loughborough-road, Brixton—Improvements in lamps adapted for burning resin oil. (Communication from D. Fehrman and F. Benkler)
363. W. Hirst, Bath—Improvements in manufacturing felted fabrics
364. W. Wilkens, South-street, Finsbury—An improved cannon, which he calls a revolving battery. (Communication from E. Ames, Baltimore, U. S.)
365. P. M. Parsons, Duke-street, Adelphi—Improvements in the permanent way of railways

Dated February 9.

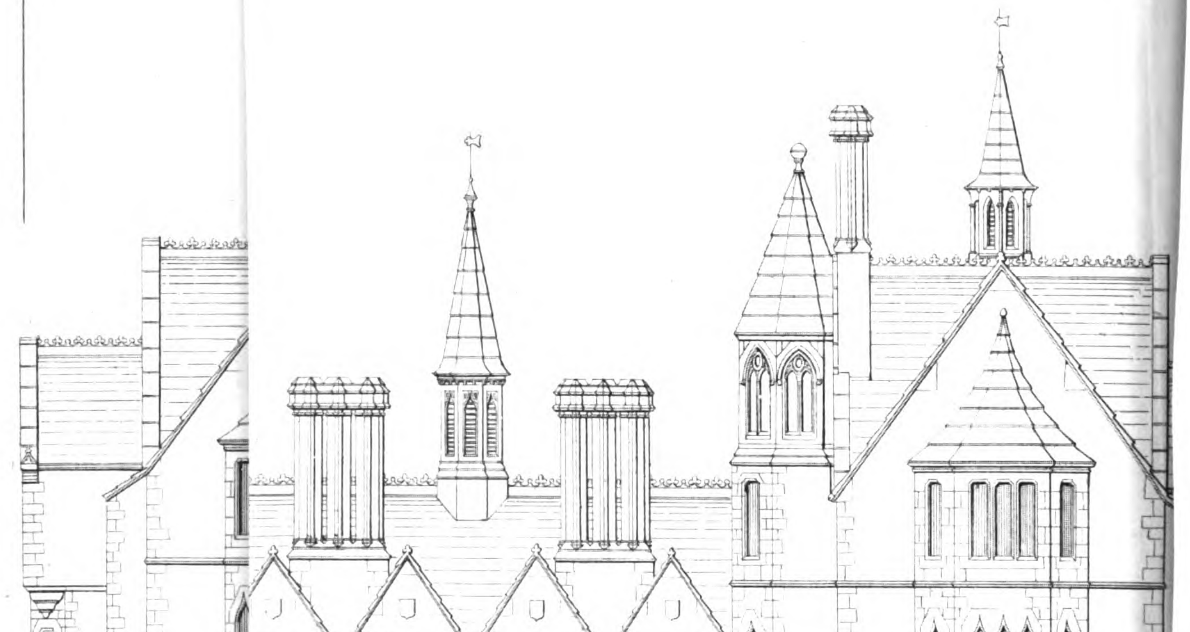
366. J. Murdoch, Staple Inn—An improvement in the process of treating the threads of floss silk, which is also applicable to the threads of other fibrous materials. (Communication from G. Armand, Lyons)
367 J. Taylor, Britannia Works, Birkenhead—Improvements in machinery for crushing various substances
368. H. Cartwright, Dean Broseley, Shropshire—Improvements in the application and mode of working eccentrics on steam engines
369. C. Turner, and L. Watermann, Liverpool—Improvements in or applicable to the class of hats made from straw, grass, palm leaf, or other like materials
370. L. Talabot, Chaussée d'Antin, Paris—Improvements in the manufacture of iron and steel
371. J. Fenn, Newgate-street—An improvement in oil-cans and other like vessels. (Communication)
372. D. Falconer, Causeyside, Paisley—Improvements in the mechanical arrangements for raising and forcing of water or other fluid, air, or gases
373. J. Harding, Leeds—Improvements in the treatment of metallic ores
374. T. J. Taylor, Seckforde-street, Clerkenwell—An improved construction of stereoscope
375. S. Groves, Judd-place East—Improvements in organs
376. H. Willis, Manchester-street, Gray's-inn-road, Improvements in organs

Dated February 10.

377. W. T. Walker, King-square, St. Lukes—Improvements in apparatus used in gas works for exhausting, forcing, transmitting, and regulating the flow of gas, and cleansing and warming gas apparatus
378. A. Stokes, Birmingham—New or improved machinery to be used in the manufacture of nails, pins, screws, and other similar articles
379. J. Bernard, Albany, Piccadilly—Improvements in the manufacture or production of boots and shoes, or coverings for the feet, and in the machinery or apparatus employed in such manufacture
380. D. B. Herts, Bunhill-row—Improvements in apparatus for stamping and embossing. (Communication)
381. B. W. Owrid, Dundalk—An improved method of connecting and disconnecting pipes or tubes
382. J. Graham and J. Shepherd, Burnley, and T. Whitaker, Acrington—Improvements in power looms for weaving
383. J. Morgan, Kidderminster—Improvements in the manufacture of steel and iron wire for umbrella and parasol frames
384. W. R. Hodges, Manchester—Improvements in the manufacture of an elastic material, and of its application to certain purposes
385. A. Chambers, Canterbury, and W. H. Champion, Lynsted, Kent—A mode of working railway breaks
386. G. Bedson, Manchester—Improvements in coating metal with metal and metallic compounds
387. A. F. W. Partz, New York, U.S.—An improved method of evaporating fluids, condensing and absorbing vapours, gases, and fumes, arresting and precipitating floculent, metallic, or other particles, and transferring heat from air or steam to fluids and pulverulent substances
388. T. F. Johnson and J. Williams, Leicester—Improvements in screw gill machinery for preparing wool and other fibrous materials
389. J. F. Watson, St. John's-square, Clerkenwell—Improvements in the construction of watches
390. J. Bridgwood, Burslem—Improvements in connecting pipes to the basins of water-closets and wash-hand basins, and also in the means of stopping the outlets of wash-hand basins
391. W. W. Pilcher, St. Margaret's-at-Cliffe, Dover—Improvements in straw shakers of thrashing machines
392. A. Royds and J. Kenyon, Lower-place, Rochdale—Improvements, or a certain improvement in machines for spinning or doubling, commonly known as throstles
393. R. A. Brooman, Fleet-street—An improvement in, or addition to, the locks of firearms. (Communication from J. B. Longa)
394. T. Howard, King and Queen Iron Works, Rotherhithe—Improvements in the construction of cranked shafts or axles
395. H. Heald and A. Heald, Sabden Whalley, Lancaster—Improvements in pickers and picker checks employed in weaving
396. H. T. Ropes and D. W. Thomas, Liverpool—Improvements in the application of filters to cocks, taps, or other valves used to draw off liquids. (Communication)

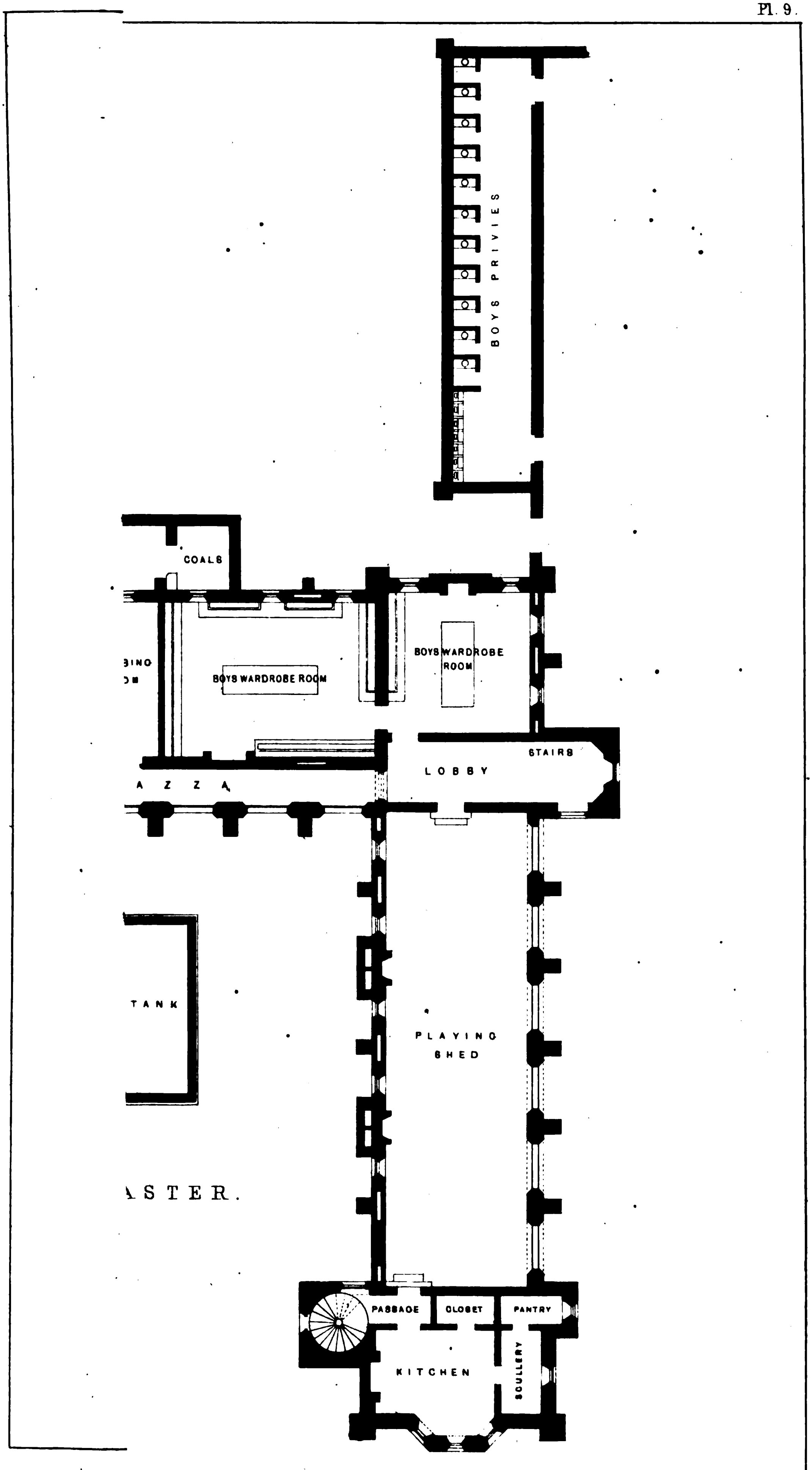
PATENTS APPLIED FOR WITH COMPLETE SPECIFICATION.

180. T. Kitelee, Everett-street, Brunswick-square—An improved combination of ingredients to be employed as a breakfast powder, or article of diet.—Jan. 21.



ASTER.

100 FEET


BOYS PRIVIES
COALS
BOYS WARDROBE ROOM
BOYS WARDROBE ROOM
STAIRS
LOBBY
AZZA
TANK
PLAYING SHED
ASTER.
PASSAGE
CLOSET
PANTRY
KITCHEN
SCULLERY

RIPLEY'S HOSPITAL, LANCASTER.

(*With an Engraving, Plate* VIII.)

This edifice is to be in the style of the 12th century, usually denominated the Early Pointed. The plan is somewhat in the form of the letter E, *i.e.* with a side and two wings, and fronts the north-west, the centre line of the building being through the centre of John o'Gaunt's Tower in the Castle,—the side between the wings being 195 feet in length, and is divided into three equal spaces by a bold projection in the centre which rises to the height of four stories (68 feet). The two side spaces rise to the height of three stories (50 feet). In the centre division of the side is the principal entrance, and stair-case leading to the committee room, upper hall, matron's room, waiting room,—and in the top story is the infirmary, nurses' room, &c. At the back are the kitchen offices, three stories high (45 feet). Over the infirmary, in the middle of the front projection, rises a clock tower 18 feet square, and 98 feet high, pierced with three tall lancet lights on each side. At the north-west angle of the tower is an octagonal turret, with spiral stair, surmounted with O. G. roof, gilded spear and vane. The broken line of this side of the building by the centre projection, the tower, and pointed gables and gablets, ventilating turrets in the side spaces, and the clustered chimneys, will produce a very picturesque effect.

The two side spaces and adjoining wings are respectively appropriated—the one to the boys and the other to the girls—having each their play rooms and grounds completely separated from each other by the centre projection and kitchen offices.

From the centre projection on each side to the wings extend arched or cloistered corridors, communicating with the wings and side divisions by broad stone stairs.

The wings on each side are 130 feet long, each four stories high (68 feet), and are terminated at the north-west extremities by houses, one for the schoolmaster on the boys' side, and the other for the schoolmistress on the girls' side. These have each a separate entrance and stair, and at the same time possess modes of access to the school rooms and dormitories in the wings.

The ground floor of the boys' side, between the school-master's house and stairs, is appropriated to a covered play room, open arched next the play ground; and from the wing to the centre projection are a large plunge bath, that can be heated in cold weather, a dressing room, and wardrobe room.

In the girls' side, on the same floor, are a wash-house, laundry, drying closet, wardrobe room, and play room. Over these apartments, between the centre projection and wings, on each side is a dining room, 65 feet long, 22 feet wide, and 14 ft. 6 in. high. A direct access to these dining rooms is obtained from the kitchen on the same floor by a wide passage on each side of a central open court, so that at meal times the food can be carried into each room, and the utensils removed, without interfering with any other part of the building. Over each of these rooms is a dormitory, intended to accomodate 50 children.

Over the play rooms in the wings, and on the same level as the dining rooms, is a school room, each 69 feet long, 24 feet wide, and 14 ft. 6 in. high. On the other side of the stairs, in each wing and at the ends of the dining room, is a lavatory, for washing either before or after meals.

Over the school rooms in the two wings, are two stories of dormitories, same size as the school rooms, each calculated to contain 50 children, making thereby for each division of the building accommodation for 150 boys and 150 girls, or 300 altogether. The stairs are so situated as to give the greatest facility of access to and from the dining-rooms, school-rooms, dormitories, and play grounds, and are with the corridors fire-proof.

Ample means for thorough ventilation throughout the whole building have been devised, and every other requirement for light, cleanliness, health, and comfort to the inmates has been most liberally provided.

The material chosen for the exterior of the building is the beautiful white sandstone from the adjacent quarries. The spaces between the hewn parts are to be filled in with inserted rubble, technically so termed, which harmonises well with the style adopted.

The architect for the building is Mr J. Cunningham, of Liverpool, and the contractor is Mr. Charles Blades, of Lancaster. The estimated cost is nearly 25,000*l.*

WOOLLAND, DORSETSHIRE.

A very handsome and successful church has lately been completed at the above place, from the design of Mr. Gilbert Scott. The spot is a most picturesque one, being situate in the Vale of Blackmore, close to one of the seats of the old Thornhill family. The property belongs at present to Montague Williams, Esq. A church existed here as early as A.D. 843, and was given by King Athelstan to the Abbey of Middletum or Milton Abbas. Mention of this church or chapel is made in the old "Doomsday" book.

The church of the middle ages was taken down and rebuilt in 1743, a little further west. The ancient church had certainly a nave, chancel, and aisle, and probably a tower. The one which succeeded was evidently a very inferior work; it consisted merely of nave and chancel, and had instead of a tower a small bell-turret of wood.

The church just finished partakes more of the original type; it consists of nave, chancel, south aisle, porch, and a remarkably fine stone bell-turret. The chancel is finished with an octangular end forming an apse, which is further distinguished in the shape of its roof. This part of the building is comparatively plain externally, and is lighted in the three faces of the apse by single-light windows only, which are, however, trefoiled in the heads. Besides these, the chancel has on the north side two two-light windows, and on the opposite side two others, which do not precisely correspond, owing to the necessary irregularity of the plan. All these windows are, internally, peculiarly rich, in arch mouldings especially, which spring from polished Purbeck marble shafts. The whole of the chancel is vaulted with chalk vaulting, on Bath-stone moulded ribs, having elaborate carved bosses at the intersections. These groin-ribs rise from red marble (Devonshire) columns, which pass down between the windows and in the angles, and have foliated caps of Bath stone. The floor is laid with Minton's tiles, having ornamental borders of other colours. The chancel arch is of two orders, the centre one being carried by marble columns of Derbyshire encrinitical marble, the two side ones by Purbeck marble polished shafts. The caps of all are fully carved. The steps both to and within the chancel are of polished Kenton stone. The fittings in the nave are low and open, but substantial looking. The seats themselves are broad, and the back slopes slightly; those in the aisle are moveable, but similar in design to the others. The ends are moulded, and the material throughout is wainscot. The flooring of the church generally is of Minton's tiles, disposed in red and black patterns. The pulpit is of Caen stone, octagonal in shape, entered by a passage in the wall behind: it has also a stone book-board, which is supported by foliage of the "French" mediæval character; down the angles of the pulpit and under the capping mould are carved rows of the ball-flower ornament, and the intermediate panels have circles containing delicately carved bosses of flowers in quatrefoils. Below the capping is carved a suitable inscription.

The south aisle is divided from the nave by two arches: the central pillar is a single one, of Derbyshire marble, and has a large capital carved with "stalk" foliage. The bell-turret is carried partly by the west wall of the church, and partly by an arch crossing near the west end, and arranged for the purpose; the space between the two being groined in stone. The composition of this end has, internally, an excellent effect, to which the proportions of the substantial-looking west window add not a little. The nave is lighted mainly by three-light windows, which are filled with ornamental glass by Wailes, of Newcastle. The aisle has, on the south side, a window, breaking, dormer-fashion, into the lean-to roof behind. The roofs of both nave and aisle are open, and plastered between the rafters. The original "Perpendicular" font is retained, but placed on a new plinth and steps. One old brass likewise is preserved and refixed (date 1616); as also some ancient classic monuments. The turret before referred to, rises externally square at first, but it is immediately converted into an octagon, having buttresses to fill out the sides which cross the angles. There is a single light into the bell floor on each of the cardinal faces, the jambs of which are boldly moulded and shafted. Above the cornice rises the lofty tapering spire, also of stone, ornamented at various stages of the height by bands of scale work. The whole is surmounted by a cross of wrought-iron, painted and gilt, bearing on its top a revival of the ancient crest peculiar to this church—a frog.

The general walling material is stone from the locality, viz.—Haselbury Briant, and Hamhill, with Caen or Bath stone for the delicate enrichments and carving. This latter, which is throughout excellent, was done by Mr. Farmer, of Westminster-road. The plans were carried out under contract, by Mr. A. H. Green, of Blandford, who has most creditably performed his task; nor must the unwearied labours of the clerk of the works, Mr. J. T. Irvine, be passed over unnoticed.

Altogether this church is, in its way, a gem of art, reflecting the highest praise on all concerned in its erection. In the churchyard is one of, probably, the largest yew-trees in England.

ACOUSTICS, IN RELATION TO THE FORMS AND MATERIALS OF BUILDINGS.

It appears to be an acknowledged fact, that it is impossible, when a building is in course of erection, to foresee whether the annoying effect of reverberation of sound will exist in it or not; and it seems to be almost as uncertain whether that defect can be remedied when it does exist. In the hope of drawing attention to the subject, with a view to present data for some practical inferences, we have collected such particulars as may be useful for the purpose, and the opinions of such scientific writers as have treated on the general question.

Sir John Herschel states that "the reflections of sound in small buildings are heard at the same time as the original sound; because as sound travels at the rate of about 1125 feet in a second of time, the echo cannot usually have so far to travel as to be heard separately." The time intervening between the primitive sound and its echo has sometimes been employed in determining the distance from the speaker to the reflecting object, allowing 571 feet for each intermediate second of time; but, like all methods depending more on individual judgment than mechanical measurement, this process must be liable to considerable irregularities. When several objects reflect sound, the number of echoes is greatly multiplied, not only from the primary echoes of each, but also from secondary and tertiary echoes, by second and third reflections of returning waves against the reverberatory obstacles. Each re-echo consists of only portions or *frustra* of the preceding; their intensities therefore diminish, and they gradually die away upon the ear, in the same manner that objects become obscure, and by degrees imperceptible, in consequence of the diminution of light when we look between two opposite and parallel plane mirrors.

As instances of the distance at which sounds can be perceived, take the following:—The watchword of the night, given by a sentinel to the patrol on the ramparts at New Gibraltar, has been heard distinctly, on a still, serene night, and the water being perfectly calm, at Old Gibraltar, a distance of about ten miles and a-half. The report of the guns at Edinburgh Castle is often distinguished twenty miles off, while the noise occasioned by the falls of Niagara is said to be sometimes heard at the distance of twenty miles. An effect of rapidly repeated echoes may be perceived in the prolonged tread and ringing sounds which we hear when walking in stillness through long galleries, cloisters, and other narrow passages with parallel sides, particularly when the air is confined; but hangings and carpetings, yielding to the influence of the sonorous waves, or stifling them by a multitude of interior reflections, together with open windows or much furniture, diminish these effects to a great degree.

"The most favourable position for the production of a distinct echo from plane surfaces is, when the auditor is placed between two such, exactly midway. In this position the sounds reverberated from both will reach him at the same instant, and reinforce each other. If nearer to one surface than another, the one will reach him sooner than the other, and the echo will be double and confused."* This, however, supposes the auditor to be so far from the reflecting surfaces as to prevent the echo from being heard at the same time as the original sound.

From these facts we may form some conjecture as to the cause of irregular echoes. If the regular echoes arise from the reflection of the sound so quickly as to be heard at the same time as the original sound, the irregular echoes would seem to be a result of the reflections having taken a longer course throughout the building; for, at the rate at which sound travels, it must be a very large building in which the *direct* reverberation from any part can strike the ear so as to be perceived after the original sound. In large buildings, such as cathedrals, the regular echo can be heard after the principal sound has ceased; "and it is owing to this that our cathedral service is read in a sustained uniform tone; and a good reader will time his syllables, if possible, so as to make one fall in with the echo of the last, which will thus be merged in the louder sound, and produce less confusion in his delivery."†

Among other impediments to good hearing may be mentioned deep recesses, open windows, hangings or carpeting, and a numerous audience in woollen clothing. These are to sound what black spaces in an apartment would be to light; they return back none, or next to none, of what falls on them. Their fault is, not so much that they reflect it irregularly, as that they do not reflect it at all. Yet there is no doubt that the advantage to be derived from echoes in strengthening the original sounds has been overrated. It is in reality most desirable that the reflections of sound shall take as short a course as possible, so that there may be no chance of an irregular echo. The Hall of the Representatives at Washington, U.S., appears to be very well adapted for the object. The outline of the plan is a semicircle of 96 feet chord, elongated in its diameter line by a parallelogram 72 feet long by 25 feet wide. The height to the top of the entablature blocking is 35 feet, and to the apex of the domed ceiling 57 feet. The crown of this dome is pierced by a circular aperture, terminating in a lantern, which admits an abundance of light, serving at the same time to ventilate the room, while not materially interfering with the currents of sound. Some alterations which have been made since the building was first erected have considerably improved its general adaptation to the purposes for which it was designed. The deciding on a semicircular form in the plan of this hall, by the architect, resulted from a conviction of its being the best suited for its purposes. Before the alterations were made, the members spoke *from* the circle, and consequently *to* the diameter or straight line; hence an indistinctness of voice, even under the most improved form, but more especially when subject to the fretted surface which the room previously possessed. On similar principles, the Hall of the French Chamber of Deputies has been constructed; this, too, is surmounted by a very flat dome—a plan unanimously recommended by a committee composed of the most celebrated architects of France. It is said to be one of the finest rooms, for speaking and hearing, now existing. The walls are perfectly plain, and the tribune, from whence the members address the chamber, is along the line of the diameter, consequently *to* the circle, and thus each auditor gains the full force of the words that are uttered. The ancient basilica form of plan has its admirers, but more on the score of admitting of convenient arrangements than on acoustic principles. The churches built by Sir Christopher Wren are generally so planned. St. James's, Westminster, pleased him better than any of his other churches, and he has carefully described the scheme on which its proportions were set out. The breadth is half the sum of its height and length, its height half its length, and its breadth the sesquialtera of its height; the numbers are 84 feet, 63 feet, and 42 feet respectively. The church is divided transversely into three unequal parts, by a range of six columns each side of the nave, forming aisles which are each one-fifth of the whole breadth; the remaining three-fifths being given to the part of the nave. The roof is carried upon these columns. Sir Christopher adds: "I can hardly think it possible to make a single room so capacious, with pews and galleries, as to hold above 2000 persons, and all to hear the service, and both to hear distinctly and to see the preacher." Concerning the place for a pulpit he says,—that "a moderate voice may be heard 50 feet distant from the preacher; 30 feet on each side of him, and 20 feet behind him"—provided the pronunciation be distinct and even. The experiments tried by Mr. Wyatt proved that the reach of the voice, when moderately exerted, was in the proportion of about two-ninths further in a direct front line than laterally; and that being distinctly audible on each side of the speaker, at a distance of 75 feet, it will be as plainly heard at a distance of 92 feet in front of him, declining in power behind him so as not to be heard at much more than 30 feet.

Among the important buildings recently erected in this country, in which we may suppose that the science of acoustics was duly considered in their construction, may be mentioned the Town Halls at Birmingham and Liverpool; Exeter Hall, London (especially since its ceiling was altered by Mr. Daukes); the Free Trade Hall at Manchester; St. Martin's Hall, London; and the new Music Halls at Birmingham and Bradford. The St. James's Hall, Piccadilly, now in course of erection under Mr. Owen Jones, and of which an interior view appeared in the late Architectural

* Herschel, 'Treatise on Sound.' † Ibid.

Exhibition, is to be of an oblong unbroken form, with a semicircular ceiling highly enriched, but with surface ornament only. How far this arrangement will be affected by reverberations or echoes will be tested in a short period, as the building is now approaching completion.

It is by large and smooth surfaces of plaster and wood, that irregular echoes are most likely to be produced; for as sound must impinge upon them at every conceivable angle, whether proceeding direct, or reflected from other parts of the building, so it must be again reflected at the opposite angle to the perpendicular, and conveyed across the building. Such large and smooth surfaces create no inconvenience of this kind in the rooms of dwelling houses, but in buildings containing one vast area, the sound has much more space to travel about. Again, roughened surfaces, if hard, reflect the sound in every direction; if soft, they do the same, but in a much smaller degree. These, therefore, present the means of shortening the course of sounds by reflecting them in all directions, instead of immediately across to some other part of a building, where they may be turned into a new course. Clothes of any kind, especially woollen ones, as has been observed, are extremely prejudicial, and the same remark applies to the drapery and furniture of a public building.

Paint has been thought unfavourable to sound, from the effects it produces upon musical instruments, which are frequently spoiled by its application.

Stone is sonorous, and produces a harsh, disagreeable tone, unfavourable to the transmission of sound; and *brick* possesses similar properties when used by itself.

Wood is well known to be both sonorous and vibrative. Of all materials it produces the most agreeable and melodious tone—a quality owing, principally, to its elasticity. For this reason it is suitable for lining the walls of buildings used for the purposes of public speaking. It will be found not to absorb so much as some materials, or to conduct so much as others, while the little resonance it occasions will be found rather agreeable than injurious.

Other substances might be enumerated, but we have preferred confining ourselves to those most in common use, so as to render our observations as suggestive and practical as possible. The subject is one as yet comparatively unexplored.

IMPROVED PILE-DRIVING MACHINE.

A paper was lately read at the Institution of Mechanical Engineers, on an Improved Pile-driving Machine, the joint invention of Mr. Michael Scott, of London, and Mr. Andrew Robertson, of Blyth. The paper considered theoretically the relative advantage of a great number of comparatively light blows or of a few severe blows for driving piles, and it was found to be desirable to have as heavy a ram as possible, with the greatest available height of fall that was compatible with the strength of the piles. The improved pile-driving machine is constructed on this principle, the weight of the ram being a ton and a half, with a fall increasing as the pile is driven, the fall being a small amount at the commencement, whilst at the later blows it amounts to twelve or fourteen feet. Two rams are raised by a portable engine between guides, which are readily adjusted to any required inclination; the engine, together with the guides, is carried on a platform high enough to be always above high water; the platform rests on a lower framework, running on a temporary railway laid on the ground for changing the position of the machine. The winding apparatus for raising the rams is so arranged that the engine raises them alternately, the working being changed by a self-acting apparatus, without either stopping or reversing the engine. The engine can accordingly be worked continuously, and an important saving of time is thereby effected in driving the piles. In consequence of the diminished number of blows required for driving each pile, on account of the greater force of each blow, the heads of the piles are not found to be at all injured in driving.

The machine is being employed at the present time to drive the piles for the construction of a wharf or a quay on the river Blyth, in Northumberland, above the entrance to the proposed new docks at the mouth of that river. The ground is principally sand, and the main piles are driven to a depth of 14½ feet into the ground; the same engine also drives an inner row of stay piles without change of position, and the machine has been found to perform the work with rapidity and precision.

NEW STREETS PROPOSED BY THE METROPOLITAN BOARD OF WORKS.

At a recent meeting of the Royal Institute of British Architects, Mr. Donaldson gave a description of the streets proposed to be formed by the Metropolitan Board of Works. He observed that as the attention of Parliament would soon be called to these projects, he thought it might be interesting to the members to be made acquainted with them, and he was happy to be able to submit the engraved plans, which had some time since been kindly presented to the Institute by Mr. Marrable. The first and shortest of the new lines was the one on the Middlesex side of the Thames, its purpose being to connect King-street, Covent-garden, with Leicester-square. It had been long felt, that there was not sufficient access to Covent-garden-market and Drury-lane Theatre from the West-end, and that much confusion was produced by the great traffic in that neighbourhood, especially during the business of the market in the morning, and at night, when the theatres were open; it was also considered very necessary to form the communication so as to continue Cranbourn-street to the Strand, and also to relieve St. Martin's-lane of the traffic between Tottenham-court-road and the northern parts of London with the Strand; and accordingly it had been proposed some years ago by Mr. Pennethorne, under the direction of the Commission for Metropolis Improvements, that a new street should be made in an oblique direction from the east-end of Cranbourn-street, at its juncture with Long-acre and St. Martin's-lane, to the west end of King-street;—a line which appeared the more eligible now that the east end of Leicester-square had been opened by the enlargement of Cranbourn-street. On the other hand, it had been suggested, that the line of St. Martin's-passage and New-street would be more desirable, and more direct; but by adopting that line, it would interfere with a much longer line of house property, and involve the necessity of widening an established thoroughfare with a particular class of business (which would incur an enormous expense), and would not provide for the north traffic; and the plan of Mr. Pennethorne, although it was a more abrupt detour than could be desired, would be generally admitted to meet, to a great degree, the difficulties of the case. The Duke of Bedford had offered to contribute some 15,000*l.* towards it; and the plan was sanctioned by the government commissioners. But when the new Metropolitan Bill was passed, and the Central Board was organised, all former proceedings were superseded, and Mr. Marrable was ordered to make a fresh survey and estimate. Mr. Marrable, however, after due consideration, arrived at the same conclusion as Mr. Pennethorne, with regard to the route; and his estimate of the cost of the new street was, for purchase of property and cost of sewer 91,820*l.*, to be realised by sale of ground rents and old materials 46,800*l.*, leaving the actual cost 45,020*l.*

Mr. Donaldson next adverted to the importance of a direct communication from the western parts of London to the Borough, the railway termini at London-bridge, &c., in order to avoid the difficulties of the route through the city. He called attention to the fact, that the existing line on the other side of the river of the York-road and Stamford-street constituted the greater portion of the communication now projected by the Metropolitan Board; and that a continuation of the latter street eastwards to the Borough would complete the line. One project to effect this latter section between Blackfriars and London bridges was along the south bank of the river; but any line of this kind must pass either under or over Southwark-bridge-road, which would be very objectionable; and, in addition, St. Saviour's Church offers a great obstacle; for the church itself would be more lost to sight than at present, or must be entirely pulled down. But a proposed line more southward would also interfere directly with the Borough-market, Messrs. Barclay's premises, and other property, which no man in his senses would think of touching for such a purpose. Mr. Donaldson next described the line proposed by the Board of Works, which commenced at a point north of the Town Hall, Southwark, and terminated opposite the east end of Stamford-street. This line was necessarily curved, in order to avoid, whilst closely infringing upon, the College Alms Houses, Messrs. Barclays' premises, Messrs. Potts' Vinegar Works, Hopton's Almshouses, the premises and market of the Hop Planters' Company, Messrs. Easton and Amos' Foundry, &c. The estimates for this line were, for purchase of property and cost of sewer 519,424*l.*, to be realised by sale of ground rent, property re-sold, and old materials, 198,753*l.*, leaving the nett cost 320,671*l.* But towards this cost there was already about 90,000*l.* in the hands of the government.

Contrasted with the above plan, Mr. Donaldson described the route laid down by Mr. Pennethorne in 1853, being a straight line from a point near the Lambeth side of Hungerford-bridge, which it is proposed to widen to a carriage way, passing close to the north side of Surrey Chapel, direct to the Town Hall in the Borough. This line it was also proposed to continue eastwards to Bermondsey, and westwards by a curved line to the Surrey foot of Westminster-bridge. The main portion of the line passed through a very inferior description of property,—the estimate made by Mr. Marrable being, for purchase of property, goodwill, and cost of sewer, 895,104*l.*, to be realised by property sold, ground rents, and old materials, 631,794*l.*, leaving the actual cost 263,310*l.* Mr. Donaldson briefly referred to another admirable project by Mr. Pennethorne, in 1844, for a line direct from Westminster-bridge to St. George's Church in the Borough, on through Bermondsey, which would then be opened up to general traffic; as also to another scheme for widening the existing line of the New Cut and the streets beyond Surrey Chapel westward to the Borough, as a cheap method of meeting the required object. He concluded by impressing upon the meeting the superiority of Mr Pennethorne's plan over that about to be submitted to Parliament, as being shorter, more economical, and as bringing into more direct play and communication Westminster, Hungerford, Waterloo, Blackfriars, and London bridges.

REVIEWS.

Dwellings of the Labouring Classes in the Metropolis. By Major-General G. B. TREMENHEERE, late Superintending Engineer of the Punjaub, F.G.S. London: Knight and Co. 1856.

Third Annual Report of the Directors of the Association for Promoting Improvement in the Dwellings and Domestic Condition of Agricultural Labourers in Scotland. And Supplementary Report, with Two Designs for Cottages, by WILLIAM FOWLER, Architect to the Association. Edinburgh: Blackwood and Sons. 1857.

There is no feature in the great sanitary scheme now in operation more important in its bearings than the care bestowed on the design and arrangement of the dwellings for the humbler classes—a measure which all grades of the community are interested in promoting; but which tends to the social and moral benefit of those more immediately under its influence, beyond, perhaps, any other means that could be devised. It has been well propounded, that "the physical sufferings of the poor are not their chief evils." The great calamity of the poor is not their poverty, but the tendency of their privations and of their social rank to degradation of mind. Society is not only disfigured but endangered by the poverty, ignorance, and vice of a multitude of its members; and its security and happiness demand nothing so imperiously as that this wretched mass should be enlightened and elevated. To quote the powerful words of Mr. Charles Dickens—"O! for a good spirit—who would take the housetops off with a more potent and benignant hand than the lame demon in the tale, and show a Christian people what dark shapes issue from amidst their homes, to swell the retinue of the destroying angel as he moves forth among them;—for only one night's view of the pale phantom rising from the scene of our too long neglect, and from the thick and sullen air, where vice and fever propagate together, raining the tremendous social retributions which are ever pouring down, and ever coming thicker! Bright and blest the morning that should rise on such a night; for men, delayed no more by stumbling blocks of their own making, which are but specks of dust upon the path between them and eternity, would apply themselves like creatures of one common origin, owning one duty to the Father of one family, and tending to one common end—to make the world a better place."

The attention of landed proprietors has been long called to the necessity for the improvement of labourers' dwellings, and thus not unfrequently has the aspect of a village been thoroughly metamorphosed by the well directed efforts of a single landlord, The Duke of Bedford, the Earl of Chichester, the Lucys' of Charlecote, at once spring to mind as notable examples; and so far back as a century ago, the benevolent John Howard converted the village of Cardington, near Bedford, where he resided, from one of the most miserable spots in the kingdom, into a really healthy, comfortable place, whose inhabitants became proportionately thriving and contented. He resolved to begin his work at the true starting point, by first improving their physical condition, supplying them with the means of comfort, thus attaching them to their own firesides, and fostering and developing in them a relish for simple domestic enjoyments. It is not enough to build cottages as we would build barns or stables, though how few people do as much for the cottage as they do for the farmyard. It is no use deceiving ourselves in this matter. If proprietors do not take at least an equal amount of interest in their cottages and their labourers as they do in their barns and stalls, their sheep and their oxen, it may reasonably be expected that the same danger will overtake them as has already blasted some of the fairest countries in Europe. The time will assuredly come —it may not be in this generation—but come it will, when those rich men only will be safe who have conciliated the personal affection of their dependants and neighbouring poor. Never was a more conservative truth enunciated than this (though of course the manner and time of its enunciation may vary its propriety), that *property has its duties as well as its rights and privileges;* and there can scarcely be one more incumbent or more grateful than that of providing decent dwellings for the poor who have settled on an estate. It is in this light that the matter should be viewed, rather than in a monetary point of view, since good cottage-building must not be expected to yield, in direct payment, even a moderate return for the outlay which a capitalist might, in other cases, expect. The landed proprietor must be content to look for his return from improved cottages just as he does from improved farm-buildings or farm-houses, viz.—in the general and permanent amelioration of his estate thereby. The fact is, that it is this very non-remuneration of cottage-building that constitutes the landed proprietor's greatest safeguard. If good cottages could really be built up at a paying price, every parish in the country that had an acre of ground, independent of the great proprietor, would soon swarm with them. Again, under such circumstances, there is a natural constructive faculty in man which leads everyone to build that can afford it, besides a love of the independence of having a house of one's own, and the privileges of a county vote; so that there would be always a herd of small builders ready to invest their capital, if they have it, if not, their labour, in this most precarious, but tempting, kind of property.

Of the two public societies whose publications are now before us, one devotes its energies entirely to the requirements of a body of men included in the above remarks—the agricultural labourer, and presents us with its third annual Report of its proceedings. Their mode of operation is essentially a *practical* one, it being their plan, from time to time to issue diagrams, with such instructions and specifications as may be needed in illustration, and receiving in return the opinions of parties who have carried them out, which are again printed and circulated on the next occasion. Thus, appended to this report is an extensive correspondence from which much serviceable information may be gathered, and it is stated that "there is every reason to believe, from a pretty extensive sale, in England as well as Scotland, that the sheet plans, sent out with measurements last year, have been thought both useful and instructive," and the present pamphlet contains additional plans, and a table of instructions, on points of importance to be attended to in regard to the different portions of work involved in cottage erections.

In the plans published by this Association one general principle has been adhered to—viz: that "three separate apartments are the minimum accomodation for a labourer's family."

"Some of these plans are arranged to have no beds in the kitchen, and none of them have more than one (excepting one of the plans in this Report, in which there is room for a child's crib in addition to the parents' bed); in some there is a distinct and separate entrance to each apartment, and in others one or more of the bed-closets are made to enter from the kitchen or room; but in all of them there is accommodation for three beds in separate apartments.

"It will also be observed that there are no back-doors in any of the Society's plans. There is a very general complaint that back-doors make a cold house, and this is not much to be wondered at, when the small area of the house is taken into consideration. When cottages are built in pairs (and they are much better in that way than when a large number are placed together), there is no inconvenience in going to the back ground by the end of the house: a sink in the scullery also does very much away with the necessity for a back-door."

Among other points of comfort enumerated is the method of arranging the fireplace, &c.

"The fire-clay hearth is much prized by the cottagers, as it retains the heat collected from the fire for a great length of time. The hollow tiles have been most successful in preventing damp in new cottages, as well as in rendering old damp ones dry and comfortable. The fire-clay grate for small bed-rooms, and the fire-clay (glazed) scullery-sink, have been used during the past season in different parts of the country with success. The latter is put up without any plumber-work,—a point of some importance in buildings, removed, as they often are, many miles from any plumber. The former requires no stone jambs, and will be found a saving of expense in those parts of the country where freestone is scarce."

The construction of cheap and durable flint walls is thus described :—

"Flint walls are formed between two planks or frames, the lime being poured amongst the flints in a liquid state. In some cases the largest flints are selected, two courses laid with them—one outside, the other inside of the wall—and the centre filled up with smaller flints and liquid mortar: the lime should be mixed with sharp sand and clean gravel. The corners are formed of brick, and longitudinal bands of brick are also introduced from 2 feet to 2 ft. 6 in. apart; these bands are formed of two courses of bricks, one header and the other stretcher. Where bricks cannot be had, flat bedded stones may be used for these bands."

Major Tremenheere's essay is a condensation of statistics, and goes to show that under judicious management, schemes for improving the dwellings of the labouring classes have not only proved self-supporting, but have provided besides a fair rate of profit for the capital embarked, and the subject is considered on purely *commercial* grounds, exhibiting the results of calculations and enquiries on this interesting point. For this purpose, reference is made to the "Society for Improving the Condition of the Labouring Classes," which has 41,000*l.* employed in buildings, of which one half or more consists of funds borrowed at the current rate of interest of the day, ranging from 3 to 4½ per cent. The operations of the Metropolitan Association are also analysed, as exhibiting the capital of the Society (84,054*l.*) distributed among the four different ways in which it is employed. These items and figures form an interesting page. In the extended remarks, allusion is made to the model lodging-houses in George-street, Portpool-lane, Charles-street, Albert-street, and Soho Chambers, the total capital of which amounts to 34,744*l.*; and the average gross rent per annum for 3 years, to 3409*l.* 18*s.* 4*d.* The comparative remuneration among these appears to be subject to much fluctuation, arising partly from a disadvantageous locality, and partly from a too extensive mass of building, for when so many individuals come together, annoyances will arise, and the chances of disagreements are proportionally increased.

The author advocates the appropriation of the site of Smithfield to the erection of lodging-houses, adding that it is near the centre of the metropolis, and that in the parish of Clerkenwell, close by, there were, by the last census, 64,705 persons, the great majority of whom were working people with families."

"Not far from Smithfield is the General Post-office, employing several hundred men. The services of these men are sometimes required at short notice, and it would be convenient if they lived in a locality from which they could be readily summoned. If model lodging-houses were erected in that neighbourhood, the Post-office servants would probably be attracted to them in large numbers; for it may be asserted without fear of contradiction, that whether as single men or with families, they could not be so well accommodated, or on terms so moderate, in any other lodging-house whatever."

The rents in the model houses described are collected weekly without difficulty; arrears occasionally occur, but defalcations, except for small amounts, scarcely ever.

"In one case, the actual losses in one year were 5*l.*, out of a total rental of 1200*l.*, which is scarcely ½ per cent. A tenant is very rarely ejected for non-payment. The Societies reserve the right of doing so for riotous conduct, or the habitual use of bad language, if persisted in to the annoyance of other lodgers. These facts augur well for the success of the model lodging-house system.

"The experiment, so far as the people are concerned, has been entirely successful, and it is believed that, for the future, it will be so also to the capitalist, if proper regard be paid to the experience of the past. If a suggestion might be ventured upon to the Associations that have been the pioneers in this good cause, it is, that all the usual means should be resorted to for attracting the employment of capital to fresh undertakings under their management; and as this can never take place without the ordinary inducement, it might be worth their consideration, whether the issue of preference shares, to which certain definite rates of interest could be attached, would not place them in a position to extend their operations considerably, and, in the end, to make the whole amply remunerative.

"The limit of 5 per cent. profits should also be removed, for it will be much more *true benevolence* to extend the advantages of healthy homes to thousands, than that the over-scrupulous should refuse to receive more than a limited return for money which can only provide a few hundreds with this blessing. The available capital must be increased, or the whole thing will stagnate to an indefinite period.

"The sanitary effects which have resulted from improved dwellings for the labouring classes are such as might reasonably have been expected. If you take men, women, and children, from a noxious atmosphere, from crowded unventilated rooms, and the depressing influence of filth, and place them under conditions entirely opposite, improved health and a lower rate of mortality will follow, as effect from cause. It is accordingly found that the inhabitants of the new and altered lodging-houses have been subject to a mortality in the proportion of only one-half of that which is known to occur to the rest of the population of London. … ..Turning to the moral results which changes of this nature in the dwellings of the people are calculated to produce, there is a wide field for thought. In the train of cleanliness, decency, and domestic comforts, how many good influences may follow and take possession of the working man? Raised first in his own esteem, he will not only himself become a better man, but will seek to educate and advance his children in the social scale, till possibly 'one and all' become amenable to feelings of a higher and more enduring interest."

Examples of Building Construction; being a Series of Working Drawings to a large scale, Selected from the Works of Eminent Architects. By Henry Laxton. Volume for 1857. London: Published by the Author.

Many excellent works have been published on architecture, but most of them are far too expensive for the limited means of pupils and workmen. Too artistic, picturesque, and minute, they may please the eye, diffuse a taste, but for all practical purposes are useless. The work before us is of a different character; it is entirely practical,—Plates taken from the actual working drawings of well-known architects, to a scale hitherto unknown, many of the drawings being made to the real size, and others in proportion to the size of the work, forming, as its title-page informs us, "an *aide-memoire* for the professional man and the operative."

The volume before us contains 80 Imperial Plates, each of which possesses its special interest, and it is published at such a low price, viz.—2*s.* 6*d.* per month, for four large plates—that it is brought within the compass of any saving workman. Among the general contents there are casement and other windows, bay windows, dormer windows, entrance and inner doors, cornices, staircases, roofs, skylights, gates, towers, columns, balustrades, pulpits, screens—and these by such eminent men as Sir Charles Barry, Sir Robert Smirke, Messrs. Pennethorne, Shaw, Knowles, Gwilt, Somers Clarke, Colling, Abraham, Billing, Cubitt, &c.

The first plate consists of a casement window and boxing shutters, drawn to the real size, from those constructed at the workshops of the celebrated firm of Cubitt and Co.; every detail is so clearly shown, that the merest tyro can understand them. Another excellent example of a casement window (Plates 7 and 8), with internal and external dressings, is taken from Sir Charles Barry, and executed at Walton House. The beautiful proportion and details of this window may serve as a model to the speculative builder, who is often much in want of such a subject. Another window, 33 (not a casement) is of a different character, and is selected from one by Mr. Shaw, at Cowbridge. The architraves are bold and effective, and have the character of former days, when a more telling and simple style was in vogue. The second-floor windows of that cleverly-designed building at the corner of Chancery-lane and Fleet-street, by Mr. Knowles, exhibit some excellent and novel details that deserve attentive study. There is no building in London that has taken hold of the popular taste so much as this design. The novel treatment of the shop-front; the several details of construction; the economical use of wood for the ornamental tracery; the iron columns to give lightness, and bold masonry solidity, are all well studied, and show a master-hand in construction. The new windows (55 and 56) of the Chapel at Hooton Hall, Cheshire, by Mr. J. K. Colling, are beautiful examples of a highly ornamental character, and exhibit the taste and judgment of this eminent and truly useful member of the profession, whose 'Details of Gothic Architecture' have established him a fame not easily effaced. Of bow and bay windows there are several examples: one at Furze Hill

Lodge (64), by Mr. Young, of irregular octagon plan, shows much ingenuity in packing the weights and shutters. Another bow window, from a villa of red and white brick, by Mr. J. Billing, is full of useful detail, every moulding being given to a large scale. A bow window (Plate 46), from "The Cedars" at Putney (G. Morgan, architect), will be found very useful for that form of bow, the plan being semicircular; the boxing-in of the shutters has been done with much thought. In Sir Charles Barry's celebrated work, the Reform Clubhouse, the outer and inner doors of the principal entrance are excellent studies, every detail given to the real size. The inner doors are folding and made to swing; they are of Honduras mahogany, veneered with best Spanish, the upper panels glazed with plate-glass. The outer doors are of deal, also folding, with bold bolection mouldings, and prepared to set back when open, and form the sides of the lobby. The enriched doorway (Plates 42 and 43) to Messrs. Munt and Brown's warehouse in Wood-street, by Mr. Somers Clarke, is a specimen worthy imitation. The doors are suspended and run into spaces left for them in the walls; they are circular-headed and of bold design. The spandrels to the external stone dressings of the circular-head are filled in with rich foliage, quarter-columns are placed on the sides of the architraves, and an enriched Doric cornice gives it altogether an imposing character. Details are also given of the loggia (Plate 41) with ornamental ceiling, the inner swing doors, and some of the internal fittings. The folding-doors to the Assembly Room, Ashton Town Hall (Plate 45), by Mr. Young, are bold and effective. The external face has a circular-head and a shell-formed panel over the door, surrounded by an architrave, and supported by angle pilasters. On each side are two enriched trusses, fixed on plain outer pilasters, and surmounted by a simple cornice. The internal faces of the doors have plain architrave dressings, with consoles and dentil cornice. The doorway to the Tower at Richmond, by Mr. H. Laxton, contains a pair of bolection moulded folding-doors, with glass fan over; the recessed moulded architraves give depth and boldness to the design, which is needed on account of the limited width of the tower. On each side of the door is a paneled pilaster, supporting a massive console vermiculated on the sides, which supports a small balustraded balcony to the window over. Cornices, both external and internal, engross a considerable number of the plates, and are excellent examples. The cornice at Munt and Brown's warehouse consists of enriched projecting mouldings, supported by a series of moulded trusses; between the trusses are panel-formed windows, with broken semicircular ends, which alternate with blank panels throughout the cornice; this is finished with a neck moulding that forms a continuous sill. Plate 67 represents the bold dentil and block-cornice, surmounted by a balustrade, at Smith and Son's premises, corner of Arundel-street. Plate 76 contains the main bracketted cornice of Bridge-terrace, Richmond, and an enriched hall ceiling in the tower. Plate 48 has the principal cornice and attic story of "The Cedars," Putney; and Plate 79 shows the eaves cornice of the red and white brick villa at Tunbridge Wells, wherein the gutter is cut out of the solid stone and cased with cement.

Of roofs there are several excellent specimens, the foremost of which we may consider that of Covent-garden Theatre (Plate 24), on account of its having been destroyed since this drawing was completed. The design is by Sir Robert Smirke, and is one of the best examples of roofs of large span, its bearing being 82 feet between the walls, and having formed within it large rooms that were used for workshops, which are securely suspended by double king and queen posts. The dimensions of the several timbers were taken from actual measurement a short time previous to the fire, expressly for this work. Plate 51 contains the drawing of a roof at Bridge-terrace, Richmond, wherein the rooms of the attic story are formed within it and over the tie-beams, and the eaves-gutter is constructed in brick and tiles, and cased with Portland cement. Plate 3 has the roof of Exeter Hall (before the alteration), 76 feet span, and the roof of Whitehall Chapel, 54 feet span. The roof of Dr. Fletcher's Chapel (Plate 39) is an example of a very flat roof for so large a span as 73 ft. 6 in.; it is strengthened by an arch formed of three thicknesses of 3-inch planks alternately bolted together to break joint, and stiffened by cross braces between the trusses. Plate 15 shows the roof over the Lambeth Baths and Wash-houses, on Ashpitel and Whichcord's latticed principle; the span is 58 ft. 6 in.. The timbers are light, but numerous, having six queens with cross trusses between each pair to stiffen them. The roof to Farringdon Hall (Plate 70) has a queen-post truss with open timbers; square panels are formed between the collars, and horizontal lights of an octagon form are introduced in the centre of the panel. These are lighted by skylights, parallel to the roof, and fixed over them. The roof to the new Chapel (late Diorama) in the Regent's-park is a study of construction, overcoming a difficulty where the supports of one end of the trusses have been removed. New strong queen-post trusses have been fixed close alongside the old king-truss, one on each side of the full length of the bearing, and the ends of all three trusses are hung up by cross-heads, fixed over an iron boxed girder, 84 feet long. Plate 27 is a hammer-beam roof of Charlton new Church, by Mr. Gwilt; and Plate 63 shows three roofs from Westleigh Church, Lancashire.

The Iron Shop Fronts (Plates 21, 22, 23, 28), erected in front of some houses at Maidstone, are of much interest, as introducing the use of iron to the ornamentation of the outside of buildings. The style is peculiar, somewhat oriental; columns and entablatures, full of enrichments, cover the surface from ground almost to roof, and much ingenuity has been displayed in securing the several parts together. Plate 28 exhibits a system of lighting and ventilation, by Mr. Whichcord, which is effected upon a good principle, the noxious vapours being carried off through tubes in the ceiling. The construction of a "sun-light burner," with the ventilating apparatus over it, is also useful, carried out on the same principle.

The simple, yet effective, screen and staircase by Mr. Thomas, the sculptor, at the Regent's Park Chapel, of which there are several plates, and the campanile lately erected by Mr. Henry Laxton, near the bridge at Richmond, of which details are given, are commendable. Plate 20 is devoted to the timber scaffolding used by Grissell and Peto in erecting the Nelson Monument: it is composed of whole and half timbers, of simple but strong construction, and answered its purpose admirably. The pulpit (Plate 11) of Mr. Arnold is given, with all its minute mouldings and enrichments; also a reading-desk and seat, well designed and worthy of imitation. The white and red brick villa erected for Mr. Reeves, at Tunbridge Wells, from the design of Mr. S. Billing, occupies many of the plates, and will be found useful to the pupil studying villa architecture. There are two excellent examples of lantern lights and skylights; the first (Plate 13) by Mr. Pennethorne, erected over the Museum of Geology, Jermyn-street, and the skylight (31) over the staircase of one of the mansions at Albert Gate, by the late Thomas Cubitt.

The several plates have been executed on zinc, with much care, by Mr. J. R. Jobbins, and have been selected and carefully arranged by Mr. H. Laxton, from drawings liberally furnished by many of our leading architects, who have generously aided the author, and enabled him to carry out the experiment of forming a text-book which shall contain a register of some of the best works of the present period. The work is well got up, has an artistically-designed frontispiece, the plates are on a strong paper, and the whole neatly bound, in two sizes—the real size and half size—the latter having the plates once folded, making the volume of more convenient size.

PROFESSOR FARADAY'S VIEWS RESPECTING THE CONSERVATION OF FORCE.

Professor Faraday has for some time past been engaged in investigating the nature and actions of forces, and at the Royal Institution, on the 27th February, he stated the results of his investigations to an overflowing audience. Prince Albert being in the chair. The title given to the paper he read on that occasion was, "On the Conservation of Force," the main point to which all his observations tended being that force is indestructible, and that, like matter, it can be neither created nor destroyed. This is not indeed, a new discovery, if discovery it be, for similar notions of the indestructibility of force have been previously entertained; but this is the first time that it has been propounded as a scientific truth, supported by well-considered inductions from experimental investigations. We will on the present occasion principally confine ourselves to Professor Faraday's exposition of the principle of the conservation of force, and shall reserve our remarks on the subject to a future opportunity; merely observing at present, that if the principle be admitted as an established scientific fact, it will have an universal application to all branches of philosophy, it will bring metaphysics and physical science into close relationship, and will open extensive fields of enquiry to be worked by the aid of this new light.

Professor Faraday commenced by showing that the force of a blow is continued after the effects it produces have apparently ended. Thus, for example, when a piece of lead is struck with a hammer, the metal is flattened,—and that seems to be all the result. But in producing that effect, the blow also generates heat; and to exemplify that more clearly, Professor Faraday applied the lead to a piece of phosphorus, which was ignited by the heat thus produced. Now, as regards heat, the principle of conservation has been well established; for it is admitted that heat is never lost nor destroyed, but is diffused or absorbed, to be again made manifest to the senses when another exciting cause operates. The intimate connection, if not the identity, of heat and mechanical force has been generally admitted, and it is a prevailing opinion that every exertion of mechanical power excites its equivalent of heat, so that if the heat produced be measured it will indicate the amount of mechanical power exerted. If, therefore, the identity of heat and of mechanical force be admitted, and also the indestructibility of heat, the principle of conservation of force, so far as regards mechanical force, would be established. Again, as all forces are supposed to be merely modifications of one and the same, the admission of the indestructibility of heat appears to involve the principle of the conservation of all forces, which it was Professor Faraday's object to prove. He might have proceeded to demonstrate the principle in that manner, leaving the difficulties involved in particular considerations of the action of force to be afterwards disposed of; and for a satisfactory solution of the problem to a mixed audience that would have been the clearest mode of definition. But Professor Faraday preferred considering in the first place the force of gravitation, which appears to be least reconcilable to the conservation of force, feeling that if the principle could be established in the action of gravitation, it must be at once admitted as applicable to all other forces. This was a bold method of proving the principle contended for; and no doubt if it could have been accomplished in the course of a single lecture, it would have been the most satisfactory method of establishing the conservation of force. The result, however, did not justify that course of proceeding. However highly we may estimate Professor Faraday's abilities as a lecturer and as an investigator of scientific truths, we cannot accord to him the merit of clearly developing in his lectures those matters which are not previously known to his audience. As an agreeable lecturer and careful experimenter, he is without an equal. He explains with sufficient clearness, and with brilliant and well-contrived illustrations, detached parts, but he fails to produce a distinct impression of his subject as a whole; and as the *rationale* of many of his experiments is unexplained, any one not acquainted with the subject must be considerably mystified by most of the professor's lectures, not excepting those specially intended for a juvenile audience. He has also a strong tendency to enter into the metaphysics of science, and to indulge in speculations which require more time and thought to comprehend the bearings of than the delivery of a lecture affords. Under these circumstances, it is not surprising that Mr. Faraday failed in his endeavour to establish the principle of the conservation of force by its application to that kind of force in which it is least manifest. Thus, for instance, he threw his audience into a state of mystification in an early part of his lecture by the startling announcement, that one of the laws of gravitation is inconsistent with the principle of the conservation of force, whilst he admitted the correctness of the law and the truth of the principle.

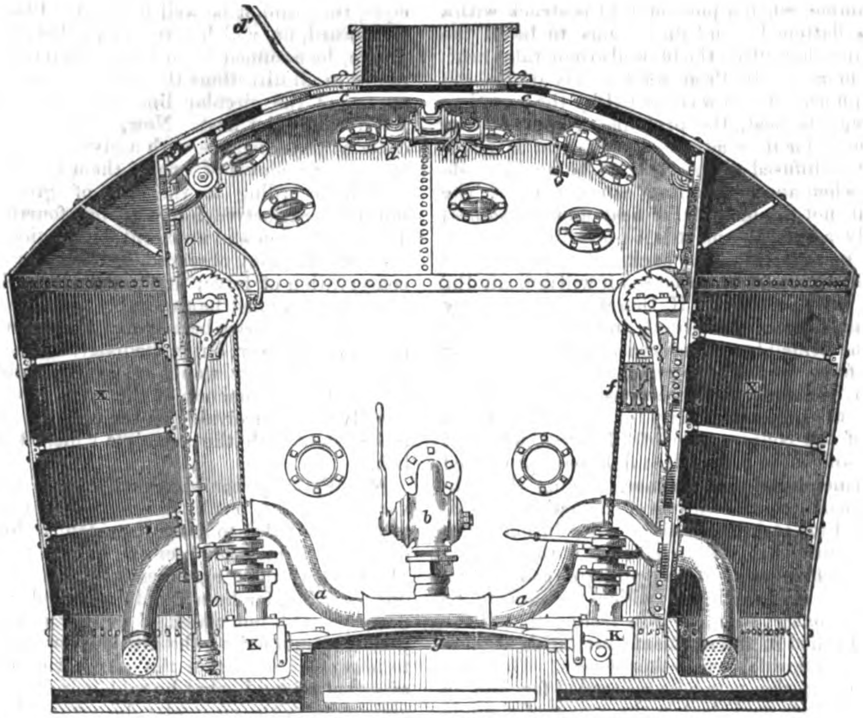
No law of physical science can be more clearly established than that the force of attraction is inversely as the square of the distance; and this law applies not only to gravitation, but is an essential condition of all forces emanating from a centre. Nevertheless, Mr. Faraday said this law is incomprehensible, whilst he admitted its validity; and that it is contradictory to the principle of the conservation of force, though that principle he affirmed to be one universally applicable. This paradoxical mode of propounding the question rendered its solution more difficult, and therefore demanded a specially clear elucidation. In attempting to reconcile the inconsistency, however, Mr. Faraday plunged into the metaphysics of science, and he did not satisfactorily extricate his subject from that labyrinth. He seemed induced almost to take for granted the thing to be proved, and then, assuming that force can be neither created nor destroyed, he adduced the force of gravitation rather for the purpose of showing a seeming exception to the rule, than as an illustration of its application. As there can be no contradiction in nature, what is true in one case must be true in all; therefore, taking for granted the principle of the conservation of force, if the laws of gravitation present any contradiction to that principle, they cannot be well founded. Placing a ball on the centre of a board, on which several equi-distant concentric circles were drawn, he assumed it to be a solitary globe, exerting attractive power in all directions throughout space. A second ball, placed on one of the circular lines, was assumed to be another globe attracted by the first. Now, if these two balls, attracting each other at that distance with a given force, were the only objects in space, the removal of one of them to the next equi-distant circle would, according to the law of gravitation, diminish these mutually attractive forces to one-fourth their former amount. The diminution and apparent destruction of power thus indicated was, Mr. Faraday observed, contradictory to the principle of the conservation of force; and yet that principle, if applicable to one kind of force, must be applicable to all. Again, if the existence of a single globe in space be assumed, there could then be no exertion of gravitating power; but immediately on the introduction of another body, that power would be exerted, and thus apparently give rise to the phenomenon of the creation of force, which would be equally as inconceivable as the creation of matter, and would be inconsistent with the principle which it was his object to establish.

Mr. Faraday combated with these assumed difficulties in a variety of ways, but he did not succeed in vanquishing them; or at least, he failed to make it evident to his audience that he had done so. It may be observed, indeed, that the giant with whom Mr. Faraday thus unsuccessfully fought was a monster of his own creation, for he not only assumed a state of things which never existed, but which, if matter cannot be created, it is impossible could exist—the introduction of a second globe into space to bring into operation the gravitating force of the first, being an assumption of what he said it is impossible to conceive. To assist him in the encounter, he sought the aid of Inertia, but that auxiliary did not give him much support, being of itself a principle of very problematical existence, and quite as unintelligible as that of the conservation of force. If we strip "inertia" of its Latin disguise, it signifies the *idleness of matter*, and Professor Faraday seems to regard this idleness of matter as latent force; and thus —in some manner not clearly developed—gravitating force is supposed to be stored up in idleness when it, apparently, ceases to operate. If this doctrine be admitted, some more fitting word than "inertia" must be sought for to express the hidden power, and *latent force* would be more appropriate than the *idleness of matter*. As regards the law that attraction is inversely as the square of the distance, we cannot see that it presents any contradiction to the principle of the conservation of force. It is as intelligible when applied to gravitation, as to light, or to any other force emanating from a centre. When one body is removed from another, the influence of the radiating actions on each other must diminish in the ratio of the squares of the distance; but these influences on other bodies are proportionally extended, and there is no diminution nor loss of force.

Having mystified his audience during a large portion of the lecture, with the attempt to apply the principle of the conservation of force to gravitation, Professor Faraday returned to its illustration in different modifications of heat; and being thus on his own ground, he proceeded much more clearly and satisfactorily. He showed, that in the varied conditions of heat, it at one time produces during chemical action with zinc the effects of the voltaic battery; that the latter reproduces the heat in different forms, either directly or indirectly, and that in the transmission of a voltaic current there is an amount of heat excited equivalent to that which is evolved in bringing the battery into action. This effect was more clearly demonstrated by the action of the thermo-electric arrangement, in which the electricity is excited by the direct application of heat, which may be again reproduced by the action of the electricity. The law of definite proportions, by which bodies unite chemically, was also adduced in support of the principle of the conservation of force, without which the definite proportions in chemical combinations could not be maintained. Professor Faraday observed that the higher we rise in the implication of effects, the more beautiful and distinct does the principle of the conservation of force appear; and the establishment of that principle would be attended with important results in scientific investigations, as it would serve to direct inquiry in the search after causes which have hitherto not been thought of.

ON APPLIANCES FOR FACILITATING SUBMARINE ENGINEERING.*

By Major H. B. Sears.



SECTIONAL VIEW OF THE NAUTILUS MACHINE.

The grand principle that air in an enclosed and inverted vessel, presenting a horizontal surface, will resist the entrance of water into that vessel, provided the air is of the same density as the water, is the principle which first determined the use of the ordinary diving-bell, an instrument now so often used in the preparation of foundations, and the subsequent erection of works under water.

In localities where the cofferdam is inadmissible, either through the cost or difficulty of construction, the ordinary suspended bell, pendant from a carriage at the surface, affords the necessary means for adjusting the work in such manner as the engineer may desire. It has been suggested, too, to use the ordinary submarine armour or dress for the adjustment in place of the stones of a work, which have been previously fitted at the surface.

In suggesting a new mode of operations, by which suspensory action might be entirely avoided, it would be impolitic to denounce the methods just mentioned, as being behind the age, since each would undoubtedly have its advocates, who from practical operations would acknowledge the advantages derived by its use, and perhaps look unfavourably on any innovation.

The Dover breakwater is an instance of the thorough efficiency of the ordinary bell, yet at the same time by its use the progress of the work has been necessarily slow.

The plan submitted in this paper for accomplishing, as it is confidently asserted, a larger amount of work in a given time, and at a less cost than by present means, is not a mere fancy, brought forward as a theory which cannot stand investigation and the application of practical knowledge to test its merits; but it is boldly placed before you, challenging the most rigid investigation of its qualities to secure the desired advantages of cheapness of construction and saving of time.

The principles involved in the machinery now presented to you, have all been thoroughly and practically tested; not in a single instance, but by months and years of careful investigation.

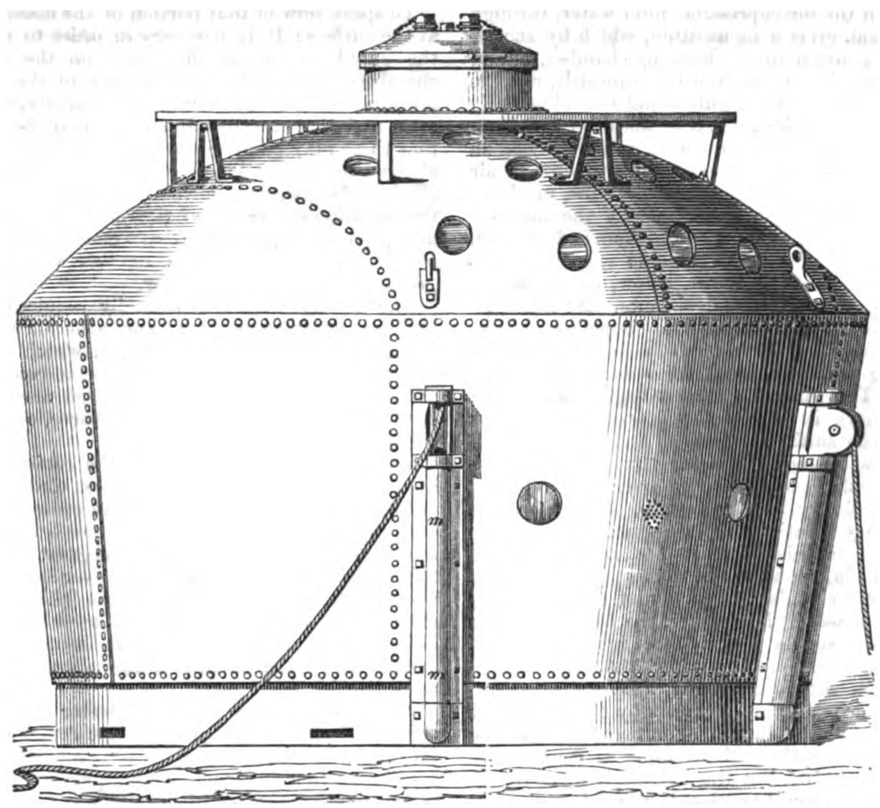
Air and water, the two combined and powerful elements, are both difficult and dangerous to contend with. Water, by its gravity carries us downward; air, by its lightness or buoyancy, carries us upwards or keeps us at the surface; therefore it becomes necessary in any machinery independent of suspension, depending on the variable preponderance of one or the other of these elements, that these powers should be under perfect and complete control. The subtle nature of air requires careful management, and a perfect adaptation of parts to secure its control.

The Nautilus machine, which is presented to you as the instrument for overcoming many of the difficulties inherent to the nature of subaqueous operations, possesses among others the following qualities: It is entirely independent of suspension; its movements are entirely dependent on the will of those within it, and without reference to those who may be stationed without; it possesses the power of lifting large weights, *per se*, and at the same time is perfectly safe, by common care, in its operations,—this latter the greatest desideratum of all. These advantages must, I think, strike all, as combining those requisites of success which have been always wanting in the present known means for constructing works under water.

The form of the machine is not arbitrary, but depends entirely on the nature of the work to be performed, adapting itself to the various circumstances attending any given position. By reference to the annexed diagram you will perceive that when at rest, being entirely enclosed, its displacement of water being greater than its own weight, it must float at the surface. Entering through a man-hole at the top (which is closed either from the inside or outside), you descend into the interior of the machine, portions of which are walled off on either side, forming chambers; these chambers are connected at or near the bottom of the pipe *a a*, which opens by a cock *b*, outwards to the external surrounding water. An opening in the bottom of the machine of variable dimensions is closed by a door or doors, susceptible of being opened or closed at pleasure. The chambers X, X, are likewise connected at top by a smaller pipe *c c*, which opens through the top of the machine, and to which opening is affixed a flexible pipe, with coils of wire spirally enclosed. Branches on this latter pipe *d d*, allow also communication with the larger or working chamber.

At the surface of the water, placed on a float or vessel for the purpose, is a receiver of variable dimensions, to which is attached at one end a hollow drum or reel, to the barrel of which is affixed the other end of the flexible pipe *a*, leading to the top of the Nautilus. At the other end of, and in connection with the

* Paper read at the Society of Arts, London.



EXTERNAL VIEW OF THE NAUTILUS MACHINE.

receiver is a powerful steam air-condensing pump. This combination represents the Nautilus machine as adapted to engineering work.

The operator, with his assistants, enters the machine through the top, which is then closed. To descend, the water-cock *b* is opened, and the external water flows into the chambers, X, X; at the same time a cock *e*, on a pipe opening from the chambers outwards, is opened, in order that, the air escaping, an uninterrupted flow of water may take place into the chambers. The assumption of weight of water causes a destruction of buoyancy due to displacement by the mass itself, and the Nautilus gradually sinks. As soon as it is fairly under water, in order that the descent may be quiet and without shock, the water-cock *b*, is closed. The receiver at the surface, being previously charged by the air-pump to a density somewhat greater than that of the water at the depth proposed to attain, one of the branch cocks on the pipe *c c*, connecting the chambers at top, is opened, and the air rushes into the working chamber, gradually condensing until a density equal to the density of the water without is attained; this is indicated by proper air and water guages, *f*, *f*. These guages marking equal points, showing the equilibrium of forces without and within, the covers to the botttom, *g g*, are removed or raised, and communication is held with the bottom on which the Nautilus is resting. In order to move about in localities where tides or currents do not affect operations, it is only necessary to step out of the bottom of the Nautilus, and placing the hands against its side the operator may move it (by pushing) in any direction. Where currents or tides, however, have sway, it becomes necessary to depend upon fixed points from which movements may be made in any direction. This is accomplished by placing in the bottom of the Nautilus stuffing-boxes of peculiar construction, *k*, *k*, through which cables may pass over pulleys to the external side, thence up through tubes (to prevent them from being worn), to and over oscillating or swinging pulleys placed in the plane of the centre of gravity of the Nautilus, and thence to the points of affixment respectively. The object to be gained by having the swinging pulleys in the plane of centre of gravity of the mass, is to hold the machine steady and to prevent oscillation. Within the machine, and directly over the above stuffing-boxes, are windlasses for winding in the cables. By working these windlasses movement may be effected, and of course the number of these cables will depend on the variable character of the situation to be occupied. Having thus secured the means of descending, communicating with the bottom, and of movement, the next point is to ascend. Weight of water has caused a destruction of buoyancy at first, and consequent sinking; if, then, any portion of this water is removed, an upward effort will at once be exerted, exactly proportionate to the weight of water thrown off. The air in the receiver at the surface being constantly maintained at a higher density than that of the water below, if we open the water-cock *b*, and at the same time open the cock on the top pipe *c c*, throwing the condensed air from the receiver above directly on the surface of the water in the chambers, movement and consequent expulsion of the water must take place, and an upward movement of the machine itself, which will rise to the surface.

It is evident that if, previously to the expulsion of the water, the Nautilus be affixed to an object below, the power exerted in that object will be exactly proportionate to the weight of water expelled, and the power will continue increasing, until there being no further weight to be thrown off, the maximum effect is produced. To apply this power to lifting masses of stone or rock, proper arrangements are affixed to the centre of the opening in the bottom, by which connection can be made with the weight, admitting at the same time the swinging around of the object suspended, so that it may be placed in any required position. In the construction of permanent works, or the movement of objects whose weight is known, or can be estimated, a water or so-called lifting tube is placed on the side of the water chamber which indicates the lifting power exercised by the Nautilus at any moment. The advantage of this guage will be recognised, inasmuch as (without it) the closest attention of the operator working very cautiously, would be necessary to determine when the weight was overcome; by its aid, however, the operator boldly throws open all the valves necessary to develop the power of the Nautilus, watching only the guage. The water having reached the proper level indicating the required lifting power, he knows the weight must be overcome, or so nearly so that the valve or the cocks may be at once closed, in order that the movement may take place horizontally. A moment's reflection will show, that if there were not an index of this character, carelessness or inattention on the part of the operator, by leaving the cocks open too long, might develop a power greater than required, and the Nautilus would start suddenly upward. The expansive power of air, acting upon the incompressible fluid water, through the opening in the bottom, gives a momentum, which by successive developments of expansion in the working chamber, is constantly increasing the velocity of the Nautilus upwards, until in any considerable depth of water, the result would be undoubtedly of a very serious character. Take for exemplification the Nautilus in 33 feet of water, the bottom covers removed, and an equilibrium at 15 pounds to the inch existing between the air and the water at the level of the bottom of the machine. Upward movement is communicated the instant the machine rises in the slightest degree, the existing equilibrium is destroyed, and the highly elastic qualities of air assume preponderance, exerting from the rigid surface of water below, an impulsive effort upward in the direction of least resistance. At each successive moment of upward movement, the impelling power increases, owing to the increased disparity between the pressure of air within struggling for escape, and the water without preventing that escape. The machine thus situated becomes a marine rocket (in reality), in which the propelling power is exhausted only when the surface is reached, and a new equilibrium is obtained. It will readily be seen, that were this difficulty not overcome, it would be impossible to govern the Nautilus; for, rising with great velocity to the surface, the machine is carried above its ordinary flotation or water-line; a little more air escapes owing to the diminished resistance, as that level is passed; the recoil, or surging downwards, causes a condensation of the air remaining in the chamber; a portion of the space previously occupied by air is assumed by water, the buoyant power becomes less, the machine settles slightly more by condensation of the air, a larger space is occupied by water, and the Nautilus redescends to the bottom with a constantly accelerating movement, seriously inconveniencing the operators by filling more or less with water according to the depth. For many months the difficulties just enumerated baffled all attempts at control. A weight attached could be lifted, but the instant it was entirely suspended, before the valves could be closed, upward movement was communicated entirely beyond control. This difficulty, so fatal, has been overcome by an arrangement of the bottom of the Nautilus, with channels which radiate from the opening to an incline direction, debouching at the sides of the machine. The moment then, that the air, by its expansion from diminished resistance, or by the introduction from above of a greater volume than can be sustained by the water below, reaches in its downward passage, the level of these chambers, following the direction of least resistance, it passes through these channels and escapes into the surrounding water, without of course affecting the movement of the machine. I have thus, I trust, shown the principles on which the engineering facilities of the Nautilus depend.

First, on natural principles, from construction, it must be independent of suspension; and here allow me to bring forcibly to your minds the distinction between a machine which, by its own power, may descend, ascend, move horizontally, lift weights, and transport them by itself (for I assume the operator to be a part of the machine), and the ordinary diving-bell so long used, by which we are enabled to perform the same operations, after much time spent in the preparation of piling, platforms, scaffolding, carriage-way, &c.; and where all necessary movements in the prosecution of the work must be made at the surface through the intervention of signals, which in all cases must be more or less liable to error and misunderstanding.

Supposing the same skilled and careful men to be placed under both conditions, the one time in the ordinary diving-bell, where, when they have determined on the necessary movements to be made, they signal to the surface, and await, first the proper understanding of their wishes, and then subsequently, their execution by those who cannot know precisely the amount of assistance required; or another time, in a machine possessing the capabilities heretofore enumerated, by which the operator, having his work directly before him, watching all the varying circumstances which await his progress, foresees and applies directly his own hand to the work, governing and directing in person those operations which he requires to be performed—certainly the balance must be all in favour of the latter position.

Another thing in the case of the ordinary diving-bell, much time is consumed in making the necessary preparations to commence the use of the machine; in the other case, when once arrived at the spot required (if in the water), it is ready for immediate service, either to examine the bottom previous to the location, or to commence the foundations at once.

To speak now of that portion of the machinery which remains at the surface: It is necessary in order to rapid movement, that the supply of air which, acting on the water in the water-chambers, causes the development of the lifting power of the machine, should be in sufficient quantity, so that no delay may arise and that a constant supply may be continually afforded, that there may be no diminution of density in the receiver. It is also necessary that the density of the air in the receiver should at all times be greater than that of the water at the depth to which the machine descends, so that the superior pressure of the air may produce instantaneous movement of the water. A proper proportion of density in a receiver would be about one-third greater than that of the water.

The amount of air continually required for the respiratory purposes of the operators, and also for the purpose of lifting weights, demands a large supply, which is obtained from the steam-condensing pump directly to the receiver. The air-pumps are constructed to throw any required amount of air, each sufficient if required, to work two or three, or even more machines engaged in lifting heavy weights.

There is no heating, owing to the rapid condensation of air at high density. The pumps will work continuously at the highest density, without any perceptible increase of temperature. The economy of working several machines from the same or different receivers, supplied by one pump, is great, as the saving of labour, fuel, wear and tear, in one engine over several, is quite apparent; which economy is due in part to the independence of suspension, allowing the receiver to be placed at any convenient point, even quite distant from the Nautilus, inasmuch as the pipe may be supported on the surface of the water to the point over the work itself.

Having the powers of air and water then at control, to obviate the use of platforms, trucks, and carriage-way, to lower stones into place, so that they may be properly deposited, you may readily see that a caisson or float, properly arranged with regard to the relative centres of gravity and buoyancy, may be moved over or near the work. A load of stone, according to the capacity of the caisson, may be placed upon it. Having this caisson so arranged by division into chambers, that the water cannot flow from side to side, and constructed with water valves and a connection with the receiver, when the load is properly placed upon it, and the water-valves opened, it will commence to sink. Regulating its descent slowly by the same process as the Nautilus itself, but governed from above, it may be placed in proper position, so that the least possible distance will be required to be passed over, in removing the stones so lowered to their ultimate position of permanency. As the weights are removed, it is obvious that more water will be required to be admitted, in order to retain the caisson at the bottom or on the work. The whole load being removed, to return to the surface, it will be merely necessary to throw from the receiver at the surface a portion of condensed air, to cause it to rise preparatory to its receiving a new load.

The comparative cost of lowering away stone in this manner, as contrasted with the ordinary crane, can hardly be doubted as being favourable to the first method, inasmuch as water is valueless, and the supply of air required to expel that water, as delivered from the condensing pump, can bear but a slight ratio of cost to the labour required to work the cranes. The cost of working a steam-condensing pump sufficient to lower as many stones as would supply two machines, as well as working the machines themselves, would not be more than thirty shillings per diem.

Where water transportation of material is afforded, the caissons themselves may be used as the means of transportation of the stone from the quarry to the site of the work; and then fulfilling their real purpose, of depositing their load in the bottom. A great facility afforded by this process is, that there must always be a supply of material below, in advance of the requirements of the adjusting machines, so that no delay can arise by waiting for materials.

For removal of rocks: the facility that is afforded by going down directly on the bed of the rock, there drilling a series of holes, subsequently charging them, and then exploding them connectedly, would seem to be almost equal to that of the quarry. If large masses be detached, camels, inflated or charged from the receivers, may be affixed to them (if too large for the Nautilus itself), and when lifted, towed to the place of deposit, and there left.

Manual labour alone can now be used below water; for steam, our great substitute, cannot be passed through so great a length of hose, and through varying temperature, as is necessary, without condensation; but air does not change its density by passing through great distances, or by a moderate change of temperature.

Having a supply of air at the necessary density for a motive power, it may then be used as such, to propel the necessary drills for boring rocks, by having the proper engines placed within the Nautilus, and exhausting to the surface. Air being at the same density as steam, and contained within the receivers, which are atmospheric boilers, we may apply the powers of air below, the same as steam to the surface, to the performance of any labour which may be required. There is no difference between air and steam at the same density in their application, except that in the use of air, which is a more subtle fluid than steam, we must exercise additional care in the arrangement of valves, &c. The powers of air which can be developed at the surface in any required amount, are not only applicable to the working of drills for boring rock, but the sawing off of piles in the preparation of foundations, and for any other purpose where the application of manual labour at comparatively high cost, should if possible, be obviated.

To saw off piles for foundations. If one pile be driven or cut off at the requsite level, the Nautilus, which by construction retains its lower surface in a horizontal position, resting on that pile, and working a saw in the plane of that lower horizontal surface, will of necessity, cut all the piles with which it may be brought in contact in the same plane, then preparing the grillage and planking necessary, when lowered, the Nautilus passing over it can cause it to be securely affixed to the heads of the piles so cut off.

It is manifest that, unless very carefully arranged, any submerged vessel descending rapidly, and striking on any projecting object, would be liable to be thrown from its horizontal position, and to be overturned. Assume that the ordinary bell is descending, and strikes on a projecting or shelving rock, lowering away from the surface; unless the signals are distinctly understood, the chances would be very great of an overturn, resulting in great danger to those within.

In the case where no suspension exists, it becomes necessary to overcome any such tendency to danger, which is done by so harmonising the centres of buoyancy and of gravity, that under no circumstances can there be but a very slight deflection from a horizontal position. Gravity acts downwards and buoyancy upwards, both in vertical lines. Construct a machine symmetrically, then, with the centres of gravity and buoyancy in the same vertical line, the one near the bottom, on account of weight, the other by peculiarity of construction, as far removed as possible from the first, or as near the top as may be. If, by any means the horizontal position should be destroyed, both forces at once act to restore its original or correct state, gravity downwards, buoyancy upwards; and the power or effective lever which tends to restore it to this horizontal state, will depend on the distance apart of these two centres; therefore I may say, in a properly constructed machine an overturn could never be experienced.

This is a very important subject to be considered, for as there is no chain or rope to cause return to the surface, unless this point were thoroughly guarded there would be no safety at all, since if the Nautilus once received an inclination by the escape of air from the upper side and entrance of water on the lower side, the movement would increase until the whole might be overturned.

It would be unadvisable to say that any given amount of work could be performed by the Nautilus machine in a given time under all circumstances. The power of the machine is positive, and can be certainly relied on; but it may not always be possible to exert that power to its full extent. The length of time required to submerge a first-class machine, lifting 6 tons, will be two and a-half minutes. Going down slowly, 60 feet per minute may be attained. While the machine is descending, the working chamber may be filled with air of the proper density to resist the entrance of water when the bottom cover is removed. Two minutes are sufficient to unclamp and raise the covers. If the object to be raised be immediately beneath, as soon as the necessary connections can be made, the water cocks are opened and the air is thrown into the water chambers, which can be entirely emptied giving its full lifting capacity of 6 tons in one and a-half minute.

As to movement horizontally.—Every practical mind can form its own conclusions as to the rapidity with which such a buoyant mass could be moved through the water. An extract from the report of Mr. Gay, Chief Engineer, U.S. Navy, to the Bureau of Docks and Yards, will verify the statements I have made:—

.........“With the assistance of two experienced persons, I descended in the bell to about 20 feet below the surface of the water. The time occupied to *prepare the bell* and reach the bottom was about *two minutes and thirty seconds*, and about a minute and a-half to return to the surface ....One of several blocks of granite, weighing about four tons each, had been previously prepared, and placed on the bottom; the bell was attached to this stone by a ‘lewis.’.........The time occupied in securing the stone and coming up was about three minutes.........I descended with the stone, and, by the aid of two men, transported it several feet laterally, with as much ease as it could have been done were it suspended upon a crane, with the advantage of placing it at any point or in any desired position.”

By skilful and practised manipulation, the powers of any machinery must be developed in a greater degree than by unskilful handling. In acquiring the necessary skill, the necessary length of time required depends much on the complication of the principles involved, or the details by which the results are obtained. In working the Nautilus it is not necessary that the operator should be a scientific man or practical mechanic. By the absolute control of natural elements, the will of the operator as it were, directs and governs the movements of the machine. It is thus the operations of the machine are comparatively inexpensive, since you are required to pay for labour alone, and not to compensate for the genius to comprehend or the skill to control a complicated and delicate instrument.

In any paper description of a new system, of whatever nature it may be, it is impossible to enter into sufficient detail to enable the mind at a single glance, or by a single hearing, to fully comprehend all or even most of the advantages claimed, or of the disadvantages which may be found apparent. In the case however of the system which I have the honour of presenting to you, as applied to submarine engineering, based as it is on purely natural principles, whose partial application heretofore has been attended with a degree of success, certainly of a satisfactory character, the principles laid down I trust are so easily understood, that noone can fail to admit that, certainly *if* the principles in their adaptation in the Nautilus, are governed as represented, the value of the improvements thus made must be of great practical importance to the engineer, by rendering his labours free from much anxiety, and enabling him with confidence to undertake works of peculiar characteristics of position, which previously considered, would have seemed hazardous.

I cannot flatter myself that in this system, a sovereign panacea has been discovered for all the dangerous symptoms which the engineer meets with in the practice of his profession under water; but I trust you will admit, that certainly his toils may be rendered lighter, his risks diminished, his expenditures curtailed, his time saved by this process.

A sketch of the construction of a work, by present process, and by the use of the Nautilus, may be permitted me. We will suppose the location selected, and that the impracticability of constructing a cofferdam has rendered necessary the use of the ordinary diving-bell, which we will also suppose is already constructed and ready for use.

The first step will be to commence driving the piles upon which the scaffolding is to rest; the scaffolding must then be constructed; the rails must be laid for the passage of the suspending trucks; these trucks must then be placed in position and prepared for use. The bell is then suspended, and we will suppose is ready for work, a considerable amount of time having been expended in this preparation. The bell is raised out of the water, the masons enter, and are lowered away. The descent must be slow, for the weight is great, the chains are stiff, and manual labour is required to overcome these difficulties. Then too, being open at the bottom, lowering away can be effected only as fast as air is supplied by the pumps from above to resist the encroachment of water. The bottom is reached and work is commenced. Movement is necessary —signals are made by blows on the side of the bell, or by the signal cord—at the same time the signal is made and understood at the surface, they commence to move the whole apparatus as directed; the truck at the surface and the bell below move together. It is desired to stop; before doing so, new signals are necessary, movements below being restricted in their efficiency by the proper understanding of signals. You wish to move slightly only, you are carried to far and must return.

In the preparation of foundations where in many cases it is required to move often from point to point in excavating or levelling, this delay becomes important. The foundations, however, are prepared, and the superstructure is commenced. A stone is lowered. The bell by signal is moved over it, and they are connected;—signal to the surface, and the weight of the bell and the stone must be raised together;—signal again to stop hoisting;—signal to move in or out, right or left;—movement is made;—the spot is reached, and the stone must be deposited precisely. The mason says—a little to the right, but he cannot say how many inches, and gets too far; then by successive movements by signal he is accurately placed and lowered away. Then to place another stone he goes through the same process. Mark the time consumed here from want of independence. He sees the stone; he knows it must go there, in that spot, but he cannot himself exercise the power necessary to place it there, but must wait the pleasure and understanding of his directions by others, who of course can only have a general idea of his wishes.

In this way the work is carried on. Other difficulties are however, in the way. The bell suspended below is a pendulum of variable length; if the water be rough at the surface, a swaying or oscillating movement is given to the pendulum, which, in its oscillation however slight, disturbs the horizontal equilibrium between the air and the water, and the air escapes from the upper side, and water enters on the lower side. The pump must then be signalled to work, to restore the volume of air and drive back the water. Oscillation too is dangerous, if at all of a serious character, for the masons may be injured in their limbs if standing on the bottom with the bell suspended. The mason knows, too, that if the chain, on which rests his entire hope of safety, should break, the chances are almost indisputable that his life is lost (numerous instances have attested this latter point); the weight is too great for him to attempt to raise it, and his workshop furnishes him with a metallic coffin. It is evident that no man, however daring he may be, can work with so much will where the chances of danger, however remote, are independent of his own power of governance, as he can where he feels that his own will can at any moment remove him from the possibility of danger.

In reascending to the surface after the completion of duty below, the movement must necessarily be very slow, owing to the same reasons previously enumerated in lowering away. If the chain break while ascending, where would be the labourer's chance?

Enough of the difficulties below. There are still dangers and difficulties at the surface. A storm arises—the work is in an exposed situation—and a portion is weakened, perhaps carried away. The necessary time must be taken to strengthen or reconstruct the damaged portions. This involves time, it involves expense.

We will now suppose a position, as the removal of a rock, or the construction of a pier foundation, &c., where it is impracticable to construct platforms and stagings. A boat from which to suspend a bell must be used. Any motion communicated to this boat at the surface, must cause the oscillation below which I have previously spoken of as greatly retarding or entirely putting a stop to operations while such motion is experienced.

Take now the location where the cofferdam is adopted. The first step is to construct the dam, which is a work of time, which is an expense. The dam however being completed and free from leakage, of course the work can then be carried on with great rapidity: but there are difficulties even here; springs in some cases cause difficulties; leaks too, arise. A storm, by weakening a portion of the dam, may cause a delay for repairs, or even may demand an entire reconstruction. Of course to the mind of everyone present this is but a suggestion of some of the difficulties which in all cases, in a greater or less degree, attend the construction of this class of works. There is no need of bringing them forward except to place them in contrast with any means which may mitigate their action in whole or in part.

To contrast the action of the Nautilus and to see how far by its action, as previously described, these difficulties may be overcome, I will suppose as in the case of the ordinary bell, the location is decided on. And first, before a decision upon that point is arrived at, you will undoubtedly recognise the facility which the engineer possesses by its use in descending himself, and by accurate survey determining the most favourable position for such location. The nature of the foundation required being determined, its preparation may be at once commenced, since, towing the Nautilus to the spot, your workmen are ready at once to commence work at the same time that, in the other case, they commence the driving piles for the scaffolding. While the scaffolds are being erected, it is but fair to suppose that great progress may have been made by the Nautilus in the construction of the work itself. I have previously shown that, being in position, but a very few moments are required for the workmen to reach the bottom. They then see their work, and are ready to prosecute it. No signals for movement are necessary; they wish to move an inch, a foot, a rod, it is done at once; there is no restraining influence which is not subject to their own will. When their labours are ended they themselves return to the surface, as rapidly or as slowly as they please.

The foundations being prepared to carry on the superstructure, the stones necessary are lowered down by any means, either by cranes or boats for the purpose, or by the caisson method previously described. They will be deposited in a given position and lowered in the order in which they will be required in the work. The chief mason or operator then, knowing the precise position of deposit, which of course will be as near the ultimate position of permanency as possible, will so arrange his facilities of movement as to pass in a direct line to and from what may be styled his quarry or place of delivery. He affixes to stone No. 1, and by the power of his machine he suspends it, then moves it, and deposits it. Is it not evident that with the great power of lifting in so rapid a manner, and the movement dependent on his own will, and the subsequent slight movement of adjustment in position, that the whole operation could be performed in very nearly the same time that the truck suspending the ordinary bell, moving by signals, could be placed over the stone ready for lifting? The stone being placed, the Nautilus returns to the quarry for No. 2. No delay is experienced, but the action is immediately performed, since all thought necessary is previously exercised. No. 2 follows No. 1, No. 3 No. 2, and so on; the exact measure of juxtaposition having been laid down before the machine is called into requisition, and the memorandum of such detail being in hand. So long as the quarry is supplied, as fast as the various powers of the machine can be called into play, the operations must continue uninterrupted.

The mason or workman feels no sensation of danger. If his single connection with the surface which supplies his power, be ruptured, he returns to the surface to make a reconnection. He is restrained for the time being, from exercising any lifting power, but his safety is unimpaired. If a stone break loose its connection, he goes to the surface and there remains until he chooses to descend to make a reconnection. So long as his supply of air is uninterrupted, he cares not for the surface or what is going on there; cut off his supply of air, he knows it and takes his own measures and precaution. While the surface of the water is agitated, unless near the surface, it does not interfere with his operations, since there being no suspension and a sufficient quantity of pipe submerged, or anchored below the surface, no action of the water can impede his movements, as there is no oscillation. The attending floats may be tossed at the pleasure of the waves, so long as they can ride at their anchors or mooring blocks. Should however, the water become too rough to operate, the Nautilus returns to the surface, and being confined by its anchors, and being a life-boat in itself, no damage can arise by leaving it in position; or the whole afterwards may be towed to a position of safety, and there await the cessation of the preventing cause of operations. The moment those causes have been removed, operations may be resumed at once, since no part of the apparatus or fixtures has been exposed to deterioration or loss.

The same number of men would be required on the Nautilus as in the ordinary bell, at the same prices for labour. The attendant labourers at the surface required in the movement and suspending the ordinary bell would be dispensed with, consequently the cost of producing the same amount of work would be less in the case of the Nautilus. But I trust that the facilities herein demonstrated have shown that the self-acting powers of the Nautilus, directly at the control of the operator, afford the facilities for performing a greater amount of work in a given time than by ordinary means, and as the amount of labour is less, there must be a saving of both time and money. There are other means, such as caissons for constructing portions of masonry which are subsequently placed in position, upon which I need not expatiate. Their use is confined to particular localities, and they are not susceptible of general application in the construction of submarine works.

In this paper my purpose has been, not to make invidious distinctions between the ordinary diving-bell now in use and the Nautilus, which occupies so prominent a position herein, but to bring forward the merits and defects of the whole system, and place them in contrast with the machinery which has developed powers, which, in the opinion of competent scientific minds, overcome many of the difficulties as well as dangers which have heretofore enveloped the science of submarine engineering.

ON CIVIL CONSTRUCTION.*

By Capt. Fowke, R.E.

The nature of the building materials in common use in different parts of the world has always exercised an important influence over the character and nature of the constructions of which they form a part, so much so as, in fact, to influence in a great degree the system and feeling of national architecture; so that we have the ponderous massiveness of Egypt, the stern grandeur of Greece, the classic elegance of Rome—all the offspring of a hard, enduring material, more or less stubborn under the chisel and mallet. The more manageable materials in use in the middle ages were undoubtedly instrumental in producing a change in the nature of the constructions of the period, and probably to such accidents of place and circumstance are we indebted for many of those beautiful and fantastic forms which delight us as much by their delicacy of execution, as by their hardihood of design, and in which the architect, adapting his work to the materials at his disposal, has atoned for his departure from the severe outline and imposing masses of classic architecture, by the introduction of a charm to which his sterner predecessors were strangers.

In our own time, in newly settled countries, such as America and many of our colonies, where wood is abundant, and stone is either difficult to be obtained or expensive from the scarcity of labour, we find a different kind of construction springing up, often picturesque in appearance, and exhibiting much talent in design, but especially creditable for its simplicity and ready adaptations; at the same time its ephemeral and temporary character cannot fail to give it more or less an air of insecurity and want of strength, however unmerited. Finally, we come to that period which has with truth been called the age of iron, in which a total change of material has effected as great an alteration in the constructions into which it enters, rendering simple, feats of construction which it would have been folly to have attempted in any of the previous periods; and of the facilities which are afforded by the use of this material for covering large areas with economy and quickness, no better illustration can be given than the buildings which have been erected for the two great Exhibitions of London and Paris.

Building Stones.

France is extremely rich in this material, and much of the architectural beauty of Paris is undoubtedly to be accounted for by the possession of inexhaustible quarries of a beautiful building stone, of an extremely enduring quality, and at the same time so even of texture and so easily wrought, as to be capable of receiving every variety of ornament. The building stones of Normandy are also justly renowned, and several of the most celebrated quarries of Caen are represented at the Exhibition under the names of Fontenay stone, Aubigny stone, &c., and strange to say, the best specimen of this material, viz. Caen stone, is exhibited by an English firm, Messrs. Gates and George, who have sent an exquisitely carved altar, reredos, and doorway, which do credit to their workmanship, and at the same time serve as admirable illustrations of the capabilities of Caen stone for the more delicate descriptions of carving, appertaining more especially to works of a mediæval character. A good sample of a peculiarly hard red sandstone from the department of the Vosges, is found in the dado which forms the lower part of the external walls of the Palais de l'Industrie, where its colour is introduced with good effect in contrast to the paler Parisian stone with which the remaining parts of the building are constructed.

There are, besides, between twenty and thirty different exhibitors of stone, marble, and slate, from all parts of France and Algeria, by far the greater number of whom contribute marbles in either rough blocks or worked up into ornamental articles or forms. Roofing slates are also sent by many persons, almost all the specimens being very much thinner than those made use of in this country, where this kind of covering is more popular than in France; in fact, the greatest objection made by French builders to the employment of slate as a covering is, that it will not bear the weight of any workman who may be sent on the roof for the purpose of repair, and this objection, which appears at first sight absurd, is easily understood when the samples of French roofing slate are examined. The very general employment of tiles, and more recently of zinc, has however divested the slate trade in France of the important place which it holds in this country among arts appertaining to construction. In the numberless forms in which we see slate now used in England, such as in flooring, cisterns, the fittings up of water-closets and other conveniences at railway stations, &c., it seems almost if not totally unknown in France, and some slate slabs for pavement, for floors, a billiard table, and a garden seat of the same material from Angers, are quite novelties to the Parisian constructors, while a stair with slate treads exhibited by Messrs. Valiguir and Co., is looked upon as a discovery. Some very fine collections of the marbles of different districts of France are seen in the Annexe, but all of such very small sizes, and set in such a way that no opinion can be formed of either their general character or the dimensions of which they can be obtained. In the Algerian collection appears a very handsome chimney-piece, as well as some detached slabs of an exceedingly delicately marked and beautifully tinted Oriental alabaster, the product of that colony, and some similar specimens, but inferior in size and colour, among the Turkish productions. This beautiful white translucent marble is quarried in the province of Oran in Algeria, at a distance of only two miles from the sea, and as it can be obtained in blocks of considerable size, and delivered at the cost at from 17*s.* to 21*s.* the cubic foot, we may hope ere long to see it brought into use as a material for internal decoration. Algeria shows several other kinds of marble, alabaster, porphyry, and granite, and of these many are said to have the advantage of being found close to the coast. From Tuscany we have, from the collection of the Royal Polytechnic Institution of Florence, specimens of the marbles for which she has long been famous, such as the yellow sienna, the travertine, the maciguo, and other well-known names. And Greece also sends us some of her anciently renowned Pentelicon, green porphyry, and "rouge antique."

The most perfect and complete collection of building stones in the Exhibition is undoubtedly that sent by Wagner of Stuttgard, and exhibited among the Wurtemburg raw produce; they are cut in neat blocks, and arranged like an octagonal gatepost, and in the order of their geological formation. They are accompanied by a description of each specimen, which adds much to their value. Among them are a sandstone from the superior strata (called Stubensanstein) coarse grain, from Schlaydorf, near Tübingen, first quality, and a sandstone from Stuttgard. These two occur in blocks of very large size, but rarely in flags. The meeting of German architects, in 1854, pronounced the last named stone to be one of the best materials known for building purposes. The exterior walls, as well as most of the sculptures of Cologne Cathedral, are of this stone, great quantities of which are still transported there on the Neckar and Rhine. This stone never decomposes, nor does any vegetation grow on its surface, as it does not contain any earthy matter; it maintains its light grey colour, resists the heat and cold, bears a heavy weight, and is easily cut without injuring the health of the workmen. Several churches built of the same stone in the thirteenth century are now in good preservation, thus proving its power of resisting the destructive influence of time. It thus shows all the advantages of granite. The best quality is found in the neighbourhood of Tübingen and Nürtingen. It is also used for different sorts of millstones, according to the fineness of the grain. It surpasses the English stones used for husking rice, and makes excellent grindstones. Its specific gravity is 2·02, and its power of resistance to a crushing weight 2095 lb. on a cubic inch.

There is also a limestone, fresh-water deposits from Geislingen, remarkable for its lightness and great resistance to the influence of the air. When first quarried it is sawn with a common handsaw; it hardens on exposure to the air, and bears a heavy weight. The stone has been employed in building very high church spires, for the arches of railway viaducts, and for fortifications. Its specific gravity is only 1·48, and its power of resistance to a crushing weight from 600 lb. to 1000 lb. per cubic inch.

* Abstract of Report to the President of the Board of Trade, on the Paris Universal Exhibition.

Besides the above there are some of the finials and other ornamental work intended for Cologne Cathedral in the great nave, which show in a remarkable degree the beauty of the Stubensanstein; it appears to take an extremely sharp arris, and to work with great ease into the most elaborate forms, and these qualities, together with its delicate tint of clear whitish grey, which it is said to keep for any length of time, seem to render it most valuable for constructive purposes, more so apparently than any stone with which we are acquainted.

Several specimens of marble and stone from Belgium are exhibited, both in the raw state and also wrought into various ornamental articles, as table tops and chimney-pieces, &c. The prices of some of the Belgian marble chimney-pieces are so low as to defy all competition from this country, where the necessary labour alone could not be obtained for the sum demanded for the finished article; the workmanship and finish of these cheap articles is manifestly very inferior, and numberless tricks of trade (such, for instance, as getting up the surface by French polishing) are said to be resorted to. Among the varieties are a good black marble from Namur, white marble and red marble from Hainault, all in the form of chimney-pieces, and a great slab of dark slate-coloured or black marble about 14 feet by 6 feet, having its surface covered with heraldic ornament in bas-relief, but for what purpose it is intended it is impossible to form a conjecture.

Before quitting the subject of building stones, it must not be omitted to notice the stone of which the Palais de l'Industrie itself is constructed, and which was quarried in the neighbourhood of Soissons, about 70 miles from Paris; it bears the name of Villars-la-Fosse, from the quarry from which it is extracted, and has been employed largely in the construction of the new galleries of the Louvre, in the repairs of the Palace of the Elysée Napoléon, and several other public works, and seems likely to become popular with the architects of Paris, as from the quarries being within three or four miles of the river Aisne, a branch of the Oise, and also within a tolerably easy distance of the Chemin de fer du Nord, it can be brought to Paris easily and cheaply; its price in the quarry is 7*d.* per cubic foot for blocks not exceeding 20 inches cube; 8*d.* per cubic foot for blocks up to 40 inches cube; 9½*d.* per cubic foot up to 60 inches cube; and 11½*d.* per cubic foot up to 80 inches cube; at Paris the last-mentioned stone is about 1*s.* 7*d.* the cubic foot; its capability of resistance to crushing is very great, in some experiments it having borne as much as 3¼ tons on the square inch, for which reason it is in great repute for foundations and substructures.

Artificial Stone.

The term artificial stone is used in connection with the many different kinds of cements and compounds that have been from time to time brought forward as substitutes for stone as a building material, and more especially with a view to the saving of the costly labour necessary in reducing the raw material to the ornamental forms required for architectural decoration; many of the substances known by that name differ from cements only in their application, and in being moulded beforehand, and used in building in blocks in a hard state, and they may be said to be distinguished from the kind of material known as terra-cotta in being a chemical combination of the ingredients of which they are composed effected without the aid of heat. In one case, indeed, which is represented in the Exhibition under the epithet of artificial stone, heat has been employed to a great extent, namely, in the great block of semi-vitrified brick or clinker, contributed by M. Beraud, and more fully described further on. And in the case of Mr. Ransome's artificial stone, which is, perhaps, the one that most of all the various attempts really deserves this epithet, the chemical combination can only be effected by the aid of great heat.

The nearest approach to Mr. Ransome's process in the Exhibition seems to be that of M. Kuhlmann, who exhibits specimens of his method of saturating soft and friable stones with silicate of potash, so as to render them hard and permanent, and not only to improve in this respect the building stones already in use, but to enable what has hitherto been thrown aside as quarry rubbish, from its softness, to be made use of in a state in which it is harder and less liable to deterioration than the naturally firmer and more valuable beds. Another obvious advantage attending the employment of this process, is that the softest stones may be wrought into the most delicate forms, and then submitted to the action of the silicate of potassium, thus saving the expense of the labour in cutting, which the harder qualities necessitate. Several experiments that have already been made on this process are said to have been attended (as far as can be judged of without the effect of time) with entire success, and the cost of silicatising the face of a wall is stated not to exceed from 1*d.* to 1½*d.* the superficial foot. The operation consists in simply saturating the stone with the liquid made use of until it is no longer capable of imbibing moisture, and the colour, although at first much changed, is eventually not injured.

Among the many exhibitors of artificial stone who appear in the French section (and, indeed, France is the only contributor under this head), a M. Dumesnil, accompanies some blocks of artificial stone with a kind of estimate of the comparative expenses of construction with brick, rubble, and ashlar masonry, and also with his artificial stone, which he makes out to be in the following proportions:—

Front exterior, complete in ashlar masonry......	£1114
The same elevation in brick	827
The same in rubble masonry	560
The same in artificial stone	480

No data are given on which these sums are founded, and knowing the extremely favourable eye with which inventors are apt to regard their own inventions, they would of course be received with caution; his manufacture has, it is said, been in use with some success for several years; it seems to be principally composed of plaster of Paris, and is cast in moulds into any shape.

M. Coignet exhibits a block of the concrete which he has used in the construction of a house near St. Denis, and which has excited considerable interest in Paris. M. Coignet has, as the results of a series of experiments, given us the recipes for making two kinds of concrete suitable for house building, which he distinguishes by the epithets of economic concrete, and hard and solid concrete. The first is composed of—

Sand, gravel, and pebbles..........................	7 parts.
Argillaceous earth	3 parts.
Quick lime	1 part.

This concrete, he says, properly beaten up and mixed, has given walls nearly as hard as the common soft rubble masonry used in Paris; in price it competes with ordinary pisé work, over which, however, it has the advantage of being able to resist moisture.

The hard concrete is composed of—

Sand, gravel, and pebbles..........................	8 parts.
Common earth, burnt and powdered	1 part.
Cinders, powdered...	1 part.
Unslacked hydraulic lime..........................	1½ part.

The materials to be perfectly beaten up together. Their mixture gives a concrete which sets almost immediately, and becomes in a few days extremely hard and solid, which property may be still further increased by the addition of a small quantity, say one part, of cement; and the price, depending principally on that of the time and labour, was, in Paris, under unfavourable circumstances, 3½*d.* to 4*d.* per cubic foot; with more favourable conditions, 2*d.* per cubic foot. A house, three stories in height, 65 feet × 45 feet, standing on a terrace having a perpendicular retaining wall 200 feet in length and 20 feet high, has been actually constructed, with every part, including foundations, vaults of cellars, retaining wall, all walls exterior and interior, without exception, of this hard concrete (Beton Dur), as well as the cornice, mouldings, string-courses, balustrades, and parapets, and without bond iron, lintels, or wood throughout; the use of plaster in the interior is also avoided, as the concrete takes a surface sufficiently fine for papering. The retaining wall measures 22,750 cubic feet of masonry, and constructed of Paris hard rubble (meulières) or ashlar, it would have cost from 1200*l.* to 1500*l.*, and in common soft rubble (moëllons) and stone coping, from 650*l.* to 750*l.*; on M. Coignet's principle it has cost—

	£
22,750 cubic feet of concrete laid at 2*d.* per cubic foot	190
Balustrade in moulded concrete........................	18
Total	£208

The entire house, M. Coignet says, only cost 400*l.*, and he further states that to build one similar of ashlar it would have cost probably five times that amount; the same person has also constructed a chemical manufactory at St. Denis, in which walls, drains, and water-pipes are all of this material, as also the foundation of a 30-horse engine. If all these statements as to cost, &c., are correct, the material of M. Coignet would appear worthy of being further inquired into, as it would seem to afford a means of construction at a price hitherto unheard of.

Another description of artificial stone, a large block of which is exhibited by M. Berand, comes rather under the head of brick than artificial stone, as it is procured by the application of fire, and is, in fact, simply an enormous mass of brick; it is proposed as a substitute for stone in sea walls and other maritime constructions, where the superior durability of vitrified material will give it an advantage over concretes made with lime or hydraulic cements; it ranks in the same class of materials with the slag cast into blocks and proposed as a building material by Mr. Chance, of Birmingham, and it is much to be regretted that both he and Mr. Ransome should have abstained from exhibiting in this class, as the artificial stone of the latter gentleman is certainly far superior to anything of the kind in the Exhibition.

Cements and Limes.

The lime which was most favourably mentioned was a new one, known by the name of Chaux d'Echoisy, the manufacture of M. Jugand Roux, of Augoulême, and of which the following analysis is given:

Carbonate of lime	803·0
Carbonate of magnesia	26·0
Carbonate of protoxide of iron	5·8
Alkali	1·2
Pyrites	8·0
Clay	146·0
Bitumen	10·0
	1000·0

It is said to be unaffected by the action of salt water, but of this some time is necessary to judge.

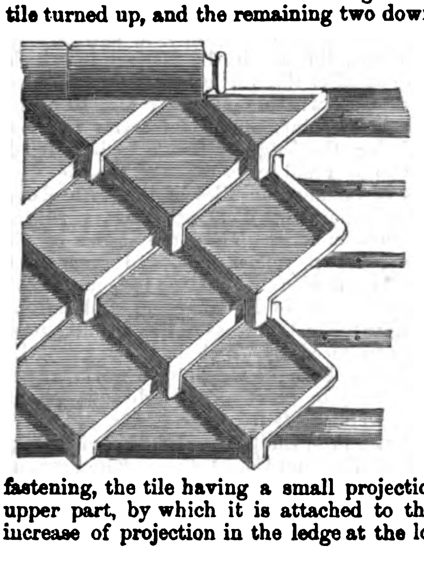
Roofing Tiles.

The several descriptions of roofing tiles shown, almost all of which are from France itself, may be considered as belonging to one of five different classes, the first of which includes the original flat tile, the examples of which differ merely in the material of which they are composed, and in their greater or less thickness and weight, governed in great measure by such material. The other four classes or general forms of tile are the results of different attempts which have been made from time to time to obviate the great objection to the employment of flat tiles—namely, the necessity of laying them so that the roof is covered at every part of its service with three thicknesses of tile, and the consequent enormous weight of this description of covering, an evil so great as to have almost entirely banished it from all large modern structures in this country, as more than counterbalancing its undoubted and great advantages of durability, great strength, resistance to the action of the wind, cheapness, and perhaps the most important of all, the fact of its being so bad a conductor of heat as to render the attics of buildings thus covered, less sensible of the extremes of heat and cold, which are so much felt where metal or even slate is employed.

The best specimens of the flat or Burgundian tiles (as they are termed in France), in the Exhibition are perhaps those of Messrs. Genot and Co., to which they give the name of grès céramé. In appearance they are almost like fine grained granite, with a very metallic ring, extremely thin and light, and no doubt of great strength and durability. A somewhat similar tile, from the factory of M. Boulanger, of Auneuil (Oise), if anything surpasses the first-named in thinness and lightness; in both, the clay is completely vitrified, and it is a pity that some particulars as to weight, price, &c., of such a remarkable material have not been sent with them. It may be mentioned here that Messrs. Genot exhibit draining-tiles and pipes of the same excellent material. The average weight of flat tiles may be taken at upwards of 5000 lb. the thousand, 380 tiles to the square of roofing, which thus weighs from 1800 to 2000 lb. in this material. The flat tile is kept in its place by pegs or nails driven through holes in its upper part, and each tile is by this means attached to the lath without being dependent on its neighbours for support; the same rule applies to the next class, which is, as well as the first, flat, and attached in the same way, and in which the attempt to reduce the weight consists merely in cutting away those parts of the tile which are concealed beneath others, and in some cases also in rounding off or pointing the exposed part, so as at the same time to contribute more or less to its ornamental character; the result is a tile somewhat in the shape of the blade of a shovel flattened, and in some cases approaching the form of a spade pip on cards, and which is fastened, as in the flat tile, by a peg driven through a hole in the short stalk or handle at its upper extremity; these tiles are further ornamented in many cases by the introduction of figures or patterns in relief on their surface; they have the advantage of being easily fixed, and lighter than the plain flat tile, but still necessitate a very high pitch of roof to enable the laps to be perfectly weather-proof. The first departure from the ordinary Burgundian pattern is illustrated by the tiles exhibited by M. Blondeau, which are merely the former with the lower corners rounded off, and a little scoop at each side taken out of the part which is hidden by the superposed tiles. Some of these tiles are more or less ornamented in relief on the surface, and when fixed have a very pretty effect. They appear to have been gradually pared away by different makers till they have assumed the form described above as that of the spade pip on a card, which seems to be the one generally in vogue among the French and Belgian makers. Belgium sends, by M. Josson, of Antwerp, some good examples of this class of tile, the weight of which is stated to be 3740 lb., and the cost 60*s*. per thousand; 220 of these tiles cover a square of roofing, the weight of which is therefore 812 lb., which gives a remarkable difference in their favour in comparing them with the Burgundian tile; their price in Belgium is 60*s*. the thousand, or 20*s*. the square, fixed. Similar tiles are exhibited by many French makers; among them may be noticed those of M. Vaultrin, which only seem to differ from those described above in being larger and cheaper, the tiles costing from 55*s*. to 110*s*. per thousand according to size, the square taking but 140 of the larger, and costing only 13*s*. M. Martin, of Bourbonne les Bains, also exhibited specimens of a similar tile, but of which no particulars as to price or weight are given.

The desire to remedy the obvious disadvantages resulting from the long overlapping joint and high-pitched roof, the necessary consequences of the two descriptions of tile just mentioned, has induced makers to resort to the construction of several varieties of tile, the general principle of which is to substitute for the lap a short vertical joint rendering the lap and high pitch unnecessary, and at the same time connecting the tiles so firmly together that they are not wholly dependent on their hold on the laths for being kept in their position; these objects are attained in different ways, which, however, all unite in the employment of tiles having their edges turned alternately up and down, so as to form vertical joints at their junction, instead of only overlapping each other as in the first two cases just described, and the remaining classes merely differ in the mode of carrying out this improvement; and, first of all, we have what may be called a third class in the common pantile so much used in London, which is made in such a form that the tiles in each separate course make such a joint with each other, but without reference to the course immediately above or below them; this mode gets rid of the difficulty of providing a great amount of lap for the longitudinal joints, but leaves the horizontal still untouched, and still therefore necessitates a considerable overlap and a high pitch of roof.

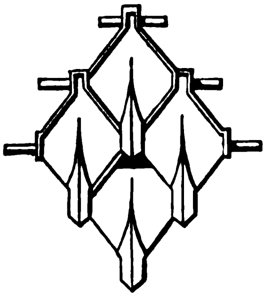
In the fourth class we have the edges inclosing one angle of the tile turned up, and the remaining two down, and the tile laid so that the angle first-mentioned shall be uppermost, and that the joints shall run in a diagonal direction, by this means continuing the vertical lap all round the tile, which thus enables it to be employed at a much less inclination, and with so little overlap as to have only one-sixth of the surface hidden or useless for purposes of actual covering; in this tile the peg is also dispensed with as a method of fastening, the tile having a small projection on the back at its upper part, by which it is attached to the lath, a very slight increase of projection in the ledge at the lower angle, which fits



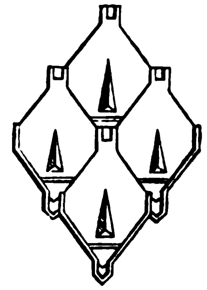
into a corresponding depression in the tile next below, serving still further to secure each in its place. This class may be subdivided into such tiles as are square, and those that are lozenge-shaped; of these, the former, known as the tile Courtois from the name of its inventor, is perhaps the most simple, while the lozenge-shape gives more scope for the introduction of ornament; the square tile has also the advantage of having a less length of joint in proportion to its length, and consequently of having rather more of its surface exposed than the lozenge.

Each one of the tile Courtois weighs 4·5 lb., and 180 of them are required for a square of 100 superficial feet, so that the weight of this amount of covering would be 810 lb., and its cost 44*s*.

One of the principal exhibitors of the lozenge tile of this class is M. Burdin, of Lyons, whose tile is strengthened by a slight rib along its centre, which adds materially to its ornamental appearance, and enables it to be made extremely thin and light, the



FRONT VIEW.



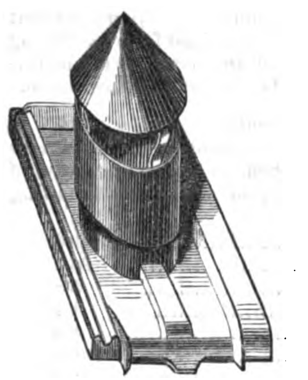
BACK VIEW.

square of this description of tiling not amounting to more than 770 lb., and the single tile being 5·1 lb.; it is shown in three dimensions, running 150, 250, and 350 tiles to the square, and costing respectively 6*l*., 3*l*. 12*s*. 6*d*., and 3*l*. 4*s*. the thousand tiles, or for the first two, 18*s*. the square, and for No. 3, 1*l*. 2*s*. 6*d*. Another maker, a M. Gaillard de Romanet, also from Lyons, exhibits a tile identical in principle with that just described, but with greater pretensions in the way of ornament; in this tile the small strengthening fillet is developed into a grotesque bird's head, something approaching to the grotesque gurgoyles so often seen in mediæval structures, which is remarkably pretty in the hand, or when seen close, but is altogether so insignificant in size, and so wanting in boldness, as to be utterly thrown away at even the lowest height of a roof in actual construction; these tiles are shown as laid alternately, white and red, and although, as before mentioned, the ornament must be considered as so much waste, yet the whole effect in a roof must be pleasing and light.

The fifth class of tiles may be considered as only differing in principle from the tile Courtois in having the tiles laid with their joints horizontal and vertical instead of diagonally, and consequently having the turned-up edge carried along the top and one side, and that turned down along the other side and the bottom; but so many modifications have been introduced, that in many of those exhibited the original or governing form is with difficulty discovered. This class, as well as the last, may be said to consist of two subdivisions, differing in the manner in which the tiles are laid; that is, whether the vertical joints of the tiles in different courses coincide, or whether they are laid so as to what is technically called break joint; the former seems to have the advantage in permitting the ledge or flange to be carried uninterruptedly along the upper and lower edges of the tile.

Among the examples of rectangular tiles of the fifth class, those of M. Pegnaut (department côte d'or) approach, perhaps, nearest to the tile Courtois in form. They are shown of all colours—red, black, white, brown, yellow, blue, and green, and are distinguished from most others in the building by being glazed on the upper surface. In the tiles of M. Gilardoni of Altkirch, who is said to be the originator of this class of tile, a centre projection or corrugation is introduced, by which the tile is strengthened sufficiently to enable it to bear the weight of a workman on the roof, and at the same time to be of great lightness; 140 of these tiles cover a square, which costs from 12*s*. to 13*s*.

But, perhaps, the best and most complete exhibition of roofing tiles is that of Messrs. E. Muller and Co., of Paris, who proving not merely for a covering, but also give the means of introducing skylights, either to open or fixed, ventilation tiles, and of employing tiles as flashing round chimneys, and in similar situations. The form of the tile seems a little complicated, but not at all so as to render it more difficult to be fixed, or to require a more skilled description of labour for that operation, and this slight complication does not seem to affect the manufacture in any way, their price not differing from that of the average of the tiles exhibited. This tile, which may be better understood by a reference to the accompanying woodcuts, has the fillets or flanges along its lower edge slightly returned parallel to the face of the tile; this return being locked into a corresponding recess in the tile next below it, more effectually secures it from the action of the wind, and

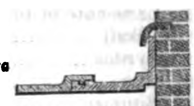


VENTILATION TILE.

ORNAMENTAL RIDGE TILE.

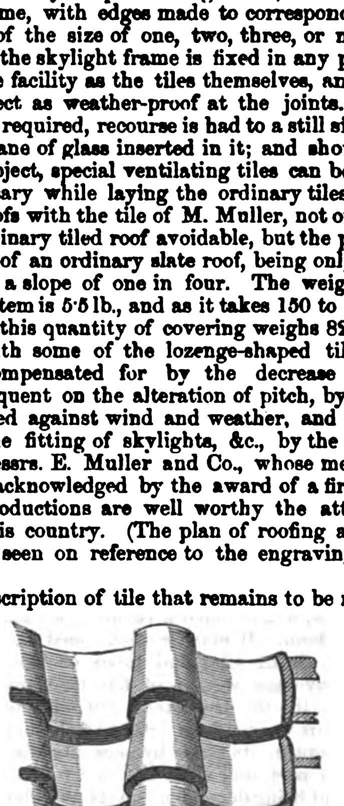
COMMON RIDGE TILE.

FLASHING TILE.

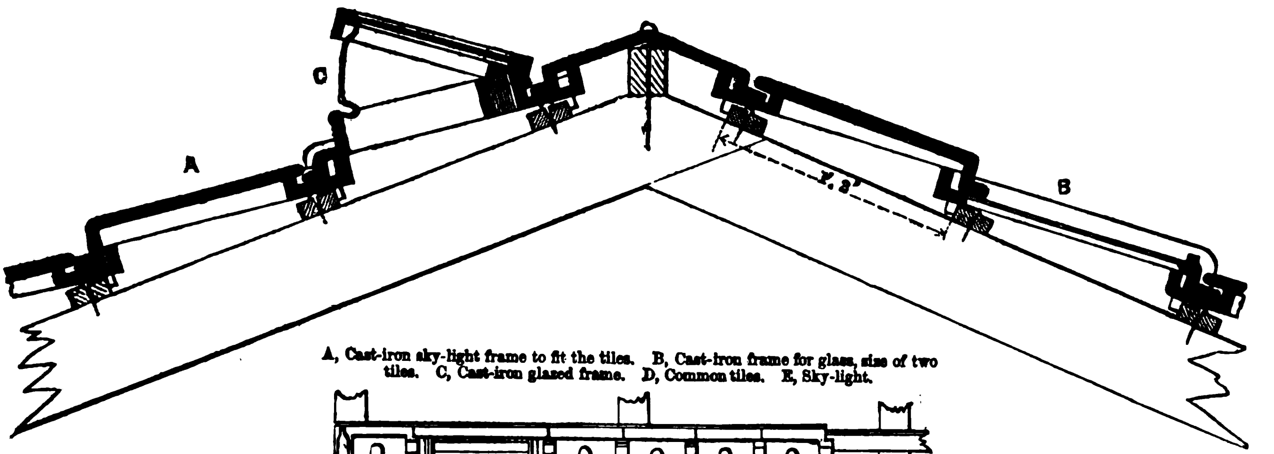


at the same time gives a water-tight joint without the necessity of a high pitch. The longitudinal joint is formed by two small fillets on the face of the one tile, fitting into two grooves in the reverse of the next, thus being secured by three edges lapping over two, instead of merely one over one as in the tile Courtois. The method of providing for the insertion of a skylight is extremely simple and ingenious; it consists in having a cast-iron frame, with edges made to correspond with those of the tiles, and of the size of one, two, three, or more tiles; this frame forming the skylight frame is fixed in any part of the roof with the same facility as the tiles themselves, and is, of course, in every respect as weather-proof at the joints. Should light without air be required, recourse is had to a still simpler cast-iron frame with a pane of glass inserted in it; and should ventilation alone be the object, special ventilating tiles can be introduced as often as necessary while laying the ordinary tiles. In the construction of roofs with the tile of M. Muller, not only is the steep slope of an ordinary tiled roof avoidable, but the pitch is reduced far below that of an ordinary slate roof, being only one-eighth of the span, or at a slope of one in four. The weight of a single tile on this system is 5·5 lb., and as it takes 150 to cover a square, it follows that this quantity of covering weighs 825 lb., or somewhat more with some of the lozenge-shaped tiles; but this is more than compensated for by the decrease in amount of covering consequent on the alteration of pitch, by the additional security afforded against wind and weather, and by the facility obtained in the fitting of skylights, &c., by the employment of the tiles of Messrs. E. Muller and Co., whose merit the jury of this class has acknowledged by the award of a first-class medal, and whose productions are well worthy the attention of constructors in this country. (The plan of roofing above described will be readily seen on reference to the engravings on the next page, 113.)

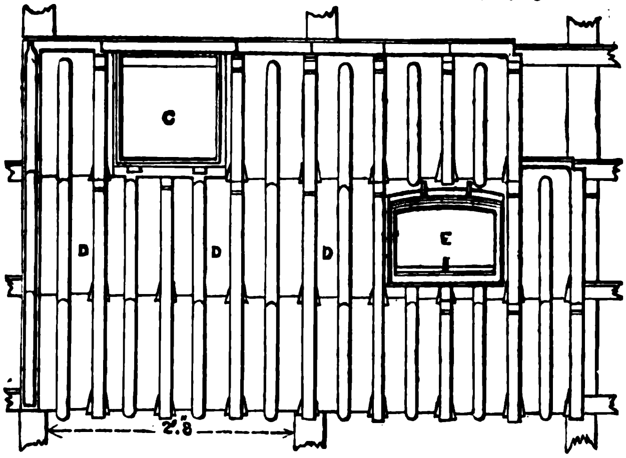
The only description of tile that remains to be noticed is that



in which the longitudinal joint is formed by a similar flange on the face of each tile placed contiguous to each other, and covered



A, Cast-iron sky-light frame to fit the tiles. B, Cast-iron frame for glass, size of two tiles. C, Cast-iron glazed frame. D, Common tiles. E, Sky-light.

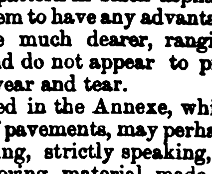


Section of Cast-Iron Glazed Frame.——A. Glass.

by a cap or bridge tile, either similar to the first, turned upside down, or formed like the Italian roofing in the shape of a mere fillet covering the joint. A modification of this system is exhibited by M. Courtois, which however does not seem to possess the same advantages as many of those kinds above described, and is, at the same time, more expensive than any of them, being 55*s*. 6*d*. the square.

Flooring Tiles.

The use of tiles for flooring, although but rarely seen in England in modern constructions, prevails to a very great extent in France, and as a consequence we have the French Exhibition full of many varieties of this useful material, some of the manufacturers claiming beauty of colour or design, some excellence or durability of material, and others lowness of price, as the distinguishing mark of their particular make or clay. When we speak of tile-making for purposes of flooring or pavement having almost become extinct in this country, we must not forget to speak of the revival of the manufacture of encaustic tiles, a revival which has resulted in the development of that branch of art-manufacture to an extent far surpassing the original type, and of which Mr. Minton has given such beautiful examples in connection with his exhibition of pottery, examples that are quite unapproached by any efforts in that direction of the foreign makers in the Exhibition, and must be mentioned quite by themselves. At the same time, it should be noticed that this beautiful manufacture, from its price, is essentially "de luxe," and precluded from being so extensively adopted in ordinary houses, as is the case with the less expensive and more common kinds so universally used in France, for the flooring of passages and rooms, both up and down stairs, even bed-rooms being constantly floored with this material, which has the advantage of being fire-proof, and when covered with a carpet, much more noiseless than a wooden floor; it seems, however, judging by the examples seen in France, to be difficult to render and keep the tiles perfectly true and level, which must thus form rather a destructive substructure for carpets. Some tiles, also with encrusted patterns, appear among the contributions of the Paris manufacturers, which seem executed with considerable nicety, and the patterns are good in themselves, but there is not that beauty of design or high finish of execution which distinguishes Mr. Minton's manufactures of this class; in one branch, indeed, that of tesseræ for pavement, he is the only exhibitor, none of the French or other foreign potters having exhibited anything of the kind. M. Martin-Brey, of Besançon, has some good flooring tiles, and at a moderate price, viz.—6*d*. per foot super.; they are glazed tiles of a dark reddish brown ground with a geometric pattern in yellow encrusted in the surface. M. Vollant, of Chateaurouge, exhibits several specimens of pavement, some in patterns formed with diamond-shaped tiles, imitating dark and light marbles, interspersed with white, red, and black, the price of which is 6*d*. per foot superficial, one a chess-board pattern in black and white at 5*d*. per foot superficial, also one at the same price in which white octagonal tiles are filled in with small square red ones, a sample at 4*d*. the foot, in which white hexagonal tiles and diamond-shaped imitative marble make up the figure, and finally a very pretty herring-bone brick pavement, in which small cubes of black brick are introduced, with good effect, between the ends of the other bricks, the price being 6*d*. per foot. The maker claims for these that they are unaffected by heat, frost, or water, that they wash well, that their colours are unalterable, and that being of precisely the same degree of hardness, there is no possibility of any unevenness in wear, as is the case where materials of different kinds are employed in conjunction.



A piece of flooring is shown by M. Dufour to illustrate a kind of tile, if it may be so called, of his invention, which is made of a sort of white cement or plaster, with a pattern in black asphalte encrusted in the surface. They do not seem to have any advantage over tiles properly so called, as they are much dearer, ranging from 6*d*. to 1*s*. 6*d*. the superficial foot, and do not appear to promise the same amount of resistance to wear and tear.

There is another invention, exhibited in the Annexe, which being used as a tile in the construction of pavements, may perhaps be introduced here, although not belonging, strictly speaking, to this kind of manufacture; it is a flooring material made of hexagonal cast-iron frames, which have parts of their surface sunk so as to form a series of cells; these are filled up level with asphalte or cement of different colours, which is prevented from being worn down by the sides of the hexagons and the other projecting parts of iron, these latter at the same time being so arranged as to form an ornamental pattern or design. The principle is somewhat similar to that of the cast-iron street pavement lately laid down in Leadenhall-street; the price is not stated, but would probably be considerably more than that of tiles, and it is doubtful whether the increase of durability would be sufficient to compensate for a larger outlay.

Perhaps the best specimens of flooring tiles in the Exhibition are those shown by M. Chabert, of St. Just des Marais, a very smooth, even, unglazed, octagonal tile of a beautiful cream-colour, and so close in texture as almost to take a kind of polish. They are accompanied by small square red tiles for filling in between the octagons. The price of the octagons per 10 feet superficial is

4*s.* 6*d.*, and the necessary number of red squares for this dimension is 1*s.* 3*d.*, so that the pavement complete costs rather less than 7*d.* per foot superficial.

M. Carpentier, (Seine Inferieur), shows red and cream-coloured flooring tiles, some with only one colour on each tile, others with red pattern on a white ground and *vice versâ*, the price being from 6*d.* to 1*s.* per square foot. From Ponchon (Oise), there are some tiles in the style of Dutch tiles, blue and white, and blue, white, and yellow, in squares, and a M. Fossarien (Paris) exhibits flooring tiles of a material which he calls "Carrelage ceramique anhydroplastic," which are painted in various colours, and are said by the maker to be durable; but these again being made of a material that sets hard in a few hours without being submitted to the action of fire, come rather under the head of cements than of pottery, as the name would seem to imply. There are some very well finished and good coloured tiles from Chartres; they are whole coloured red and white unglazed, of three forms, octagonal, hexagonal, and rectangular, and the prices and dimensions are as follows:

Octagonal (pure white), 9 inches in diameter, 4*l.* 16*s.* per thousand.

Octagonal (red), 9 inches in diameter, 4*l.* 8*s.* per thousand.

Rectangular (white), 9 inches by 4 inches, 2*l.* per thousand.

Hexagonal (red), 8 inches diameter, 2*l.* 5*s.* per thousand.

Some curious looking flooring tiles are exhibited by Messrs. Corballa-Delucca and Co., of Turin; they are thin, light, well burnt and made, but being meant to represent a dull reddish coarsely-veined marble, they are not so pleasing in appearance as some of the French flooring tiles enumerated above. With this single exception none of the foreign states contribute anything under this head.

Bricks.

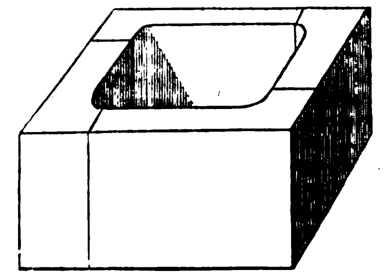
The principal show of French bricks was from the Burgundy district, and their distinguishing feature is their very beautiful colour. They are a rather small brick, very even, and of a very remarkable tint of reddish brown, which forms a good contrast with dressings of any warm light-coloured stone, such as Caen stone or the building stone of the Paris basin. M. Gerard has some small red bricks roughly glazed on one side, apparently a rude imitation of some hollow bricks with coloured glazes, which were exhibited in 1851. M. Mallé, of Paris, shows some bricks with a very deep projection on one side keying into a corresponding hollow in the next brick. Messrs. Chaudet and Son (Paris) have some hollow bricks of a peculiar form for making partitions, ceilings, flues, &c.; they are about 9 inches by 7 inches, and 1½ inch in thickness, each brick having a projection at one end which fits into a groove in the end of the next. They are used on edge, and some of them that are shown put together seem to form an extremely strong and good partition. Their weight is from 3 to 3½ lb. each; they are furrowed on the outside for plaster where it may be required, but the bricks themselves being of a good greyish white colour, this might, perhaps, be omitted in many cases. Partitions formed in this way have the advantage of being proof against fire, vermin, and sound, and of saving room by being not more than half the thickness of an ordinary lath and plaster partition.

M. Paul Borie, of Paris, has a very large and valuable exhibition of his various kinds of hollow brick, which are now so largely employed in all constructions in Paris. They are made of six different dimensions, to suit the various uses to which they may be put, viz.—

No.	Length in inches.	Breadth in inches.	Thickness in inches.	Weight in lbs.	Price per thousand.
1	8¾	6	1⅛	2·8	48*s.*
2	8¾	4⅜	2	2·9	48*s.*
3	8¾	4⅜	2¾	2·9	48*s.*
4	8¾	4⅜	4⅜	5 4	80*s.*
5	8¾	4⅜	4⅜	5·4	80*s.*
6	8¾	5½	3¼	5·4	80*s.*

These bricks differ from the hollow bricks that are in use in England in the form and extent of their perforations or hollows. Those that have appeared in this country being generally pierced with a number of small round holes in a transverse direction, and M. Borie, on the other hand, constructing his with one or more rows of square openings running from end to end of the brick, and so disposed that every part of the skeleton, as it might be called, into which the brick is thus divided, is precisely of the same thickness, and that, consequently, there is no tendency to shrink in one part more than another, and that all parts are equally burnt, and the brick of equal strength throughout. They are made of a very fine clay, and are said to be stronger than solid bricks. These hollow bricks are used not only for brickwork in walls, but also on edge in partitions similarly to those of M. Chaudet, and the principle is also carried into the manufacture of lintels for doors and windows, which are made of the required lengths by M. Borie, of brick clay, and perforated with longitudinal openings, the same as in his bricks. A hollow brick beam of the same section as one of his smallest common hollow bricks, viz.—4⅜ inches wide, and 2 inches deep, pierced with two longitudinal openings, which reduced its sectional area to 4·2 square inches, was loaded during the whole time of the Exhibition with a weight of 220 lb. on its centre, the extremities being supported on bearings, 3 ft. 9 in. apart, and another of these long bricks or lintels, measuring 4⅜ wide by 2¾ deep, with a solid sectional area of not more than 5·2 square inches, bore with the same bearings, viz.—3 ft. 9 in. between the supports, a weight of 440 lb. on its centre.

M. Hasbrocq, architect, of Paris, shows bricks moulded into peculiar forms for special purposes, as, for instance, for the construction of flues, for which he employs a brick, the form of



which may be better understood by reference to the annexed cut. He also proposed the same shaped brick to be used for rounding off the angles of rooms, and when covered with a white porcelain-like glaze to be employed in conjunction with a similarly glazed flat brick, for linings of apartments where glaze is preferable to plaster, as, for instance, water-closets, &c. In the figure these bricks are represented as lining the corner of an apartment.

Terra-cotta and Porcelain.

In passing from the subject of hollow bricks to that of terra-cotta employed in construction, we first come to the exhibition of the Count de Pourtales, whose goods fill a sort of intermediate position between tiles and bricks; they are a species of terra-cotta tile or slab, strengthened on the lower side by deep ribs or flanges running longitudinally from end to end, and are proposed to be employed in forming ceilings, more especially where plaster cannot be conveniently used, in stables, &c.; the specimens shown are about 18 inches long, by 6 or 7 inches in width, with a thickness of from half to three-quarters of an inch, and having four ribs each 2 inches deep and half an inch thick. They are shown bridging from one joint to the next, their ends resting on a small fillet attached to the lower part of each joist. They have the advantage of combining great strength and lightness, and in connection with iron joists would no doubt make an admirable fire-proof ceiling, and the system might probably be extended to the construction of floors also. An Englishman, a Mr. Taylor, has a method, a very ingenious one, of facing brick buildings with a thin veneer (as it may be called) of terra-cotta; the pieces of terra-cotta which he uses are flat tile-shaped slabs of about 15 inches by 9 inches, and 1 inch thick, with a small return or fillet extending along the upper edge, which forms the means of connecting it to the brickwork; he proposes to employ the same system with any building stone that is sufficiently manageable to be readily sawn into similarly shaped slabs, and exhibits a model showing a very neat way in which a great number of these pieces may be sawn out of a block of stone without waste, so that a house may be faced with less than a sixth part of the stone at present employed for the same purpose; this system is said to have been tried in several houses with perfect success.

There are two French manufacturers who exhibit very fine specimens of terra-cotta, as applied to architectural decoration, viz.—M. Virebent, of Toulouse, and M. Garnaud, of Paris, the former of whom has a magnificent deeply recessed and elaborately sculptured Norman doorway, the recessed sides of which decorated with figures of saints in niches, and the arch mouldings in many highly-ornamented concentric rings, would have been very costly to produce in even the softest and most easily-wrought stone, as it presents a surface of from 250 to 300 superficial feet of carving. It is here produced in a beautiful Caen-stone-tinted material for 120*l*., or not 10*s*. a foot superficial.

A chimney-piece in biscuit, by M. Gille, and some caryatides and other figures in the same delicate material, intended for interior decoration, do not give so successful a result as the coarser terra-cotta, as they cannot compete with marble in appearance, and probably will exceed it in price; and the difficulty of executing such large subjects in such a material—a difficulty which is well exemplified by the cracks and failures of which those exhibited are full—will always present a bar to its being extensively employed in construction.

In the garden behind the Palais de l'Industrie the front of a house is shown, which is largely decorated with plaques of earthenware or porcelain, painted with flowers and other devices in colour. The effect is more fantastic than in accordance with good taste, but still the attempt is not without value as suggestive of an exterior decoration, which might be turned to good account in an atmosphere like that of London, where its quality of readily washing and being easily and cheaply cleaned would render it worthy the attention of shopkeepers, as being in this respect more economical and better looking than paint.

Perhaps the most successful application of earthenware to decoration is exhibited in the construction of the Exhibition building itself, where, in the grand entrance, in a kind of open porch, may be seen some two or three circular plaques or medallions of Lucca della Robbia ware, which are inserted in the ashlar work of the wall with extremely good effect. Altogether there is enough to convince any one who may look into the subject that terra-cotta and earthenware may be brought with advantage to play an important part, both in the construction and decoration of our edifices of all classes and for all purposes.

Asphaltes and Bitumens.

Again referring to the French classification of objects in the Exhibition, we come to the next subject, which is that of asphaltes and bitumens, both natural and artificial; and here, as in the last section, we find the great bulk of the articles exhibited are from France, which country, indeed, supplies almost all the material of this kind at present in use; in fact, with the exception of one exhibitor from Switzerland, M. Babineau, and specimens of asphalte from a Canadian Company at Hamilton, all the asphalte exhibited was French.

The floors of several parts of the Exhibition building presented good examples of the various methods adopted in Paris for laying asphalte as a pavement, whether plain, ornamented with patterns in various colours, or marked into small squares with deep scores to form a footing for horses; this substance is now very much employed in Paris in the construction of footpaths to the different streets and open places, and seems to have met with much more success for this purpose than in England. Nothing novel, either in form or manner of treatment of asphalte as a pavement, has been elicited, but a material exhibited by Messrs. Automeyer, of Paris, is deserving of notice; it is called "bitume laminé," and is proposed for roofing flats, and in fact for all roofing purposes for which lead or zinc is now employed, such as the covering of domes or cupolas, flashings, gutters, &c., and, with the exception of its non-capability to resist the action of fire, seems well adapted for that kind of work. A small summer-house was shown covered with it, and was made in the most irregular forms, apparently with a view of showing the facility with which the material could be employed, and although it was exposed through the whole summer to the intense heat of a Paris sun, it never at any time showed any symptoms of becoming soft, nor did it even in the parts where it covered the perpendicular sides of the small erection, exhibit at the close of the summer, any traces of having run, or altered in form or in any other respect; it is a preparation of asphalte in the form of sheets, which can be procured of several thicknesses and widths, any length (that exhibited being about a yard wide and three-sixteenths of an inch thick), and is applied somewhat like sheet lead, the joints being made by slightly melting or softening the parts to be joined by a hot iron. It might, perhaps, be employed with advantage as a substitute for lead in lining water-tanks or cisterns, and in fact in any situation where lightness and cheapness was an object; in the two qualities of lightness and facility of application it has a decided advantage over the former material.

Iron in Construction.

The Exhibition, as would naturally be expected, presents great variety, and contains many points of interest in connection with the employment of iron in construction; and this part of the subject is above all others characterised by the display of novelties and improvements in the application of this most important material; and there seems to be one singular difference between the two countries in the direction which the employment of iron seems to be taking; for while in England it has become the property of the civil engineer, and is almost entirely confined to large and important constructions, in France, on the contrary, wood and stone still seem to be the most popular materials for this kind of works, and iron, although employed also to a considerable extent in civil engineering, has entered on a course in which it is comparatively unknown in this country, namely, that of supplying the place of wood in private and domestic edifices. The iron made use of for this purpose also shows a difference between the practice of the two countries, England making use of cast and wrought-iron, while in France the iron now invariably used for all girders and beams in the construction of houses, is rolled at once into the exact form required.

Rolled Iron Girders.

The employment of rolled iron in girders and joists for floors, which is almost unknown in England, and which is now very largely adopted in Paris, owes its origin to the circumstance of a very extensively organised strike of carpenters which took place in that city in the year 1846, before which time iron was, even to a greater extent than in this country, debarred by its price from entering into competition with wood in the construction of buildings and private dwellings. In order to extricate themselves from the position in which they were thus placed by such an event, and with a view of preventing its recurrence for the future, the Parisian architects and builders turned their attention to the substitution of iron for wood, both in the roofs and also in the flooring of buildings, and more particularly to the best means of reducing the weight and cost of the material, which, as stated above, formed the greatest obstacle to its general employment. The first difficulty to be encountered was to obtain a sufficient supply of iron of the sections most suitable for the purpose, the roofing of several of the theatres, which had been constructed by a combination of such sections as could be obtained in the market riveted together, showing that the cost of labour consequent on such an arrangement must necessarily prevent its being generally employed.

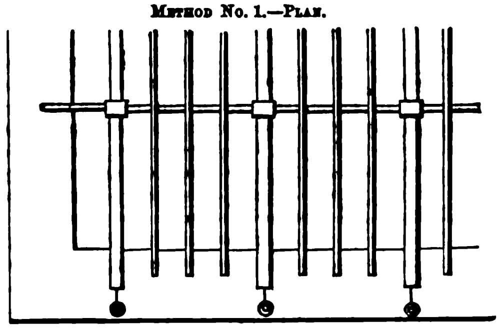
M. Vaux proposed and carried out the application of very thin flat bar or plate iron for floor joists, but these being obviously ill-adapted to give the necessary amount of lateral stiffness and rigidity, were quickly superseded by a joist or girder whose section was in the form of a cross, proposed and made by M. Bleuze, and in which he sought to give lateral rigidity by a single flange at the neutral axis of the beam, which thus assumed in section the form of a Greek cross. This, although a failure as far as the section was concerned, was a great advance in one respect, viz.—that it was an iron beam made in one piece, specially for the purpose for which it was intended, instead of being merely made up of various shapes riveted together, as had been formerly the case, and as is to this day the case in constructing wrought-iron girders in England. Much of the difficulty experienced by the French architects in perfecting this new construction was occasioned by the fact that, according to the custom which obtained at the time, the iron was transmitted from the manufacturer to the builder through the intervention of a dealer, who was totally ignorant and careless, both of the requirements of the latter or of the capabilities of the former to meet those requirements; and it was not until the manufacturer and builder were brought directly into communication that the best forms of iron were made, especeally for the purposes of construction, forming what are called in France "fers speciaux."

The cross-shaped girder of M. Bleuze being, as might have been expected, weak in proportion to its weight, recourse was had to a girder which was first adopted in the construction of the St. Germain railway station, and which was a slight modification of the common I rail, but which being made a great deal too heavy, fell to the ground from its consequent high price, and it was not till the month of February 1849, that the I girder as now used was produced, and first applied in Paris in the flooring of a house, No. 18 in the Boulevard des Filles du Calvaire for a bearing of 18 feet. A number of experiments were instituted by M. Zorès, for the purpose of obtaining the best possible section for these new rolled iron girders, which resulted, first, in proving the uselessness of a third flange which had been introduced by some makers, as in the case of M. Bleuze's girder, at the centre or neutral axis of the I girder, and afterwards in the gradual development of what are now considered in Paris to be the best and most practical forms of rolled iron girder, and which are described below.

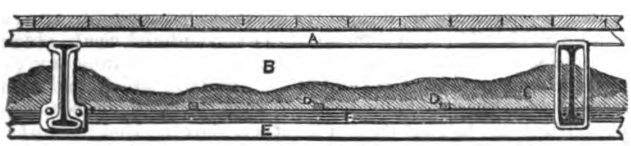
The principle of the substitution of rolled iron for wood having now been established, numerous modifications were proposed in the manner of its application and arrangement as to the ties, struts, and connection with the remaining parts of the floor and ceiling, for both which a variety of methods of construction have been from time to time adopted, and of which some of what are considered the best forms are here described.

The first has the girders of I shape, slightly arched, having a rise of ·06 inches in each foot, placed at a distance of 3 ft. 3 in. from centre to centre, and connected at intervals of 3 ft. 3 in. throughout their length by ties of flat bar iron on edge, resting on the lower flange of the girder, and fastened one to another

Method No. 1.—Plan.



Section Across Girders.



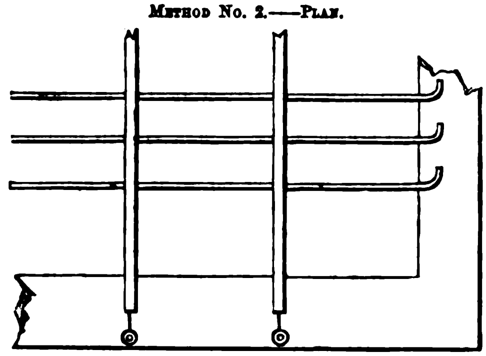
Cast-iron Chair. Wrought-iron Chair.

A. Joist. B. Hollow. C. Plaster. D. Square iron. E. Flat iron tie.

either by wrought-iron straps or cast-iron chairs. Upon these ties are placed square bars, three between each pair of girders, running parallel to them from wall to wall, into which their ends, turned down, are built. The girders are further tied to the walls at each end by iron straps fastened to vertical iron bolts in the wall, and in a lateral direction by the ends of the cross ties being built in in the same way as the longitudinal bars. On the iron framework so formed the thick plaster ceiling is formed without wooden laths, a wooden platform being held under it while the plaster is thrown in from above, and removed after it has firmly set. Small square wooden joists are laid over the girders, and the wooden floor laid on these in the ordinary way.

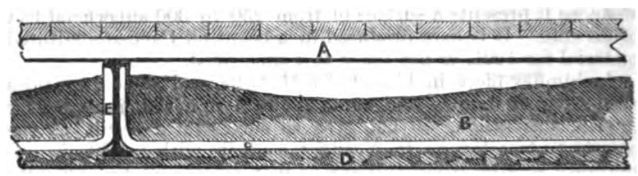
In the second method described, the I girders are also placed at from 3 feet to 3 ft. 3 in. from centre to centre, and are tied, or

Method No. 2.—Plan.



rather strutted, at intervals of one foot by small square bars, reaching from girder to girder, and resting on the lower flange, having their ends turned up in an elbow the height of the web of the girder, and kept upright merely by the plaster with which

Section Across Girders.

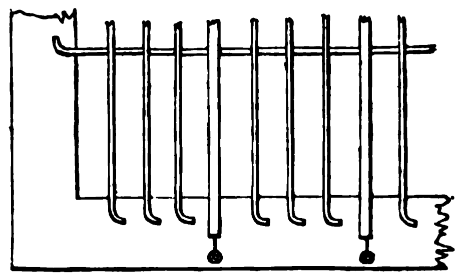


A. Wooden joist. B. Plaster. C. Iron rod. D. Plaster ceiling. E. End of rod.

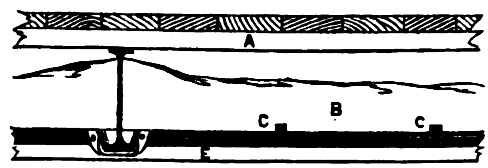
they are filled in; this, as will be seen at once, is the most simple of these methods, but it is deficient in the ties with which the others are strengthened.

The third method differs from the first merely in the manner in which the cross-ties are connected together, being a simplification of the chair already described.

Method No. 3.—Plan.

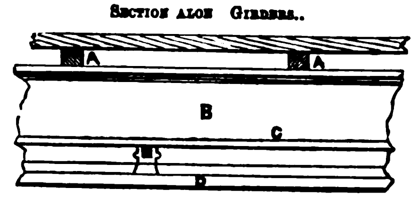


Section Across Girders.



. Joist. B. Plaster. C. Square iron. D. Flat iron bar. E. Plaster ceiling.

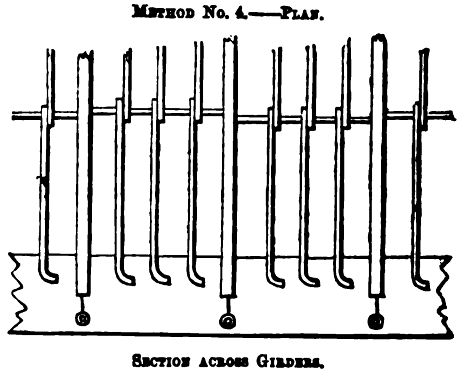
Section Along Girders.



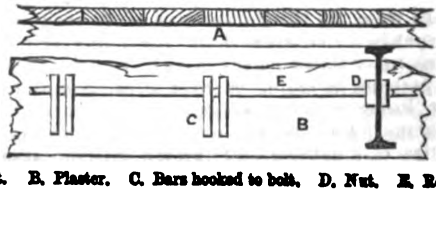
A. Joist. B. Girder C. Square iron. D. Plaster ceiling.

The fourth method is that which has generally had the preference among the principal builders; in it the girders are tied

Method No. 4.—Plan.



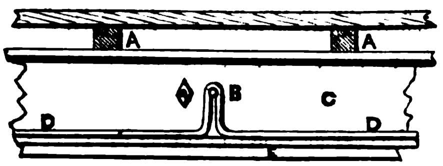
Section Across Girders.



A. Joist. B. Plaster. C. Bars hooked to bolt. D. Nut. E. Round iron.

together in pairs, at 3 feet intervals, by round iron bolts $\frac{3}{16}$ths of an inch in diameter, passing through holes at the neutral axis of the girder, and nutted up at each end. Small square bars are hung on to these tie-bolts by hooks at their extremities, of suffi-

SECTION ALONG GIRDERS.



A. Joist. B. Bolt. C. Girder. D. Square iron bar. E. Plaster ceiling.

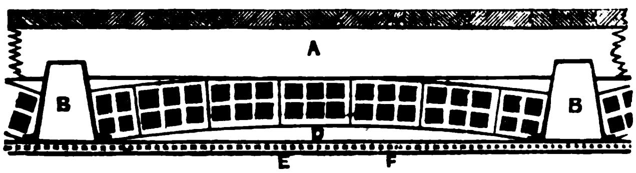
cient length to permit them to hang nearly level with the bottom of the girders, to which they are parallel, as described in the first method, the description of the floor and ceiling of which answer for all four methods.

In speaking of the gradual development and improvement in form of the rolled iron girder, an allusion was made to forms now in use in Paris which are considered superior to the I section commonly employed, of which the four methods above are applitions. These were exhibited by M. Zorés along with the collection of hollow bricks by M. Borie, and were of two forms, called by the inventor "fer tubulaire" and "fer à coulisse," the first being, perhaps, more strictly speaking a girder, and the latter a joist, where only a single floor is required.

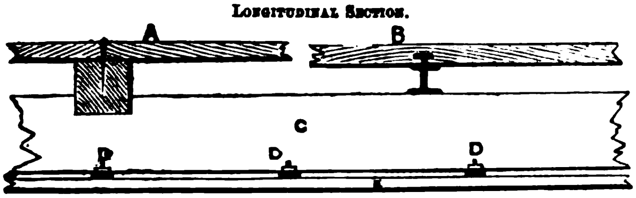
The "fer tubulaire" may be described as being in section of the form of a capital A without the small triangular top; those

SECTION ACROSS GIRDERS.

A. Wooden joist. B. Hollow girder. C. Hollow brick arch. D. Plaster. E. Iron tie. F. Ceiling.



LONGITUDINAL SECTION.



A. Wooden joist. B. Joist of "fer à coulisse." C. Girder. D. Iron ties. E. Ceiling

exhibited are said to be for a bearing of 20 feet and are of the following dimensions, viz.—$4\frac{3}{4}$ inches high, $2\frac{3}{8}$ inches wide at top, 4 inches wide at bottom, exclusive of a small flange of $\frac{3}{4}$-inch projection on each side. The sides of the girder are $\frac{3}{16}$-inch in thickness, and the top and flanges $\frac{7}{32}$-inch. These girders are placed at a distance apart of 2 ft. 8 in. from centre to centre, and are tied together at intervals of 3 feet by flat bar iron ties of $\frac{3}{4}$-inch × $\frac{3}{16}$-inch bolted to the bottom of the flanges, and the flooring finished according to one of the following methods.

Method No. 1.—Flat arches of hollow brick between the girders with joists of "fer à coulisse" (hereafter described,) or of wood, and wooden flooring, or for passages with the spandrils filled in with plaster and floored over with tiles, ceiled underneath to soffit of flat arch.

Method No. 2.—The spaces between the girders filled in with hollow blocks of plaster 4 inches deep. Flooring and ceiling as in No. 1.

Method No. 3.—Wooden flooring as in No 1, with ceiling on small iron laths; hollow between floor and ceiling.

Method No 4.— Wooden flooring without ceiling.

The girders of this section are said to possess the following advantages over those of the I form commonly used; first, with equal weights they give a strength or resistance nearly double, as ascertained by the following experiment: a girder of this form, 20 feet in length, $4\frac{3}{4}$ inches in depth, and weighing 9·5 pounds the foot, deflected 2·34 inches with a load on its centre of 3 tons.

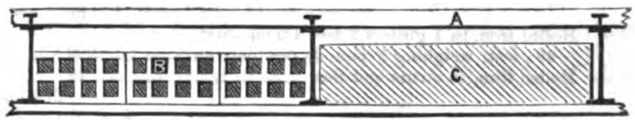
A girder of the I form, 20 feet long, $8\frac{1}{4}$ inches in depth, weighing 16·9 pounds the foot, deflected 2·49 inches with the same weight.

Again, on the score of economy. A floor of 20 feet square, calculated to bear a weight of 200 lb. on the square foot exclusive of the flooring, costs in Paris 9*l.* 6*s.* 10*d.* per square, including everything, when executed with the I rolled iron girder; and a floor similar in all respects, but having the girder "fer tubulaire" substituted for the I, costs but 7*l.* 9*s.* 5*d.* per square.

Another great advantage that this form of joist has over that in ordinary use in Paris is, that it does not require any strutting, while the I girder requires lateral pressure to such an extent that it is said not to be employed to the best advantage unless absolutely filled in with either hollow brick arches or plaster, more than half of its strength being dependent on its lateral rigidity.

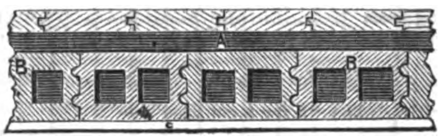
The other form of girder or rather joist, viz., the "fer à coulisse" exhibited by M. Zorés is said to be the invention of a M. Chibou. It is the form of the I or double T girder, but with the addition of a second upper flange, longer than the first and close to it.

SECTION ACROSS GIRDERS.



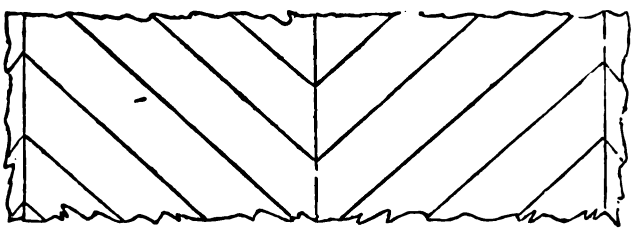
A. Flooring board. B. Hollow bricks. C. Hollow block of plaster.

LONGITUDINAL SECTION.—Showing Method of filling-in with Hollow Blocks of Plaster.



A. Girder. B. Blocks of Plaster. C. Ceiling.

The dimensions of the specimens exhibited are girders $5\frac{1}{2}$ inches deep, top and bottom flanges 1 inch wide, third flange $\frac{3}{8}$-inch below the top one, and $1\frac{5}{8}$ inch wide, and the thickness of the web and all three flanges alike, viz. $\frac{3}{16}$-inch. A girder of this section weighs 3·6 pounds the foot.



PLAN OF FLOORING.

These girders are placed closer together than those just described, viz., at a distance of 1 ft. 8 in. from centre to centre; and are said to possess considerable advantages as compared with those of the I or double T form; first, as to strength, the addition of the second upper flange, from its position so close to the first, may be said to form, in conjunction with it, one flange, having nearly the same resistance to the compressive force exerted above the neutral axis as if it were a single top flange, and coming very near to that which has been laid down by Mr. W. Fairbairn as the best proportion between the top and bottom flanges of malleable iron girders; while, at the same time, it exerts a considerable influence in stiffening the girders in a lateral direction, and thus materially tends to remedy the defect spoken of above, of being liable to torsion or twisting under heavy strains, unless well strutted or filled in solid with brick, plaster, or other material. A second advantage claimed for this section of girder is, that it affords a means of laying flooring at once on the iron without the intervention of joists, and without the employment of nails; and this is effected in a very neat way by having each end of the oak batten, of which the parquet or French flooring is formed, ploughed with a tolerably deep groove into which the top flange of the girder fits, the lower side of the batten resting on the second or broad flange, and its upper surfaces meeting over the centre of the top flange, which is thus effectually hidden; and this method is not only more economical in the first instance, but has the additional advantage of rendering it impossible for any board of the floor to get out of level or start up, and also to give the means of removing the whole or part of the floor at any time and relaying it without the slightest injury, and also of tightening it up in case of any shrinkage of the wood. The facilities for laying a floor in this way are much increased by the French method of flooring with oak in short lengths, and in a kind of herring-bone pattern called "point de Hongre." As to the expense the following is the cost of a square of flooring in Paris, executed in three different ways, viz., in wood, in double I iron, and in the "fer à coulisse" just described.

First, in wood:—

	£	s.	d.
Fir, rough and framed, in girders	2	10	0
Ceiling, and ceiling joists	1	5	0
Sound-boarding and pugging	0	12	6
Flooring, including joists and nails	3	10	10
Fixing joists	0	4	2
Ironwork	0	10	0
Total for a square	£8	12	6

Secondly, in double I iron:—

	lb.
Rolled iron, in I girders 2 feet 1 inch apart, $49\frac{1}{2}$ feet, weighing 6 pounds per foot run	297
Rolled iron, in struts and ties	77
	——374 lb.

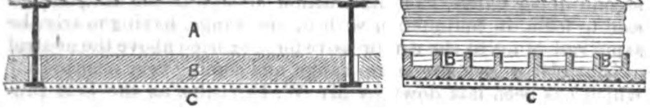
	£	s.	d.
At 22*l*. per ton, including fixing	3	13	6
Ceiling, without ceiling joists	0	16	0
Filling up solid with plaster	1	12	6
Fixing joists	0	4	2
Flooring, including joists and nails...............	3	10	10
Total for a square	£9	17	0

Thirdly, with girders "à fer à coulisse":—

	£	s.	d.
Rolled iron, in girders 1 ft. 8 in. apart, $65\frac{1}{2}$ feet, weighing 3·3 lb. per foot run, 216 lb., at 22*l*. per ton, including fixing	2	2	5
Flooring, laid without nails or joists	2	6	8
Filling in with cast hollow blocks of plaster 3 in. in depth, including plastering thereon for ceiling	1	4	0
Wrought-iron ties, at 6 feet apart	0	4	2
Total for one square	£5	17	3

The ordinary price of first-class rolled iron in Paris is 12*l*. per ton, which price was taken as the basis in putting the price of the girders fixed at 22*l*. per ton. In England the rolled iron could probably be produced at from 8*l*. to 10*l*. the ton, and if so, a floor of this description, perfectly fireproof, could be constructed at a cost considerably under that of the ordinary wooden floors. The weight, and perhaps the cost, of such floors might be much diminished by the employment of ribbed tiles, such as those already described as exhibited by the Count de Pourtales, instead of hollow brick or plaster of Paris, for filling in and supporting the ceiling;

SECTIONS, SHOWING PROPOSED FILLING WITH TILE.



A. Hollow, or filled with Plaster. B. Tiles. C. Ceiling.

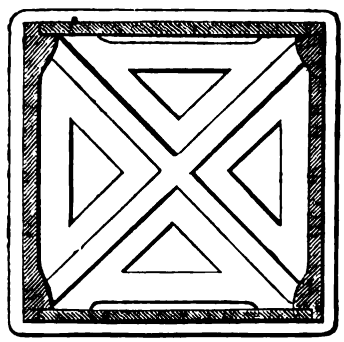
these would be much lighter, would afford a good hold for the plastering, and would give also a fireproof floor. The weight of such tiling would not exceed, perhaps, 800 lb. a square, much less than that of ceiling joists, laths, sound-boarding, and pugging, the place of which it would supply. M. Zorés has a smaller section of "fer à coulisse" which he employs for joists, and in which the web is reduced to $1\frac{1}{2}$ inch in depth, the third flange being exactly midway between the top and bottom, and the dimensions of all three flanges being the same as in the girders, viz., 1 inch, $1\frac{5}{8}$ inch, and 1 inch; these he uses with the "fer tubulaire" girders instead of the wooden joists mentioned above; and in this case the flooring is also laid without nails, in the manner described for the girders "à fer à coulisse." An additional advantage possessed by the girders and joists of these sections is, that a strong floor is obtained with a very much less sacrifice of space, as the following statement of the relative thicknesses of the floors will show.

For the same bearings, and to fulfil similar conditions as to strength, the thickness of the floors would be represented by the following numbers:—constructed entirely of wood, 14 inches; with double I iron girders, 9 inches; with the "fer tubulaire," joisted with "fer à coulisse," 7 inches; and with the "fer à coulisse," having the flooring laid directly on the girders, the thickness does not exceed 6 inches, which, in a room of 20 by 20, would make a saving in the walls of about 68 feet of reduced brickwork, equal to an expense of 3*l*., taking brickwork at 12*l*. per rod.

Rolled iron is also shown in the Exhibition in the form of a string for a well staircase, the particular application being a patent, the property of a M. Coulon of Paris, and in fact this material seems to be to a very great extent taking the place of cast-iron in objects appertaining to construction in that city. Skylights of rolled or wrought iron, some by M. Cordebart, of Angoulême, measuring 3 feet by 2 feet, are offered at from 16*s*. to 20*s*. each.

A girder or bressumer is exhibited in the contribution from the manufactory of Creuzot, which consists of two flat bars or plates of rolled iron $9\frac{3}{4}$ inches deep by $\frac{5}{8}$-inch thick, placed parallel to each other on their edges, and kept at a distance of 12 inches apart by flat plates $\frac{1}{2}$-inch thick, fitting into rabbets in the first-named pieces at top and bottom. These four sides are further sustained

SECTION OF SINGLE GIRDER.



in a rectangular form by the insertion at intervals of about a foot of cast-iron frames, in the form of a rectangle with its diagonals, and at each of these frames the girder is hooped round with a wrought- iron band 3 inches wide and $\frac{1}{2}$-inch thick. The whole thus forms a very strong wrought-iron box girder, without the use of a single rivet. Another girder is also shown similar in construction, but double, being formed of two separate ones, such as that just described, but only 8 inches wide instead of 12 inches; the two are hooped together with wrought-iron bands, thus forming a bressummer of about 18 inches in width from out to out.

Another description of girder is that exhibited by a M. Grebel, of Valenciennes, who sends two specimens, one of 20 feet span, consisting of an arc of rolled iron of the I form, $4\frac{1}{2}$ inches deep and $\frac{1}{4}$-inch thick, having a height or versed sine of 2 feet to the bottom of the chord connecting its extremities, which is of cast-iron 8 inches deep by $\frac{3}{4}$-inch thick, and with a bottom flange 3 inches wide; this is attached to the arc at every 18 inches of its length by a wrought-iron strap 1 inch by $\frac{1}{2}$-inch. The weight of the girder is 1122 lb., and it is stated to be capable of resisting a weight of 40 tons uniformly distributed. The cost is 10*l*. 12*s*. 6*d*.

A lighter girder is shown by the same firm, with a portion of a floor constructed on it; it has a span of 24 feet, and is 18 inches from floor to the ceiling below; it is formed of an arc of rolled iron † shaped in section, $2\frac{1}{2}$ inches deep and $\frac{3}{16}$ thick, with a chord of rolled flat bar 2 inches deep by $\frac{1}{4}$-inch thick; a bar of T-iron, 2 inches deep by $\frac{3}{16}$ inch thick, runs tangent to the arc and parallel to the chord, and all three are connected at intervals of 2 feet by small iron straps, as in the former case. These girders are placed 2 ft. 6 in. apart, and have wooden joists 3 by $2\frac{1}{2}$ inches notched down $\frac{1}{2}$-inch on to the T-iron tangent. The ends of the arcs are held in cast-iron shoes, which bear 8 inches by 8 inches in the walls. The girders are further tied together transversely at bottom by light iron straps. The weight of each girder is 475 lb., and its price is 6*l*.

A model of a roof, 115 feet span, is exhibited by a M. Joly, of Argenteuil, the principals, which are 24 feet apart, are light wrought-iron lattice girders, connected by angle-iron to flat plates forming flanges at top and bottom.

Rolled iron of a variety of sections is exhibited by several o the great ironworks of France, among which may be mentioned those of Creusot, Maubeuge, Montataire, La Providence; the two latter of which show rolled girders up to a foot in height and 36 feet in length.

Cast-Iron.

Cast-iron is exhibited a good deal in the form of ornamental fronts for balconies, and in the open ornamental panel work so much employed in the large entrance gates or "portes cocheres" of dwelling houses in Paris, as also in small ornamental work which is introduced with good effect under the soffits of window openings, and also across the lower parts of the French windows, forming at the same time a precaution against accident, and a very effective decoration.

Zinc.

Zinc is also a metal that enters much more largely into construction in France than in this country, where indeed it has been to a limited extent employed, instead of slate or lead, as a covering for roofs, but not with such success as to warrant its general adoption for that purpose; in France it is now very largely used for this purpose, and seems to give satisfaction, as its use is being continued in almost all the houses now in course of construction in Paris. French builders give as a reason for this difference in the durability of sheet zinc, that in England it is used much too thin, but probably it may be better accounted for by the superior dryness of the Paris atmosphere, and its comparative freedom from the acids contained in the products of the combustion of coal, and from any saline particles that may enter into the composition of the air in England from greater proximity to the sea.

Stamped zinc also appears in a variety of forms, both of ornament and utility, as for instance, in brackets, columns, mouldings, pinnacles, balustrades, and in ornamental tile-shaped plates for roofing, exhibited by the Vieille Montagne Company, and by Grados and Fugin of Paris; it is also shown by a number of French makers in different patterns of crest ornaments for roofs, and in the small open work fringe-like ornament which gives such a neatness and finish to the eaves of the roofs of little verandahs and porches, and which every one must have remarked as constituting quite a feature in the street architecture of Paris and its suburbs, as a border for signboards, and applied to every variety of use. Prussia sends some very light windows in this material, the whole frame, styles, &c. being formed of hollow drawn zinc (zinc tiré). A French casement window of this kind, 8 feet by 3 ft. 6 in., is marked at 1*l.* 5*s.* including the espagnolette or fastening, and a semicircular fanlight of 3 feet radius at 10*s.*

Small zinc plates of different patterns, to be used as tiles, are found in several instances in the Exhibition, but, except for portability, their advantage over ordinary zinc roofing is not apparent, as the number of joints in the covering, and consequently of places to keep water-tight, is much increased, without any corresponding benefit being derived from the employment of such a roof; the best of them are, perhaps, by Levayer (Vaugirard), who has zinc tiles, if the term may be used, 2 feet square, with a copper hook on the back for the purpose of fastening, and with a raised edge lapping over a fillet. Zinc nails for slating are exhibited by the Vieille Montagne Company, as a substitute for iron or copper.

One of the best examples of architectural zinc work is contributed by Prussia; it is an octagonal lantern of the geometric period of mediæval architecture, surmounted by a crocketed pinnacle pierced with small openings. The lantern has a two-light opening in each side, with a quatrefoil in the head; the whole is of thin hollow zinc, and is 20 feet high by 4 feet in diameter.

WOOD.

Considered as specimens of timber for construction, the Canadian collection, both of woods, and articles manufactured from them, stands unrivalled for the magnitude and beauty of the examples of the raw material, and the eminently practical character of the entire collection. These woods are shown both in the rough and also in an immense variety of different objects into which they have been converted, and many of which are remarkable for the extremely low prices at which they can be sold; as, for instance, an interior door, 6 ft. 6 in. by 2 ft. 9in., of white pine, four-panel square, with jamb-linings, &c. complete, for $2·75 or 11*s.* 5½*d.*; another, same size, four-panel, moulded both sides, with jamb-linings, double rebated, and beaded, for $3·50 (14*s.* 7*d.*); also a sashframe and sash, 6 feet by 3 feet, $2·0 (8*s.* 4*d*); and outside Venetian shutters or jalousies for the same, $1·50 (6*s.* 3*d.*) The woods from some of the other British Colonies are also deserving the attention of builders and constructors in this country, more especially those sent from New South Wales, British Guiana, and Jamaica, the results of some experiments upon the strength of which show that out of 79 different kinds of wood experimented upon, 42 exhibited a capability to resist a crushing strain superior to that of oak, one having three times the strength of oak in this respect, while its specific gravity was less than one-half greater, or nearly as 11 to 8. Forty-seven of these timbers proved superior to oak in bearing a transverse strain, some of that number being at the same time of a less specific gravity. A large collection of woods appeared also from Algeria, but none of them of such a character as to come within the limits of this Report, being almost, without exception, more calculated for small work and furniture-making than for purposes of construction.

When on the subject of woods, it is necessary to allude to the process of M. Boucherie for the preservation of timber destined to be exposed to the action of the weather or buried in the ground. In the garden behind the Palais de l'Industrie, several railway sleepers were exhibited, each pair cut from the rough trunk of a tree, and in each case one of such pair had been submitted to the process in question, which consists in injecting sulphate of copper into the pores of the wood. The sleepers exhibited are said to have been all buried side by side for nine years; and they certainly presented a very remarkable contrast, those which had been operated upon by M. Boucherie being perfectly sound, while the remainder were as entirely destroyed and useless. The cost of the process is said to be something under 4½*d.* per cubic foot; and one of the advantages claimed is, that it will give the means of employing, for railway sleepers and telegraph posts, woods that are cheaper and have hitherto been reckoned worthless instead of the more costly descriptions now used for those purposes.

Carpentry.

The class of wood-working machines were tolerably well represented, but one in particular may be mentioned as being a novelty in this country, although a good deal used in France, viz.—an endless or ribbon saw (scie sans fin), in which a very fine endless saw, not more than ½-inch wide from front to back, works like a strap over two wheels or pulleys; it is an improvement on a reciprocating saw, inasmuch as there is no up stroke, the saw being always cutting, and consequently saving half the time of the former, and it possesses the advantage over the circular saw of being capable of cutting the sharpest curves; it was shown at work during the Exhibition, and was accompanied by specimens of work of the most elaborate kind performed entirely by the saw.

Among the many examples of carpenters' tools in the Exhibition, may be noticed a plane in the French part, in which the wedge is made of two plates of iron hinged together at the point, and kept open to a wedge form by a screw through one of them acting on the other; the wedge, on being placed in the plane by hand, can thus always be tightened or loosened by a turn of the screw, without being obliged to have recourse to the clumsy expedient of knocking with a hammer. It is to be regretted that no models or designs were shown of the French method of scaffolding, which differs in many points from that in use in this country; it is entirely of squared timber, and put together with bolts and nuts, and instead of ladders regular stairs are constructed in different parts of the scaffold itself; ready means of ascent and descent are a point of more importance in France, from the fact of the substitution, in a great degree, of manual labour for mechanical means in raising material to the work; to such an extent is this carried, that in the construction of a wall 50 feet in height, which was erected at the request of the British Commission between the building devoted to the Exhibition of Fine Arts and an adjoining sugar refinery, the stones of which it was composed were handed up from man to man by men placed on a ladder and along part of the scaffold, and 20 men were constantly so employed. A sort of travelling scaffold was exhibited by Messrs. Nepveu, the contractors for works in the Annexe or machinery building, but which was more for the purpose of a crane or gin than a scaffold; it consisted of a cross-beam supported by four legs, two at each end, diverging outwards, and having a wheel about 2 ft. 6 in. in diameter at the foot of each leg moveable like a castor, and on which it travelled; it was a good deal employed in raising some of the heavy French machinery, and seemed to answer its purpose well; it was remarkable for the lightness of scantling of the pieces of which it was composed, a principle which seems to characterise M. Nepveu's works in carpentry. Several small pieces of scaffolding were, during the Exhibition, from time to time erected in the course of the works, and all displayed great ingenuity and cleverness in adaptation of general rules to special cases.

Messrs. Nepveu showed a model of a fine piece of carpentry, being the roof of their workshops at Clichy; it has a span of 53 feet in each direction, and is remarkable for the very small scantling of the pieces of which it is composed.

A very novel and curious form of roof is shown near the one ust mentioned, by M. Mehedin, of Paris; it is a semicircular arch or vault, and is composed entirely of lattice work of battens apparently about 6 inches by 1½ inch or 2 inches; there are no principals or any timbering of any kind, but the whole roof is kept in form by a number of wrought-iron radial tie rods proceeding from the centre of the semicircle, each rod branching into four about halfway between the centre and circumference, and having the ends of these branches attached to the lattice work at equal intervals; the appearance of the roof is extremely light and pleasing, but whether it has ever been applied does not appear.

Pattern Flooring.

The exhibition of wooden floors, in ornamental patterns, was very varied, and some of the specimens very handsome and well executed; one part of the nave of the Palais de l'Industrie was floored with oak in pattern, the pieces being laid on the ground in hot asphalte, without joists, and of course without nails or fastenings of any kind; this seems a cheap and simple way of laying a wooden flooring on the ground, but it is probable that the wood would speedily be destroyed by the want of ventilation underneath. Some of the Belgian examples of parquetrie floors were particularly beautiful, and many of them at prices much lower than might have been expected for work of that class. The principal wood employed in their construction, and in fact the wood generally used in all French and Belgian floors and house joinery, is a straight grain wainscot or oak; the relative values of oak and fir being very different on the Continent from those usually quoted in this country. The exhibitor of the cheap Canadian doors and windows already mentioned, stated, through his agent, that he can deliver on board ship at Montreal, flooring board, of black walnut, (a beautiful wood susceptible of the highest polish, and of which some fine samples were shown in the Canadian collection), inch thick, at 2*d.* per foot superficial; and in that case there seems to be no reason why architects and builders in this country should not avail themselves of this valuable adjunct in interior decoration, in situations such as halls, public rooms, &c., where carpets are not used, and where a parquet floor would form a valuable and legitimate element of decoration.

(To be continued)

RAILWAYS OF THE UNITED STATES.

By Captain Douglas Galton, R.E.

(*With an Engraving, Plate* IX.)

Construction of Road.

The character of American railways, so different in its prominent features from that of railways in this country, is the result of the want which they have been called upon to supply. A means of communication was required which could be laid cheaply and rapidly through forests and uncultivated districts where high speed was of far less consequence than certainty of communication. A railway was the instrument best adapted to supply this want, and it would afford a better means of communication at a less cost of maintenance than an ordinary road.

As the first cost of a railway was a more important consideration than the after expense of working the line when made, sharp curves and steep gradients were unhesitatingly adopted, and the railways were opened with a minimum of accommodation. The Baltimore and Ohio Railway affords a striking illustration of a line opened with steep gradients, which have since been improved. In order to avoid for a time an expensive tunnel, which has since been constructed, the line was carried by a series of zig-zags, ascending over a hill by a gradient of 1 in 18 at its steepest part. Each zig-zag terminated in a short level space, so that the train was run up one zig-zag on to this level space, and then backed up the next zig-zag, and so on. The load which could ascend in this case was of course very small. There are curves on this railway of 360 feet radius, and curves of 400 feet radius are common; the railway follows the sinuosities of the valleys in its passage across the Alleghany Mountains: it is also carried through the streets at Baltimore down to the wharves, and passes round right angles. In these streets the traction is by horse-power.

The embankments and cuttings of a railway at its opening are generally completed; the bridges are ordinarily of timber, which, not being always well seasoned, is often a cause of considerable expense. The designs of many of the bridges for large spans, and also of the roofs of stations in which timber alone, or timber in connection with iron is used, exhibit great engineering skill, and are very instructive. The railway bridge of largest span is the suspension bridge over the Niagara river, connecting the United States with Canada. The span of the bridge is 800 feet; and the level of the rails is 250 feet above the water. The particulars of this bridge have been already published in this country. On many railways, iron and stone are being adopted to replace timber structures which have decayed. I have appended a sketch of a wooden bridge of recent construction, which well deserves consideration. (See Engraving, Plate IX.)

The ballasting is generally very deficient at first. On the prairie lines it is impossible to procure ballast except from very considerable distances. In constructing these lines a ditch is dug on each side of the road, and the soil banked up so as to cover the centre of the sleepers, but sloped off on each side, leaving the ends of the sleepers exposed, in order to allow rain to drain off rapidly.

The elasticity of the soil makes these roads far from disagreeable to travel over when dry; but in wet weather and frost the absence of ballast is a source of great inconvenience and danger. This may be remedied, to some extent, by placing a good drain under the centre, as well as at the sides of the roads; but nothing can compensate for the absence of ballast, which, in a severe climate like that of America, should be of broken stone, not less than 2 feet in depth under the sleepers, with good drainage. It is sometimes customary to slope the top of the ballast on each side, so as to cause the snow melted on the surface to drain off.

The gauge of American railways varies: the general gauge in the United States is 4 ft. 8½ in.; the gauge of the Ohio railway is nominally 4 ft. 10 in., but it is in many cases in practice made 4 ft. 8½ in. The New York and Erie, and one or two lines in connection with it, have a 6-feet gauge. The gauge of Canadian railways is 5 ft. 3 in. The break of gauge is of less consequence than in this country, because there is not so much interchange of working stock between the several railway companies.

The sleepers on American railways are usually of oak, cedar, or hemlock spruce, of about 6 inches by 8 inches scantling, and from 7 feet to 9 feet long.

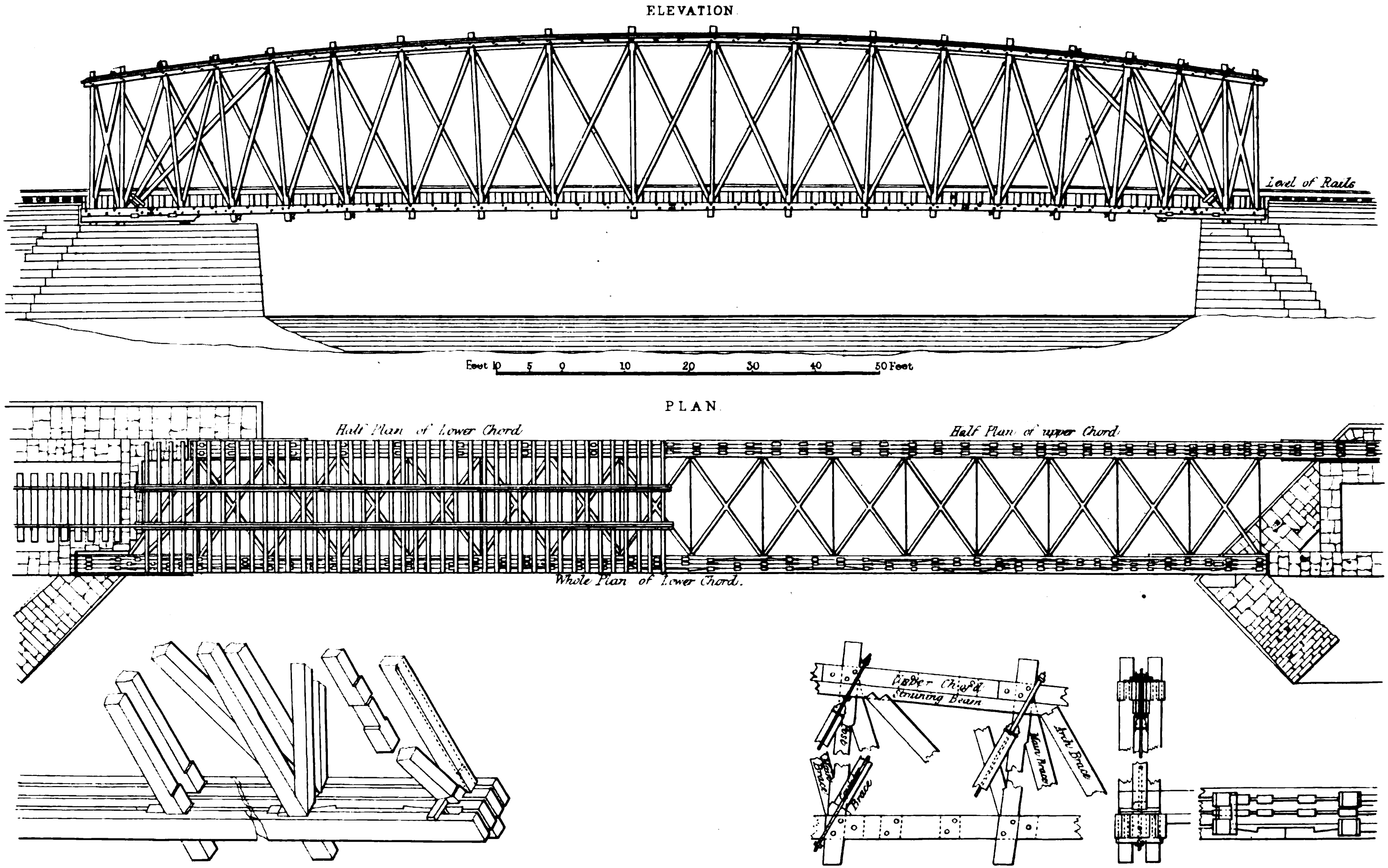
In consequence of iron being taxed to the amount of 30 per cent., the American railway companies have been obliged to economise iron to the utmost. The rails are made as light as possible, the usual form being the contractors' rail of from 50 to 65 lb. weight. Many railway companies obtained rails from England, for which they paid by mortgage bonds. The rails thus obtained have not, it is stated, generally proved durable. With regard to rails obtained from American iron works, the plan is frequently adopted of contracting that the rail shall last a specified time, the failure of any rail being made good, together with expenses incurred in consequence. The rails are spiked to sleepers laid transversely, the joint being generally secured by means of a chair made of boiler-plate, with a lip cut out on each side and turned up; the lip is barely 3 inches broad, and projects about 1½ inch on each side of the joint. It is stated that the lip soon works up, and when hammered down is apt to break off; consequently the joints on a road of this description soon become very bad; and several plans have been tried to improve them. On the New York and Erie Railway, in some places eleven sleepers have been placed under an 18-feet rail. On some lines I saw a wrought-iron chair 14 inches in length, of the form shown in diagram, fig. 1, made to slide on to the rail without any keys.

Several forms of compound rails, for avoiding joints, have been tried, but I was informed that they have invariably failed. The ordinary fished joint had been tried, but the necessity for economising iron, and of preserving a sufficient breadth of base,

INFLEXIBLE ARCHED TRUSS TIMBER BRIDGE OF 190 F^{T} SPAN OVER THE SUSQUEHANNA.

ERECTED ON THE NEW YORK AND ERIE RAILWAY

Designed by D. C. M^{c} Callum.



J. R. Jobbins

has so limited the depth and modified the form of the rail that it is not generally well adapted to this mode of fastening; and it

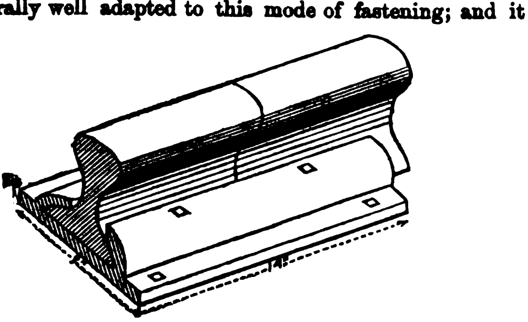


Fig. 1.

was stated not to have proved successful. A modification of the fished joint, in which a piece of iron about 12 inches long is used on the inside of the rail, and a piece of oak 5 feet long on the outside, has been tried on the Baltimore and Ohio and other railways, and appeared to answer. This is shown in the annexed engraving, fig. 2.

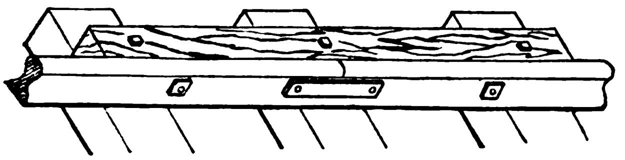


Fig. 2.

The switches and points in use upon English railways are almost unknown in America, shifting rails or contractors' points being universally used in lieu; and consequently, if the points are set wrong, the vehicles which pass through them must leave the rails. The result of this is that the points are almost always kept locked, and a signal is invariably attached to them.

On the Newhaven Railway, in order to render it impossible for the switches ever to be set except for the main line, they are worked from inside a box, the lever of the switches being connected with the door of the box, so as to shut it when they are held open for the siding; thus the pointsman cannot get out of his box unless the points are set right for the main line.

The signal arrangements at stations, and even at junctions, are generally very imperfect. Level crossings are scarcely ever provided with gates or gate-keepers, except in special cases near towns; but a large board is placed over the crossing with the words printed on it in large letters:—"*Railroad crossing. Look out for the cars when the engine bell rings.*" On the Philadelphia and Reading Railway, a blue coloured light is shown at all level crossings at night. It is the invariable duty of the engine-driver to ring a large bell, placed on his engine, whenever he approaches a level crossing or passes along a street.

Cattle-guards are constructed on each side of every level crossing, in order to prevent cattle and animals from straying on to the line. These are trenches about 4 feet deep and 4 ft. 6 in. broad, cut across the railway, the rails being supported by narrow balks laid across the opening. Laths, a few inches apart, are laid across the opening to enable persons to pass over.

The railways are generally well fenced, except at stations or where the railway is carried along roads or streets, in which case no separation is made. The main line of the Baltimore and Ohio Railway runs through the streets at Baltimore to the passenger station; the trains are drawn by locomotives, and a man on horseback rides along in front of every train, blowing a trumpet, to warn people to keep off the track.

A very general practice prevails of distributing the goods traffic by means of rails laid along the streets to wharves and private establishments, along which the railway cars are moved by horse power. At some seaport towns in this country, as, for instance, Aberdeen, Dundee, and Birkenhead, rails are carried on to the wharves, but not to the same extent as in America. The practice is, however, one which might be adopted in many places in this country with great advantage, and with saving of expense in unloading and reloading. The construction of the cars in America enables them to be moved round very sharp curves.

The stations are generally unfenced, and passenger stations are considered public thoroughfares. The accommodation is generally inadequate and very indifferent, there being a great want of waiting-rooms and other conveniences, as well as of means of obtaining information. At some stations, however, where the passenger traffic is large, the booking-office has a second opening into the ladies' waiting-room, so that ladies travelling alone can obtain tickets without crowd or difficulty. This arrangement is one which might be adopted with great advantage in this country.

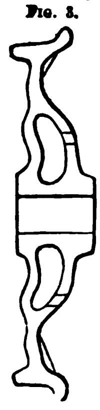
Construction of Rolling Stock.

The practice of constructing the railways in a hasty and imperfect manner has led to the adoption of a form of rolling stock capable of adapting itself to the inequalities of the road; it is also constructed on the principle of diminishing the amount of useless weight carried in a train. This principle is, that the body of the car or wagon is carried by two four-wheeled trucks, one at each end. The body is attached to these trucks by means of a pintle in the centre, the weight resting on small rollers at each side. The main framing of the truck is supported on springs resting on the axles, and the pintle and rollers are fixed to a cross-beam, which is attached by springs to the main framing; so that between the body of the car and the axles are a double set of springs. India-rubber springs are in general use, but they often become hard; consequently sometimes steel springs are used, with great advantage. Any side movement which might result from the slight play allowed to the cross-beam is counteracted by springs placed between its ends and the framing. An iron hoop attached to the framing passes under the axle on each side so as to support the axle in case it should break.

The bearings do not differ materially from those used in England. But the axle-box is formed so as to allow of oil being used as a lubricator, as it is well adapted to withstand heat and cold. The oil is contained in the lower part of the axle-box, cotton waste being pressed in to prevent it from shaking about as well as to keep it in contact with the axle; the front is screwed on, and, at the back, a leather fits close round the axle, and prevents the admission of dust. It is stated that under favourable circumstances this kind of box will run sometimes for a month without requiring to be touched, but there is great difficulty in obtaining good oil.

The wheels used on American railways are of cast-iron, with chilled tyres. The wheels are from 30 to 36 inches in diameter, made without spokes, and generally of the section shown in fig. 3. These wheels, when made by the best makers, will run from 60,000 to 80,000 miles before the tyres are worn, and they are said not to be liable to break; they weigh rather more than 500 lb., and cost from 3*l.* to 3*l.* 10*s.* each; they are not of course so true as turned wheels, but their first cost is less; they wear well, and during the time they last they require no expenditure for turning up; any crack can be more easily detected by sounding with a hammer, and when a wheel breaks it does not always do the mischief that is done by a broken tyre. Chilled cast-iron tyres are used on some of the railways for the driving-wheels of engines; they are made 3 to 3½ inches thick, and 6 inches broad, and cylindrical; they are bored out to a true cone to fit the centre, which is also of cast-iron, turned to a similar cone, and secured in place by screws. These chilled castings are stated to be preferable to steel, or to wrought-iron, on account of their being less liable to fracture in frost. The iron of which they are made is of a very superior quality, and great practical skill is necessary in the operation. It is stated that there are only three firms in the United States whose wheels are fully to be relied upon.

Fig. 3.



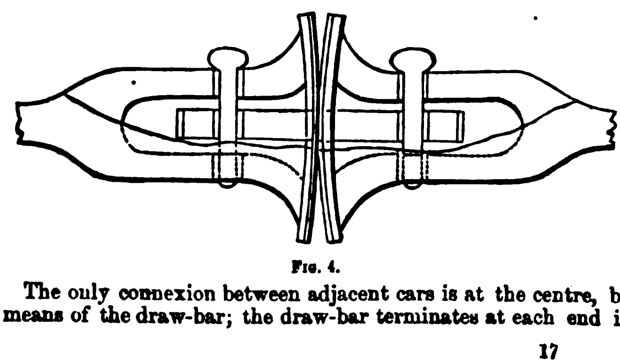


Fig. 4.

The only connexion between adjacent cars is at the centre, by means of the draw-bar; the draw-bar terminates at each end in what is termed a bumper, which enables it to act as a buffer, as well as a means of connexion, (as shown in the accompanying engraving, fig, 4.) In the most approved construction of car the draw-bar is continuous under the car, and is attached to elliptic springs which act in both directions.

No force is necessary in coupling the cars, as the ends of the draw-bar or bumpers, which are of the shape shown in the sketch, abut against each other; a shackle is introduced through the opening behind, and two pins are passed through the eyes; about an inch play being all that is allowed. An iron shackle is generally used; but on some railways the skackle is made of oak 18 inches long, 2 inches thick, 6 inches broad, with holes for the pins 1½ inch × 2 inch, at a central distance apart of 12 inches. The block, as well as each hole, is bound with iron; but the iron band round the block is divided on each side at the centre, so that if a car leave the rails the side wrench would break the shackle transversely.

In coupling passenger cars the man stands on the platform at the end of the car; but in freight cars, when there is no platform, the following self-acting contrivance for dropping in the pin, is sometimes adopted to prevent injury to the man employed. When two cars are to be coupled, the pin in the bumper of one of the cars is supported by means of a ball, and the shackle is fixed by its pin in the bumper of the other car; when the cars are moved one against the other, the shackle in one bumper pushes back the ball in the other, and allows the pin to drop into the hole.

All passenger cars, and almost all freight cars, are supplied with breaks, which are applied to all the wheels, worked from either end of the car. The blocks of the breaks are lined with plates of cast-iron; and it is never intended that the wheels should be completely skidded.

On the Philadelphia and Reading Railway there is an arrangement by which a sudden check in the speed of the engine applies breaks to the wheels of all the cars.

Passenger and emigrant cars, covered freight cars, or low-sided and platform cars for timber and minerals, &c., are placed upon the trucks I have described. Upon some railways coal and ballast wagons are used, constructed in the same manner as those upon English railways.

The bodies of the passenger cars are from 30 to 45, and even 60, feet in length. This length render it necessary that the sides should be supported by a truss, either in the framing or by iron trussing-rods below. On lines of 4 ft. 8½ in. gauge the cars are about 9 feet, and on the New York and Erie, 10 feet wide, and from 6 ft. to 7 ft. 6 in. high. There are two classes of passenger cars, of which one is limited to the conveyance of emigrants. In the centre of each end of the cars is a door, conducting to a small platform, about 2 ft. 6 in. wide, from which steps descend on either side to the ground. There is a railing to the platform, with an opening to allow passengers to pass from the platform of one car to that of another, and thus through the whole train. On many railways this free passage is not allowed to passengers, but the foremost door of each car is locked, so that all passengers must enter at the rear door, and the conductor or servants of the train alone pass through with keys.

The interior of the car forms a large room, with a passage, of from 1 ft. 9 in. to 2 feet wide, down the centre, upon each side of which cross seats are arranged. These seats are intended for two passengers each; they are from 3 ft. 3 in. to 3. ft. 6 in. long, about 1 ft. 6 in. wide, and 1 foot apart. The back is arranged to be turned, so that the passenger may sit with his face in either direction. The seats and backs are comfortably cushioned, and there is a window, and ventilator above, to each. A capacious netting is carried along each side, from one end to the other, for the reception of umbrellas, bags, and cloaks. In winter the cars are warmed by means of an iron stove in the centre; and they are lighted at night by lamps placed at the sides.

In a certain proportion of the passenger cars, a portion, about 7 feet long, 3 ft. 6 in. wide, is partitioned off, in which is a small room for the convenience of ladies nursing, and a watercloset. In the summer iced-water is placed in water-coolers in the cars.

On some railways, where the journey occupies a considerable time, as for instance, the Illinois Central between Cairo and Dubuque, some of the cars are fitted with compartments about the size of our first-class carriage compartments, in which the seats are arranged for the backs to turn up, and so to form two tiers of berths, or sofas, for the accommodation of passengers who may wish to lie down. For these an extra price is charged.

The dust caused by the friable nature of the soil is the great inconvenience of summer travelling in the United States. Several plans have been tried to avoid it. On some railways windows have been constructed so that the sides should slant outwards and throw it off.

On the Michigan Central Railway a screen of tarred canvas is fixed so as to reach from the lower framing of the cars to within about 2 inches of the rails outside the wheels. The screen terminates in a framework, which is arranged to abut against a similar framework on the next car, so that from one end of the train to the other a tunnel is formed under the cars, in which the dust is confined, and can only escape at the end of the train. This plan prevents dust in the cars, but it is said to cause heated axles.

On the New York and Erie Railway, the following plan secures freedom from dust and good ventilation. A funnel placed at the top of the car, faces the direction in which the train is proceeding, and the movement of the train causes the air to pass down this funnel into a chamber, where it is purified. A cistern of water is fixed under the car, and a pump worked by the rotation of the axles of the car forces the water into the chamber through jets arranged to fill the chamber with spray. The air, in passing through this spray, is freed from dust. In cold weather a stove is placed so as to warm the water. The air then passes through flues under the floor into the interior of the car. The windows must be kept closed. As this arrangement is in practical use on several cars on the New York and Erie Railway, it would be well worthy of a trial upon English railways, especially in large saloon carriages.

A baggage car, or a compartment of a passenger car reserved for baggage, is invariably placed next to the engine. The baggage cars are furnished with doors at the sides to facilitate the loading and unloading of baggage. Baggage cars are generally 30 feet long. Next to the baggage cars in the trains are placed the cars with the compartment for mails, or for the Express Companies, who undertake the parcels traffic.

Freight and cattle cars are usually covered. Their ordinary length is 28 or 30 feet, and they are more strongly built than passenger cars.

Almost every car is provided with a break, which can be applied to all the wheels of the car. It is worked from either end, so that one man can work the breaks of two cars. In freight trains the guards usually pass along over the tops of the cars, the small number of bridges and tunnels rendering this course safer than it would be in England.

In every train a simple and perfectly effectual communication between the guard and engine-driver is provided by means of a cord. In passenger trains a cord, with swivel-hooks at each end, is provided to each car. It passes through rings in the ceiling, and it is the duty of the conductor to see that the communication between adjacent cars is complete before a train starts. In freight trains the cord is passed over the tops of the cars. This cord is attached to a bell on the engine.

The construction of a train on American railways favours this mode of communication more than on English railways. The carriages are longer, and therefore there are fewer of them, and consequently fewer connections to be made; and these connections are between rigid draw-bars, without expansion or contraction of buffer springs; and as a person can walk from one end of a train to another, these connections are made very easily, and any omission is immediately detected.

From the above account it will be seen that the rolling stock on American railways differs considerably from that in use in England.

In designing their rolling stock, the Americans appear to have taken their ideas more from a ship than from an ordinary carriage, and to have adopted the form best calculated to accomodate large masses with a minimum of outlay for first cost, as well as the one which involves a minimum of attendance upon the passengers in getting in and out of trains. Whilst the cars have been designed with a view to avoid every appearance of privilege or exclusiveness, or of superiority of one traveller over another, they have been constructed so as to secure to every traveller substantial comfort and even privacy.

There is only one class, but as the cars are designed with more regard to comfort than English railway carriages, this class is very much superior to second and third class carriages, and only inferior to the *best* first-class English carriages. It is much to be regretted that almost all English railway companies have so entirely disregarded the comfort of second and third class passengers, although, as a general rule, second-class and sometimes even third-class passengers pay a higher fare than is required for the much superior accommodation of American railways.

No doubt the American railway cars cannot contain so many passengers as would be contained in a carriage of equal length divided into compartments, but the use of a door at each end, in lieu of several at each side, effects a saving in first cost, as well as in subsequent trouble to the company's servants, and allows the cars to be made wider than they could be with side doors, steps, &c. It is also very convenient for the passengers to be able to move about, especially on a long journey. The absence of compartments facilitates ventilation, warming, and lighting at night. There is an advantage derived from the use of trucks, which deserves consideration, viz.: that carriages can be moved easily round curves, and that consequently there is some diminution in the resistance of curves; and the use of double springs renders the motion of the cars very easy on a good road. Indeed, these cars travel without accident over bad roads at velocities, when our carriages would probably leave the line. The small diameter of the wheels possibly increases the friction to some extent.

Vehicles of this description would be very convenient in this country on all omnibus lines, and for a second and third class traffic; but it is likely that many English first-class passengers would prefer the privacy of a compartment. The use of this description of vehicle would, however, probably render necessary a reconsideration of the mode of buffing and coupling carriages together, if not the adoption of the *bumper* at the centre. This mode of coupling entails very much less risk upon the companies' servants than the mode in use in this country, and it prevents the possibility of danger arising from the couplings not being properly screwed up; and the use of a rigid draw-bar through the train would afford an easy means of enabling the engine driver to apply breaks simultaneously to all the wheels of the train. The mode of connecting American cars affords rather more protection than ours against that class of accident in which one carriage is forced through the adjacent one, as in such cases the platforms at each end, amounting to 5 feet of space, must be crushed before the body of the car is injured.

The main advantage of the American cars is that they convey a larger number of passengers, in proportion to the dead weight, than can be conveyed in the carriages generally used on English railways.

On the Baltimore and Ohio Railway, on account of the sharp curves, the cars are shorter than on many other lines, viz., 40 feet in length; these cars will contain 60 persons, and it was stated that they weigh about 7 tons. As a general rule on English narrow gauge railways the same number of second-class passengers would scarcely be accomodated under a weight of 10 tons.

The passenger car of the New York and Erie Railway Company is 60 feet long, and would contain above 80 people.

The freight cars on the Baltimore and Ohio Railway, 28 feet long, with a capacity for a load of 9 tons, weigh 6 tons. On narrow gauge English railways, as a general rule, the weight of the goods wagon is not much less than the weight of load.

Engines.—The American engines are constructed upon principles somewhat analogous to those on which the cars are constructed, with the view of obtaining great stability on roads which present at certain seasons considerable irregularities of surface. The weight rests as nearly as possible upon three points; the fire-box end being supported on the driving-wheels, and the smoke-box end upon a pin which rests in the centre of a small truck. The driving-wheels are generally four in number, coupled together, with from 5 ft. to 5 ft. 6 in. diameter, and placed at about 1 ft. 6 in. apart. The hinder pair of wheels is furnished with flanges, but the leading driving-wheels are generally without flanges, and are frequently cylindrical.* When great speed is required the wheels are increased to 6 feet diameter,† but it is the almost invariable custom to couple four wheels in all engines.

For working steep inclines, engines with eight wheels coupled are used; the wheels are cylindrical and about 3 ft. 6 in. diameter; the leading and trailing wheels alone have flanges. In attaching the framing to the springs the compensating balance lever is used. Some of these engines weigh 30 tons, the position of the engine-driver being on the top of the boiler.

In the ordinary engines the truck is made as light as possible, its wheels being generally from 2 ft. 6 in. to 2 ft. 9 in. in diameter, and about 1 ft. 6 in. apart. These wheels are of chilled cast-iron, similar to the car wheels. The driving-wheels are generally of cast-iron in the centre, and the tyres are of wrought-iron or sometimes, as has been already mentioned, of chilled cast-iron, which is stated to be better able to stand frost.

In most engines the cylindrical part of the boiler, instead of butting against the fire-box, is connected with it by an inclined plate, so that there is no right angle at that part.

Notwithstanding that the coal fields of the United States occupy an area of 130,000 square miles, and extend into Pennsylvania, Ohio, Indiana, Illinois, Kentucky, Virginia, and Michigan, until very recently wood was the fuel invariably used on American railways. Wood has, however, risen very much in price lately; and on the prairie lines wood is not to be had, but coal is found in their vicinity; on other lines, which pass through the coal measures, coal is a cheaper fuel. Hence its use is gradually being extended on railways, and it will probably soon entirely supersede wood.

Several attempts have been made to burn bituminous coal in engines, without coking it. In one, the fresh coal is supplied into the fire-box from below, so as to under-lie the heated fuel; in another, the fire-box is divided into two parts, from each of which a flue, with a damper, leads to the tubes, and there is an opening below the surface of the fuel from one part of the fire-box to the other. The fires are alternately charged with fresh fuel, the damper of the fire most recently charged being closed, to cause the smoke to pass through the other fire. I cannot give any decided opinion as to the satisfactory results of either arrangement. This subject is receiving at the present time great attention in this country, and the economical results which are stated to have been arrived at by Mr. Beattie in some new engines which he has constructed for the London and South-Western Railway are very extraordinary.

Anthracite coal is used on the Pennsylvanian railways. A form of fire-box, adopted by Mr. Mulholland on the Philadelphia and Reading Railway, is stated to be very successful. (See fig. 5.) It is shallow, with a large grate area; the bars are of cast-iron, ¾-inch broad, and with ½-inch spaces between them; and a row of air holes 4 inches deep by 1½ inch wide, which can be opened and closed at pleasure, extends along the front of the fire-box, just over the bars. There is also an arrangement to admit air to the heated gases near the tube plate. The anthracite coal is spread over the grate bars in an even layer 9 inches thick. The fire-box is made of iron, as is almost invariably the case in the United States, the sides being considerably sloped inwards to ensure that the steam generated from the water in contact with it shall pass off rapidly, and keep the water in constant contact with the iron.

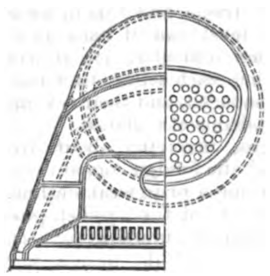


Fig. 5.

It may be mentioned that the contract for the supply of boiler plate from the makers is frequently similar to that for rails—viz., that if defects in original manufacture are discovered, the plate is to be made good, and all expenditure incurred upon it defrayed.

In those engines in which wood is burned, the chimney is surrounded with an inverted funnel of iron, with a grating at top to catch and contain the sparks. A door at the bottom of the funnel allows the ashes to be removed when necessary.

American engines are provided with what is termed a "cow-catcher," in lieu of axle guards. It is composed of a series of iron bars uniting in a salient angle, formed to throw to one side any thing that lies on the track. The lower bar is about 3 inches from the rail, and the upper part terminates at the framework of the truck. This implement derives its name from having been used to protect the engine from cattle straying on the line, and with a moderate depth of snow it answers all the purposes of a snow-plough. Every engine is furnished with a bell of at least 30 lb. weight, which is always rung by the driver

* Since my return to England I have been informed that a great saving in wear and tear has been effected on an Austrian railway by the use of cylindrical wheels. It is stated that the tyres do not wear sharp, they last one-third longer, and that the oscillation of the carriages is much less than with coned tyres.

† On the Philadelphia and Reading Railway there is an engine, constructed by Mr. Mulholland, with four 7-feet driving-wheels coupled, 17-inch cylinder, and 30-inch stroke. This engine weighs nearly 28 tons, of which 12 tons rest on the leading truck, the remainder being distributed between the driving-wheels.

before the engine is moved forward at a station, and also when approaching level crossings, or moving along streets. The bell gives notice of the approach of the engine without frightening horses, as much as the whistle. The side from which the sound proceeds can be easily distinguished, and in the neighbourhood of towns it is a much less objectionable sound to the inhabitants. The whistle is used on emergencies, and as a signal to apply the breaks, &c.

There is one arrangement connected with the engines in America which mere humanity should cause to be adopted in this country—viz., the protection afforded to the engine-drivers and firemen against the inclemency of the weather. The foot-plate of the engine is covered by a roof supported by glazed sides and a glazed front. The windows are arranged to open readily, and a passage is afforded to the front of the engine. This shed is open at the back towards the tender. This arrangement makes the engine-drivers and firemen much more comfortable, and enables them to keep a far better look-out than when unprotected.

NEW MEMORIAL CHURCH, CONSTANTINOPLE.

It will be but a thrice-told tale to say that the long-expected decision in respect to this competition has been made, and that Mr. W. Burges has proved the successful competitor; the remaining premiums having been awarded to Mr. G. E. Street, and Mr. G. F. Bodley, with the recommendation of an extra prize to Mr. W. Slater.—These four designs, comprising in themselves a goodly number of drawings, were fortunately secured for inspection at the late Architectural Exhibition a few days before its close, owing in some measure, we believe, to the energy of its indefatigable secretary, Mr. Edmeston. In accordance with an original notification of the Church Committee, the whole of the drawings are now on view, and will remain so till the 16th instant, at King's College, Strand. The hanging and general arrangements were here also entrusted to Mr. Edmeston, and it is certainly due to that gentleman to state that the best has been made of a comparatively small space. Though the corridor allotted for use is some 70 feet long, and proportionably wide, it is manifestly insufficient for the requirements of the occasion: in one item, however, and that an important one, viz.—light, there is abundance, and it is well distributed. Although it has been necessary to erect a double screen along the centre, a fair amount of light is still obtained to each frame, and this in some degree atones for the above and below level plan of hanging to which it was needful to resort. Another difficulty, not always so carefully met, is the keeping together each set of drawings; but in the present instance it is well managed, and their several characteristics are judiciously distinguishable at a glance.

In all, there are 46 sets of designs, involving about 370 drawings, in all varieties of "getting up," the foreign competitors, of whom there are five, generally preferring a plain weak outline. Thus a feature which pervades the majority of the English productions—intermixture of colour by bandings, inlaying, &c.—is, in their case at least, unappreciable as part of the design; nor would it appear, judging from the feeble shadowings set forth, that the deficiency is any great loss. In a word, it is matter of surprise how such an extraordinary production as that of M. Emile Veillade (Paris) was adventured by its author. It is absolutely beneath criticism, both as to ideas, and more especially *sketching* (for it is not drawing), and really is the ultimum of very much that is worthless. The neighbouring set, by M. Henszlemann, has the advantage of clearer drawing, and a wash of colour on the perspective; but this, unfortunately, only reveals its poverty, which has scarcely any redeemable point; it looks for all the world like one of our country chapels executed, say, twenty years since, and duly smoothed over with compo! The remaining continental efforts are more or less at fault, though one of them, by M. Franke (Meiningen), has been distinguished by an honourable mention. On what grounds this has been decreed we are wholly at a loss to discern, unless the simplicity and proportion of its plan, which are certainly prepossessing, have gained the honour. Still, looking around, we should say (with deference to the adjudicators) there are at least a dozen others that are equally worthy of the distinction.

Having been led casually to refer to one of the foreign contributions, we have thought it well to note some remarks on the others, and so to dispose of the subject as far as *they* are concerned. If the specimens before us may be taken as a sample of what will be submitted from the same quarter for our new "Government Offices," English architects undoubtedly have no cause for alarm. Before proceeding to examine the drawings generally, it may not be amiss to devote a few words to the subject generally.

The original proposal for the erection of this church was issued in May of last year, and it was intended as a "monument to the gallant men who have fallen in the service of their country;"—"adapted to the solemn worship of Almighty God, according to the English Ritual, and to be by its architectural style and character, worthy of the people who have raised it, and of the dead whose memory it is designed to perpetuate." A site has been granted by the Sultan.

The intending competitors were shortly after furnished with instructions, among which were the following requirements: The style of architecture to be a modification (to suit the climate) of that "known as 'Pointed' or 'Gothic;'" and the building to be capable of containing, without galleries, not fewer than 700 persons; the cost not to exceed 20,000*l*. Eight general drawings were stipulated for, with the requisite detail drawings, and two perspectives only.

The interest which attached to this competition is attributable, not merely to the circumstances out of which it originated, but also to the novelty with which the subject is invested—novelty of situation, with local peculiarities to be considered; and novelty of materials, with their practical and judicious combination. It is at once evident that what would be every way desirable in our northern clime, would be very wide of the mark in a land of heat and earthquakes. Hence, it is curious to note in the several designs where these things have been duly weighed, the contrivances (often "dodges") which have been resorted to. Some show high-pitched roofs, others—the majority—low, and each is recommended as best calculated to exclude heat: several have double roofs—that is, an outer and inner, for the same purpose. Some have thick walls, shallow buttresses, and slits of windows; others thinner walls, deep buttresses, and windows of larger opening, sheltered by hood walls; while in many cases (especially where the aisle, or what may be considered as answering to such, serves as the receptacle for monuments) the light is admitted entirely from a lofty clerestory, so that the sun's rays would never strike directly on persons assembled within. The modes of entrance, too, are variously suggested, but deeply-receding portals appear most in favour. The question of towers, also, has been treated with amusing variety; for instance, the selected design is altogether without one, unless the detached and fancifully-placed campanile, which is suggested on a fly-leaf, be accepted as part of the scheme (though it looks like an after-thought);—the second approved design has two small spired turrets; the third, an unmistakeable tower; and the fourth, two unmistakeable towers *and* spires. But it is time to particularise.

Mr. Burges' design, which is about to be carried out, is simple in arrangement, measuring internally from end to end about 150 feet, and in breadth about 55 feet. The additional width where the transepts occur is about 24 feet. The nave consists of six bays, separated by alternately large *single*, and smaller *coupled* columns; the line of the nave wall is carried also round the chancel, which is in form a slightly extended semicircle, and the outer aisle wall is also carried round, forming an ambulatory for monuments. The external features of the design are simple, the three west doorways being most elaborated; these entrances are sheltered by a plain lean-to screen stretching across the whole front. Above is a continuous arcade, the three central divisions of which are pierced, and above this is a large central rose window. A considerable amount of inlay and coloured surface work is contemplated in lieu of moulded details. The roofs are of low pitch throughout. The materials to be used will be selected from the following:

St. George's limestone, of a consistency between Bath and Portland stone;

The Maltese limestone, like Caen stone;

The Macrican stone, like the St. George's;

And a bluish-black limestone, used principally for rubble walling;

The Marmora marble, of a dull cloudy white;

Italian marble, used for paving;

Possibly, also, a red marble resembling the Siena; with bricks and terra-cotta. The roof to be of spruce fir, from the Black Sea; and the filling in of the vaulting to be of a light concrete, like that used in the lately restored chapter-house of Salisbury

Cathedral. (This system, the author states to have observed in the cloisters of Rouen, and in other places in France.) The core of the walls will be of black stone rubble, faced in and out with various ashlars of terra-cotta, brick, and white and black stone. Marmora marble to be used for the dado of the nave, the caps of the columns, and the tracery plane of the windows; while the black stone and red marble, slightly polished, will be employed for the various columns.

Mr. Street's design (second prize) differs considerably from that of Mr. Burges': in plan it is longer but narrower, and in only one span, their being no aisles, while the author has availed himself of the unusual projection which his buttresses required to counteract the amount of thrust from the stone roof, to contrive a low ambulatory between and through them, an idea which may have been suggested by the similarly-arranged side chapels of King's College, Cambridge. The nave is but of four bays in length, to which succeed deep transepts, in the inner angles of which rise the turrets; the chancel is nearly the width of the nave, proportionately long, and terminated polygonally. The roof is similar in pitch to those of the last-mentioned design, but the transepts are steeper owing to their being of narrower span, yet rising to the common ridge. In the precautions taken to keep the building cool are—narrow windows high up, with outer and inner traceries; also a passage round, in the thickness of the wall, at their base, "to allow of blinds of lattice work being put up and taken down if it were found necessary." The design generally commends itself for its simplicity of parts, while the detail drawings show to what extent decoration and finish might be applied. The amount of care which has evidently been bestowed upon this design renders the set of drawings (twelve in number) among the most interesting it has for some time fallen to our lot to examine.

Mr. Bodley's design, which gained the third premium, differs considerably in its type from either of the preceding, partaking more of the character of northern architecture. This is most apparent in the general outline, and in the tower, whose detail scarcely appears to comport with the rest. The plan, including chancel, is simply a parallelogram, unusually long for its width, and of very lofty proportions. There is, in addition, a *narthex* or large porch at the west end. The tower is placed at the west end of the south aisle; the roofs are of stone, with stone arch principals, the chancel arch noble, and has its sub-mouldings delicately cusped; the windows to the church are from the clerestory only, and in arrangement are of three-lights; in the chancel they are coupled in each bay, and have above and between each a small cusped circular window. The nave is divided into five bays by circular columns with richly foliated caps, and transepts are wholly ignored. In the interior view, which is most minutely drawn, is indicated a considerable amount of surface enrichments in bands and geometric patterns, as well as the alternate voussoirs of the stone arches.

Thus much for the three designs to which the stipulated premiums have been awarded; but a fourth has been recommended to a like distinction, it appearing (say the judges) "to possess a degree of merit so nearly equal to that of Mr. Bodley, would have fairly entitled its author to a prize, had there been a fourth placed at our disposal." Now we must at once confess that we cannot detect these superlative merits; on the contrary, we should set it down without hesitation as at least second-rate, and far inferior to many of its rivals. To say nothing of a raw, uncomfortable-looking outline, without pretension to the least mixture of *taste* in its composition, the everlasting streaking and striping, so pertinaciously carried out from ground to ridge, both inside and outside, would seem enough to settle the question; but if this were passed over, what can be said in defence of the wagon-vaulted interior, interlaced with ribs proper only to a really intersecting construction? It is but a mockery and delusion, inconsistent with true art.

Five designs are considered as deserving of especial mention, viz.: those by Messrs. Gray,—Pullan,—Truefitt,—Weightman, Hadfield, and Goldie,—and White. Mr. Gray's is comparatively plain, rather Lombardic in character; it has low-pitched roofs, small continuous arcades, and a large rose window to its west front, near which is an almost detached campanile connected with the aisle by a short cloister. There is a great deal of plain face to the walls, which imparts considerable repose and dignity to the composition. In plan it is a parallelogram, with the chancel terminated semicircularly; to this a small octagonal sacristy is appended, chapter-house like; and in place of transepts, two small semicircular "memorial chapels" are attached, which range in roof with the aisles.—Mr. Pullan's commended design (for he has two), is in plan exceedingly like Mr. Bodley's, but it has six bays instead of five; externally, it partakes of English rather than Italian characteristics: this is very noticeable in the steeple, which is nothing less than an everyday broach; the roofs are also of high pitch; there is no clerestory, but internally a triforium gained by the stilting of the aisle roofs. Much of the complete effect would be produced by colour, as the architectural members are but scanty.—Mr. Truefitt's design is, as might be expected, original and clever: the scheme of the plan, which is a combination of octagons and squares, has considerable novelty, and occasions considerable play in the grouping of the roofs. The two transepts are very short, but the walls are continued outwards, forming towers, square up as high as the roof, whence they take an octagonal form, well managed. The metal screen shown in the interior is happily conceived.—Messrs. Weightman, Hadfield, and Goldie, exhibit a highly-finished set of drawings, in which more than the requirements of the "instructions" have been furnished. We allude to the spacious court of approach, with its sheltered ambulatory and central fountain, which is added at the west end. The plan of the church does not differ much from some to which we have already alluded, unless that it is of longer proportion (there being six bays to the nave); the termination to both chancel and transepts is octagonal; there are two western towers; the general group is well shown by a masterly bird's-eye view. Internally, we have a lofty roof, with stone arched principals, and the free use of polychrome. This latter decoration is still more profusely applied in the design of Mr. White; indeed, there is scarely a bit of quiet plain wall either inside or out. The architect's predilections on this point are well known; and if not, the detailed drawing, showing parts of the interior, would be quite sufficient. To the occasional bonding in which so many of the competitors indulge, there can be not the slightest objection; it is a reasonable and pleasing adjunct to the construction, and serves to satisfy the eye by binding together the parts—a real as well as apparent result. But when, as in the instance before us, colour is indiscriminately bespattered, its tawdry, kaleidoscopic effect is rather repulsive than to be coveted. The design is illustrated by an ample number of drawings, carefully executed; the nave has but three bays, very wide, and each subdivided in the clerestory into three windows,—(the weight of this walling compared with its support looks venturesome); beyond the nave is a central tower, square at the base, with a low pyramidal roof, which, internally, is converted into a kind of dome. There is a detached campanile, after the same idea as Mr. Gray's, but of much uglier design; its covering is a high octagonal spire, whose angles start from the centre of each face of wall and from the four main angles of tower, a mode not unfrequently adopted on the continent.

Having thus commented on the selected designs, we must dismiss the remainder with more brevity. In fact, there is not a great deal to provoke criticism of a favourable kind, a vast proportion of the schemes differing nothing from what their authors might have been expected to submit for an English building. Thus we have Mr. Derick's, in almost every particular of this class, even to minute details; his windows are large and open, copied from the chapter house at York, from Merton College, and elsewhere. Mr. Batter's is debased English "Perpendicular," smothered with shallow panelling; Mr. Thrupp's is a jumble of the "Early English," Mr. Francis's and Mr. Gabriel's little better: Mr. Rohde Hawkins' design is nondescript as to style, and feeble in composition; Mr. Conybeare's is absolutely atrocious, not worth a single remark but that it may be so easily described as consisting of a few square lines, enclosing an unvarying series of lancets (windows or arcading) throughout; aisles, triforium, chancel, belfry, and all. There is something rather pleasing in Mr. Raffles Brown's scheme, which has evidently cost some pains: its tower and spire, however, appear far too slender for safe execution under local circumstances (see section). The spire is planted similarly to Mr. White's.

We must not overlook a class of designs which have the feature of an external dome. It may be inferred from the wording of the "instructions" that such an introduction would not be sanctioned, since "the imitation of any forms connected with the religious architecture of the Mahometans" is expressly mentioned as objectionable. Mr. Wigley, in the face of this, gives a palpable reproduction of that of Sta. Sophia, which has the additional absurdity of being suggested for a site immediately contiguous to its celebrated prototype! Mr. Aitchison's conception is entirely based on a dome: the plan has but slight additions to this simple form; it forms at the base a polygon of sixteen sides, with a core or inner dome, whose sides are reduced in number to eight. The covering is on the ridge-and-furrow principle. There is considerable breadth in the exterior effect, and of colour in the interior: the author is evidently conversant with his subject. Mr. Mitchell also has a dome as the chief element of his plan; directly under its centre is placed the pulpit, from which all the seats are shown to diverge. The outside effect is unpleasing, partly owing to the main outline, and partly to the style (Flamboyant) in which the author has indulged. The spire to the octagon is shown to be of pierced tracery. Mr. Garling's design is, on the whole, but tame and unpromising; we notice it for the sake of referring to its dome at the intersection, which is evidently a small imitation of that of the baptistery at Pisa. By far the best composed design with a dome is, to our mind, that of Mr. Nicholl, which, though partially borrowed from Florence, has considerable novelty in parts. The construction has been well studied, and the internal effect of the main features combined with the pendentives, &c., would doubtless be satisfactory. The chancel is finished by a half decagon.

Among other designs may be singled out for commendation those of Mr. Bell, his interior especially; (by the bye, the side elevation shows the chancel *higher* than the nave);—Messrs. Prichard and Seddon's, which is perhaps overdone in gables and colour;—and Messrs. Howell and Budd. The same defect, the too liberal use of colour, is in this also observable, while the whole design is far too ambitious to come within the means stipulated. Another equally overloaded design is by Mr. Castle, whose plan has some good points, but in other respects is most unprepossessing. The style is the continental Flamboyant.

Judging by the numbers who flock daily to view the drawings, the subject is one of unabated attraction, and an hour or two passed in the gallery just now will repay the sacrifice.

It has been proposed to publish the whole of the 46 designs submitted in competition for the Memorial Church at Constantinople, each architect to lithograph his own work or to superintend its being done. To carry out the idea a meeting has been held, but as nothing can be done till the drawings are returned to their authors, it has been thought best at present merely to ask all competitors to write to the Hon. Sec. Mr. George Truefitt, 6, Bloomsbury-square, to say if they will assist in carrying out so desirable an undertaking—one, which will be of no expense to them; for if each competitor obtains three or four subscribers to the work, the whole cost of publication will, it is calculated, be defrayed. The Commitee hope that the competitors will write as above requested.

At a special meeting of the Royal Institute of British Architects, held on the 2nd ult., it was resolved, "That it be humbly submitted for Her Majesty's gracious consideration, that the Royal gold medal, for the year 1856, be awarded to Owen Jones, Fellow, author of the 'Alhambra,' 'The Grammar of Ornament,' and other works."

The new library which is to be erected for the Society of the Middle Temple, from the design of Mr. H. R. Abraham, will be 85 feet long, 42 feet wide, and 62 feet high to the underside of the ridge. Beneath, will be class-rooms and rooms for the benchers. The building is Gothic of the Perpendicular period in style. There will be an oriel window at the end next Garden court, and a large traceried Pointed window in the end, which will be seen from New-court. There will be a louvre and spiret on the roof. The new library will be connected with the old hall by means of a new turret to be added to the latter, with a flight of stairs which externally will take the shape of a flying buttress. The library will have an open timber roof.

The subject selected by the Royal Academy for the gold medal competition of this year, both in sculpture and painting, is "The Good Samaritan." It is expected that there will be a large number of competitors.

We regret to announce the decease, on the 18th ulto., at Edinburgh, after a long illness, of Mr. William Playfair, one of the greatest of our northern architects. Mr. Playfair was born in London in July, 1789. His father was an architect of note in his day, and his uncle was the celebrated mathematician and philosopher, Professor John Playfair.

THE GOVERNMENT BARRACKS COMPETITION.

It will be remembered by most of our readers, that nearly twelve months ago, 114 sets of plans, elevations, sections and specifications, for the new cavalry and infantry barracks, were exhibited at Burlington House, and that the successful candidates were then declared. We trust, after this long interval, that we may be excused asking the Commissioners who have this matter in hand, why the architects who carried off the first prizes have not been instructed to carry out their designs? We may state that the first prize of 150*l.* for the infantry barracks was awarded to Mr. Morgan, architect of Danes'-inn; the second of 100*l.* to Messrs. Lockwood and Mawson, of Bradford; and the third of 50*l.* to Mr. Jones, of Sleaford, near Liverpool. In reference to the cavalry barracks, the first prize was awarded to Messrs. T. H. and M. D. Wyatt, of London; and we should be glad to hear that the successful parties have been instructed to carry out their respective designs.

ARCHITECTURAL IMPROVEMENTS OF LONDON.

No. IX.—Our Streets.

In continuation of our notices of the new erections in Cannon-street West, City, we may especially name a very large block that comprehends the entire mass from Friday-street to Bread-street, and now all occupied by Messrs. M. J. Devans, Minchener, and Routledge. This large pile, like most of the new structures in the street, partakes principally of Italian characteristics, and is carried five stories in height above the roadway, with large basements underneath, the upper portions of the windows of which are 3 feet above the footpath. The ground story is constructed of a series of thirteen stilted arches, which have segmental arched-heads, the extreme end ones being inserted in the chamfered corners of the building. Within the western one is the principal entrance, the jambs of which are composed of pilasters and slender parallel shafts, the latter of which remind us of Gothic treatment, and certainly are not in accordance with true orthodox Italian design; neither do the stilted arches, and the tame, inexpressive circular-headed windows of the first-floor, without impost mouldings, afford avery favourable impression of what may be effected, even under ordinary circumstances, with Italian elements of composition. The various dressings of the three upper story windows are all of the ordinary kind, without possessing any peculiarities that call for special comment. The elevations are terminated at the eaves of the roof by a somewhat heavy, plain cornice, the corona of which is supported by large moulded blocks.—The next mass of building in the street, still stretching eastward, and on the same side, extends from Bread-street to New Earl-street, the latter of which branches from Cannon-street in an oblique line, and intersects the eastern side of Bread-street, near St. Mildred's Church, which is very abruptly hemmed in here between Cannon-street and Bread-street. The general effect of this block is in a great measure marred by the extreme plainness of its eastern portion; for, although the same enriched cornice is continued throughout the whole, there is a singular want of embellishment about the upper windows, and those of the ground story have no dressings of any description around them, but merely consist of segmental heads with a bead round their jambs and soffits, giving them a starved and meagre effect that is very unsatisfactory. The western end of the block is, however, of a much more ornate character, but only serves, by contrast, to make that portion to which we have adverted, look worse. The ground stories of these buildings, which extend also down Bread-street, are not yet finished, but the upper portions are nearly so—at least, externally. The first-floor windows are divided, Venetian fashion, into three lights by pilasters, which have Ionic capitals, over which are suitable entablatures. These windows are segmental-headed, whilst those over them are circular, and divided from each other by moulded piers, at the top of which are enriched consoles; above these a cornice is run that breaks into a segmental pediment over the central portion of the windows. The principal cornice, which we have observed is continued throughout the whole block, of both the plainer and more embellished portions, is enriched with modillions and dentils.—On the northern side of the street, and extending from *Friday-street* to *Bow-lane*, the old buildings of which the range is composed present a most heterogeneous jumble of discordant elements, some being four stories high, in dingy brick; others three stories, plastered and painted; and some with preposterously clumsy balconies projected at the sills of their second-floor windows. Others, again, have great staring glazed photograph rooms in their roofs, and the whole range more or less disfigured at the termination of their chimneys by long red tile funnels, and zinc pipes equally ugly. Assuredly there is much improvement required here, and we hope ere long that the whole will be swept away, and replaced by buildings erected under the control of the City architect, who, we trust, will enforce the observance of some degree of uniformity and harmony, by the various builders of the new erections.—Eastward of Bow-lane, however, we rejoice to see a proper spirit of improvement gradually progressing, two respectable structures having already been built, and another large one beyond them now nearly finished, from the designs of Messrs. Tillott and Chamberlain. The edifice has a frontage in Cannon-street of 84 feet, with nearly the same depth, and occupies the sites of the two houses, Nos. 14, and 15, which formerly stood here. The building comprises five stories in height above the footpath level of the street, and its ground-floor story is entirely faced with Portland stone, the plain surface of the superstructure being white Suffolk bricks, with Portland cement dressings to the various windows. The façade has merely a minor cornice at the eaves, the principal one, which is highly enriched, being carried across the front at the level of the sills of the attic story windows, and is stopped at its ends by trusses in pairs, instead of being returned across the gables. Unlike some of the business premises in the City, the upper floors will not be devoted to domestic purposes, but the several areas of every stage will be used for warehouses and the sale of goods. The internal area of each floor is about 80 feet by 46, and the whole are supported by a series of cast-iron columns, which rest at their bases upon granite plinths, under which are brick pillars set in cement upon a depth of 3 feet of sound concrete.—Extending our review still further east, and on the southern side of the street, we come to a large, new façade, of much more pretentious character, and more ornate in its embellishments than any of those previously noticed. This is what is familiarly known as the "Unity Buildings," designed by Mr. Belsher, architect, of Adelaide-place, London-bridge. The street front of this large edifice is purely Italian in its style, and, longitudinally, is in four general divisions, which, as regards the first, second, third, and fourth floors are lighted by large windows of three lights each, the widest being in the centre. The dressings around the windows of the first and second-floors contain a very large quantity of moulded work and enrichment about them. Those of the first-floor are divided by piers, on the front faces of which are engaged columns with Ionic capitals, over which are highly enriched cornices, and above this cornice, extending over the heads of each, window are open balustrading, having pedestals between them immediately over the columns below. The same vertical arrangement is observed in the second-floor windows, but the capitals of the columns are of the Corinthian order, and above the central lights of the windows are segmental moulded pediment-heads, springing from the horizontal line of the cornice. The dressings of the third and fourth story windows are of a plainer description, and the whole elevation is terminated by a well proportioned cornice enriched with modillions, egg-and-tongue bead mouldings, dentils, and a frieze of boldly-cut foliage. There are two principal entrances in the façade which are both of similar design, composed of pilasters on each side, having enriched capitals, over which are moulded consoles supporting a segmental pediment, the tympanum of which is filled with foliage. Between these entrance doorways, and over the heads of the ground-floor windows, extending the whole width of the elevation, is a very characteristic string-course composed of mouldings encasing a Vitruvian scroll, and an enriched ovolo at bottom. The external angles of the building (together with the vertical breaks that divide the structure into what may be termed compartments) have rusticated quoins from the lower string-course to the upper cornice; those portions of the ground story, including the surfaces below the sills of the ground-floor windows, and which form portions of the piers and heads of the basement windows, being vermiculated. This structure, as a whole, may be considered a very favourable example of modern street architecture.

CONTOUR LEVELS.*

If (for illustration) a model, to scale, of the Isle of Wight—with its base corresponding to high-water mark—were placed in a tank containing enough water to cover it, and there were pegs in one side of the tank (say) at every 10 feet height by the scale, the removal of which would permit the water to run off; and if these pegs were successively taken out, beginning with the top one, and when the water fell to the level of each, a line were scratched upon the model, following the edge of the water, and their respective heights also marked upon them—these lines would be lines of equal level, counting from each high-water mark as a datum; and they would correspond to the contour lines which are laid down upon maps for sanitary and other purposes. Upon inspection, it would be found that, in the more level districts, the lines, though vertically equi-distant, were, horizontally, wide apart; while, in the precipitous localities, their horizontal proximity would be very decided: in this respect, also, they would correspond with the map contours, which are closest together where the inclinations are steepest, and widest apart where they are least appreciable—crossing all the steep roads, but running parallel with streams, or whatever is level.

A map, say of an estate, may be contoured by adopting the following course: Take parallel and equi-distant lines of levels all over the estate, also parallel lines at right angles to, and of the same width apart as the first. In running the former, take the points which correspond to the intersections of the transverse lines, and peg them. Supposing the distances to be 100 feet—where the land is comparatively level, the squares thus formed will be small enough; that is, the levels will be sufficiently frequent. But, where it is steeper, divide, and if expedient, subdivide the squares with other parallel and transverse lines. Having taken the levels—all, of course, with reference to one datum—lay down the lines upon the map, and mark the levels in figures at the intersections—the lines in pencil, but the figures in ink. The levels will be odd quantities, while the contours are to be set at even heights above the datum. Therefore, the intermediate even heights will have to be ascertained by calculation; and the surface from point to point, sectionally, will have to be considered straight—which it will be if the squares are taken with due regard to the undulations of the land. Suppose that the contour lines are to be at 5 feet vertical distances apart, and that it is required to find the position of the intersection of one of them on a 100-feet line, the levels of the two ends of which are respectively 84·15 and 76·65, difference 7·50; say, as fall 7·50 : 100 : : fall 4·15 to the distance of point 80 from 84·15, = 55·33 feet. The point thus found will be a point in contour 80; and the remaining points in the same contour will be found by observing all those pairs of heights between which the 80 feet must come; and so also will the points in all the other required contours on the map. The lines will then have to be drawn, with due curvature, through the points found, and inked-in, and figured at their terminations for the purpose of identity. The heights found by levelling being true heights, their continuing to accompany in figures those found by calculation will be found advantageous rather than otherwise. By counting the lines, and multiplying their number by their vertical distance, differences of level will be at any time readily ascertained.

Without contour lines, the surface-map is imperfect,—representing the locality in one only of its two chief phases, of which one is hardly less important than the other. In the 'Report on the Health of Towns' is a map of the City of London, with contour lines of 18 inches vertical distance, counting from 10 feet below top of cap-stone at foot of step, east side of Blackfriars-bridge; and a map of London and its environs, 3¼ inches to the mile, with contours representing 10-feet grades of altitude, and the 50-feet lines marked strongly, and figured,—counting from Trinity Standard of 1800, taken at Shadwell entrance of London Docks, was issued during the past year by Mr. R. W. Mylne. Ordnance surveys of northern, and other parts of the kingdom, both county and town, of late years, show contoured levels—for example, that of the town of Lancaster—5 feet to the mile. Continental governments pursue the same practice as regards their capitals and principal towns.

* From Adcock's Engineer's Pocket-Book, for 1857.

INSTITUTION OF CIVIL ENGINEERS.

March 3.—I. K. Brunel, Esq., V. P., in the Chair.

The Paper read was "*On the Results of the Use of Clay Retorts for Gas-Making.*" By Jabez Church, Assoc. Inst. C.E.

The substitution of fire-clay for metal, in the construction of retorts was attributed to Mr. Grafton, and dated back as far as the year 1820. Originally they were square in transverse section, but that form was soon changed for the D, or oven-shape, which had been since adhered to, both in this country and abroad; this latter form of retort admitting of a stratum of coal being distributed of an equal thickness throughout. The comparative quantities of gas made by iron and clay retorts, of the D form, of 15 inches by 13 inches in section, and 7 ft. 6 in. in length, had been found by the author to be as follows:

The iron retorts lasting 365 days, and working off 1½ cwt. of coal for each charge, effected the carbonisation of 2190 cwt. of coal, which at 9000 cubic feet of gas per ton, gave a total quantity of 985,500 cubic feet of gas per retort; whilst the clay retorts lasted 912 days, carbonised 5472 cwt. of coal, which, at 9000 cubic feet of gas per ton, gave 2,462,400 cubic feet of gas per retort. It would thus be seen that the clay retorts yielded a greater quantity of gas, from the same weight of coal, than the iron retorts, but the specific gravity of the gas so made was less, and its illuminating power was diminished, in consequence of the increased temperature of the clay retorts, which caused the last portion of the gas to be decomposed.

The most practical method of working clay retorts in large works, was with the addition of an exhauster. This reduced the pressure on the retort, and prevented the escape of gas through the pores and fissures; and by that system the quantity made was increased about 200 cubic feet per ton of coal. In small work, the expense of an exhausting apparatus, and steam machinery to work it, would not be compensated by the gas saved. In such cases, therefore, it was necessary to work at as low a pressure as possible; and it had been found, that a water gauge pressure of 7 inches was the most profitable. The deposition of carbon from the decomposition of gas at a high temperature, was more abundant in clay than in iron retorts, and it had been determined, experimentally, that its amount was also influenced by the particular kind of clay used, as well as by the smoothness or roughness of the interior surface of the retorts, the deposition being greatest in the latter case. The principal portion of carbon appeared to separate from the gas at the earlier period of working the charge of coal, and ceased to be separated towards the latter part of the time; so that every time the retorts were charged and worked, there was a distinct layer of carbon thus formed, and eventually this accumulation became so great, that it required to be removed. The removal of this carbonaceous incrustation, on account of the fragile nature of the clay retorts, required to be conducted very carefully. In the ordinary way atmospheric air was introduced into the retort for from nine to thirty hours, and then the carbon was detached by means of chisel-ended bars. The author had tried the plan of inserting an earthenware pipe through an orifice in the lower part of one of the lids, the inclination of the pipe being changed, so as to allow the air entering through it to impinge successively on every part of the carbonaceous mass; being, at the same time, a temporary connection made between the ascending pipe leading to the hydraulic main and the main flue of the retort stack leading to the chimney shaft. By this method only half the time was needed for the removal of the carbonaceous incrustation.

With respect to the quantity of fuel required for carbonising the coal, it had been found, that with short retorts, the results were about the same, whether clay or iron retorts were used. In ordinary working, about 25 to 30 per cent. on the quantity of coke made was consumed, assuming that Newcastle coal was used, and that a chaldron of coke was produced by each ton of coal. With clay retorts of 20 feet in length, a saving of fuel was effected.

In conclusion, the author stated, that the cost of clay retorts was about 50 per cent. less than that of iron retorts, and that there was a saving of about 20 per cent. in the setting, whilst their durability in work was two and a half times greater, the former lasting two and a half years, and the latter only one year.

In the discussion, the general results given in the Paper, were confirmed; it was, however, stated that the quantities of gas obtained from iron and from clay retorts must be in proportion to the qualities of the coal used. In some places where 7600 cubic feet of gas had been produced by iron retorts, as much as 9200 cubic feet had been made in clay retorts; and the produce had even been as high as 11,000 cubic feet per ton of coal.

In general there was an increased yield of about 2000 cubic feet per ton when using clay retorts. It was probable, that the power of the clay for retaining heat had some influence on the quantity of gas produced.

It had been observed, that instead of following the usual law, the leakage of gas through the pores, or fissures of the clay retorts was exactly as the pressure, instead of as the square of the pressure.

The circumstances under which the bi-sulphuret of carbon was evolved were treated of at some length, and it was shown, that even the method now adopted, of leaving in the gas a small portion of ammonia, was not entirely effectual, in removing the prejudicial effect of the bi-sulphuret of carbon which was so severely felt in the rooms where gas was burned.

It was stated, that the carbonaceous deposit in the retorts could be more speedily removed by the use of a small quantity of salt thrown in when in a heated state. It was very important that the interior surface should be as smooth as possible, to reduce the tendency to deposit, which was believed to proceed from the tar produced in the process of destructive distillation of the coal, rather than from the gas. The use of clay retorts was admitted to be now almost universal, except in very small gas-works, and that the economy they induced was even greater than had been stated in the Paper.

March 10.—R. Stephenson, Esq., M.P., President, in the Chair.

With reference to the discussion at the previous meeting "On the Results of the Use of Clay Retorts for Gas-making," it was remarked, that the merits of iron retorts had scarcely been fairly stated, as in some instances, quite as much gas had been made by the latter as by the former; unless in cases of peculiar qualities of coal being used, and that the iron retorts had been in constant work for two years and a half.

It was stated, that the course the discussion had taken might lead to fallacious conclusions, for although clay retorts, when well set and carefully managed, might endure twice, or thrice as long as iron retorts, and the materials of these retorts and also of their settings were cheaper than those of iron retorts, yet on the other side of the account must be placed several important items of charge, which under certain circumstances would turn the balance in favour of iron retorts, in certain other circumstances render it matter of indifference which description of retort was used, and in a third state of circumstances prove that clay retorts ought to be preferred. If, for instance, the following practical case was assumed: Let the cost of an iron retort mounted for use be 10*l*., and of a similar clay retort mounted for use be 7*l*. Let the durability of the latter be 2½ times that of the former, and let the quantities of gas made in each be respectively 900,000 cubic feet and 2,250,000 cubic feet prior to final destruction. Granted also that the sale price of coke was 15*s*. per ton, the consumption by iron retorts 3-10ths of the quantity made, and by clay retorts 4-10ths of the quantity made, and let it be admitted, that one ton of coal carbonised would produce $\frac{2}{3}$rds of a ton of coke—then the amount for equal productions of gas would stand thus:

	Iron Retorts.	Clay Retorts.
1. Materials and Setting......	£10×2½=£25 0 0	£7 0 0
2. Extra Repairs of Furnaces, &c.		1 10 0
3. Expenses of Exhauster, &c.		1 5 0
4. Blowing-out Apparatus, &c.		5 0
5. Coke used in Furnace	37 10 0	50 0 0
Total	£62 10 0	60 0 0

Showing that when coke would sell at 15*s*. per ton, and the other circumstances were as stated, iron retorts and clay retorts were of very nearly equal value. If coke was dearer, iron retorts were to be preferred, and if it was cheaper clay retorts should be preferred.

Coals, however, varied much in quality, and so did the quantity and quality of the coke produced, and hence the gas engineer must in every case be governed by the particular circumstances with which he had to deal.

Clay retorts were well adapted for generating gas from the Scotch cannel coal, which produced coke of no appreciable value; but it might be doubted, whether they were in useful effect equal to iron retorts, for the distillation of coals containing, or yielding a large quantity of liquid matter, as for instance with coals which yielded 350 lb. per ton of ammoniacal liquor, instead of the very usual quantity of 100 pounds. Nor were they to be commended for small works, using a coal producing valuable coke, for in such works an exhauster could not be applied; neither was the management and employment of the retorts so careful as in larger establishments, conducted under intelligent supervision. An error had been committed by some speakers in supposing that clay retorts could be worked at a pressure of 7 inches of water with more advantage than at lower pressures. Clay being a porous material, allowed the gas to transpire through its capillary passages, and hence it was better to work under a low pressure. Neither was it ordinarily correct to say, that clay retorts would produce more gas than iron retorts, or gas of better quality. In fact, clay retorts would not evolve more, nor indeed, so much, gas as iron retorts, if they were not, by the expenditure of a much larger quantity of fuel, sometimes worked at a much higher temperature than would be prudent with iron retorts. In many such cases, however, the additional quantity was obtained, not only at the expense of the illuminating power, but also at the expense of purity.

Much had been said with respect to the supposed anomaly of the law of leakage through the substance of clay retorts—the quantity being found by experiment to be as the pressure, rather than as the square root of the pressure. This, however, was no real anomaly, for the law of the transmission of fluids through tubes was well known to be represented by the formula

$$P \propto av^2 + bv$$

in which P represented the pressure, v the velocity, and a and b two experimental co-efficients. Now when the motion was minutely slow, as it always was through capillary tubes and porous substances, v^2 became indefinitely small in respect of v, and consequently

$$v \propto P$$

or, in other words, the quantity lost was as the pressure placed upon the retort. The same law obtained in the leakage of gas from mains, and hence, by mere observation, it was discoverable whether the loss was from a broken pipe, or from capillary apertures; because in the former case the loss under a given head P would be as $\sqrt{P}$, while in the latter case it would be as P simply.

In respect to the greater deposition of carbon in clay retorts, it was believed that this arose in a considerable degree from the decomposition of the gas transpiring through the substance of the retort, this gas parting with its carbon while entering the highly-heated pores, which carbon then became left on the inner surface of the retort.

The Paper read was, "*On High Speed Steam Navigation; and on the Relative Efficiency of the Screw Propeller and Paddle Wheels.*" By Robert Armstrong.

The first part of the Paper was devoted to the consideration of the circumstances which appeared to limit the maintenance of higher speeds than were now attained by steam ships, in deep sea navigation, and the causes which had hitherto prevented the asserted high speeds of steam navigation, on the American rivers, from being attained in England.

It was remarked, that it was of primary importance in calculating the velocity of steam ships, to "separate the performances of the machinery from the question of the form of the vessel," for it was believed, that the increased effective power of the engines had been completely neutralised by the theory of the sharp water line, and that the speed which had been hitherto attained was not due so entirely to the skill of the naval architects as had been asserted. Where great speed had been obtained, it was shown, that it was always with a proportionately small midship section, augmented length, and increased steam power, above the ordinary proportions of other steam ships.

It was argued, that the propelling power was as the square of the velocity, and not as the cube, which was the prevailing opinion, and that the formula based on this law, and on the fact that one effective horse-power was required for one square foot of midship section, to produce a velocity of 10 miles per hour, would be,—

$$V^2 \text{ (in miles)} = \frac{\S\ 1 \text{ H. P.} \times 100}{\text{Mid. Section}}.$$

It was shown, that the actual speed of sixteen out of twenty-nine screw steamers was within 10 per cent. of the speed calculated by this formula, the results being given in a table, in which the midship section, the indicated horse power, the actual speed in miles, the pitch of the screw, and the number of revolutions per minute were given. Variations from the formula might arise from imperfections of the engine, the form of the propeller, and the immersion of the vessel. The midship section was not always the greatest section to the line of motion, especially in screw steamers; and at velocities of 13 miles per hour, or upwards, the immersion of the after end rapidly increased. With coarse pitched screws, the actual was less than the calculated speed by the formula. It was suggested, that the "angle from the axis of the screw" would be a better expression for the pitch than that now adopted.

The report of the trial of the French war steamer *Charlemagne* was quoted in support of the author's views. With two boilers there was an expenditure of 3064 lb. of coal, to propel the vessel at the rate of 8 miles per hour, and with three boilers the consumption was 2659 lb. of coal, to attain the same speed; whilst with four boilers, and a consumption of 5733 lb. of coal, the speed was 10·9 miles per hour. According to the square theory, to attain a speed of 10·9 miles per hour, with two and three boilers respectively, would involve an expenditure of fuel as shown in the following proportions:—

$$8^2 : 3064\ \text{lb.} :: 10{\cdot}9^2 : 5688\ \text{lb.}$$
$$\text{and } 8^2 : 2659 :: 10{\cdot}9^2 : 4936$$

whilst according to the cube theory these proportions would be

$$8^3 : 3064\ \text{lb.} :: 10{\cdot}9^3 : 7749\ \text{lb.}$$
$$\text{and } 8^3 : 2659 :: 10{\cdot}9^3 : 6744$$

whereas the actual consumption with four boilers for a speed of 10·9 miles per hour was, as before stated, 5733 lb., the midship section being in both cases nearly equal. This Report also showed a saving of fuel of 4 tons per day, by increased boiler space. It was stated, that in sea-going steam ships, 5 lb. of coal per diem might be taken as the consumption of one effective horse-power. It was remarked, that the system adopted in the French navy, of recording, in minute detail, the results of the trials of their steamers, was to be commended, and that it was one well worthy to be extended to this country, as it could not fail to be of essential service in the improvement of naval architecture.

From the arguments adduced, the author concluded:—

1st.—That in the separation of the performances of the machinery from the question of the form, in calculations of velocity, the duty of the naval architect was merely to provide the requisite displacement at which the vessel might float, with the proposed immersed midship section, and to show the stability, the strength, and other properties required in a vessel, all considerations for velocity being entirely the province of the engineer.

2nd.—That the rate of sailing between two vessels, with an equal moving power in each, did not depend on the form of water-line, but entirely on the area of the greatest section to the line of motion.

3rd.—That displacement in the line of direction did not materially add to the resistance; and,

4th.—That the friction between the sides of the vessel and the water need not enter into any calculation, for any required velocity.

It was asserted, that the requisite principles were not fulfilled, for the maintenance of higher speeds, than were now attained by steam-ships in deep sea navigation; and that the length of the vessel was the most important element for this purpose; a comparison being drawn between H. M. S. Yacht *Fairy* and the *Himalaya*, the speeds of which were nearly identical, whilst the other proportions were very dissimilar, as the latter was three times longer, had twenty times the displacement, and yet had only five and a half times the power of the former. It was believed, that an increase of 200 feet in the length of the *Himalaya* would be advantageous, as it would enable 2000 tons of extra cargo to be conveyed at the same velocity; and by doubling the present power on board, a speed of 22 miles per hour might be obtained, with an increase in the consumption of coals of only 300 tons, still leaving space for 1000 tons of cargo, with the same immersed midship section. If a further extension of length of 200 feet was made, the displacement would be increased three times, and the power being similarly increased, a speed of 27 miles per hour might be obtained, and the distance from Liverpool to New York would be accomplished in five days. The proportions last indicated were, it was thought, very similar to those of the *New World*, one of the most recent of the American river steamers. It was shown, from Admiralty records, that the four vessels having the largest proportional displacement to nominal horse-power, and also to the midship section, were the most efficient for speed; proving that the midship section, and not the weight, was the sole basis for calculations of velocity, and that displacement in the line of direction did not increase the resistance. It was believed, that the *Great Eastern* steam-ship, now building, would be propelled at the rate of 18 miles per hour, if the engines worked up to the same indicated horse power as the *Himalaya*, and that 10 tons would be conveyed at the same speed and cost as 4½ tons.

When the fact was received, that the midship section was the sole basis for calculations of velocity, the best form of water-line could soon be decided, and the stability, and other requisite conditions, in the construction of vessels, could be established. Then with a form of vessel increased in length amidships, without the risk of that continual change which had existed during the last twenty-five years, and which was a strong proof of the absence of established principles in naval architecture, machinery could be most profitably employed in the building of ships.

In the second part of the Paper 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, was considered. For this purpose, the trials of the *Himalaya*, a screw-steamer, with the *Atrato*, a paddle-wheel steamer, were referred to. The engines were valued by their efficiency, 50*l*. per nominal horse-power being taken as a basis for testing their economy, the consumption of coal per effective horse-power, and that required to propel one ton of displacement a given distance were calculated, and the efficiency of the vessels for velocity was tested by a common standard of resistance. From this it resulted, that—

	Himalaya.	Atrato.
Value of engine per effective H. P.	£25 12 0	£32 1 0
Consumption of coal per effective H. P. ...	5·5 lb.	6·3 lb.
One ton of displacement carried one mile by	·146 lb.	·181 lb.
Ratio of actual rate to rate given by formula	100	83

The engines of the *Himalaya* were therefore 20 per cent. more efficient than those of the *Atrato*, the consumption of coal was 14 per cent. less, the displacement carried bore about the same per centage, and the efficiency for speed, in these two examples, was that the paddle-wheel was 17 per cent. less than the screw propeller.

March 17 and 24.—The Discussion on Mr. R. Armstrong's Paper occupied the whole of these evenings, and was announced to be continued at the meeting of March 31st, after which the abstract of the whole would be published.

Since the death of the late Mr. J. Meadows Rendel, C.E., the Lords of the Admiralty have appointed Mr. John Coode, C.E., as Engineer-in-Chief of the Harbour and Breakwater works at Portland.

COMPETITIONS.

Plans and Estimates are required for building a depôt in Field-lane, Bury St. Edmund's, for keeping the arms, accoutrements, ammunition, and stores of the West Suffolk Militia. Particulars at the office of Mr. John H. Borton, Clerk of the Peace, Bury St. Edmund's. Plans to be sent in by the 6th instant.

The Committee of the Northallerton Provident Corn-mill are desirous of receiving Plans, Specifications, and Estimates, for erecting the building, the engine of 20-horse power, four pairs of stones, with additional room for other two pairs, if required, together with the whole apparatus requisite to form a complete corn-mill. The building is proposed to be the subject of a separate contract. Further particulars may be had of Mr. Farrar Vasey, Northallerton. Plans to be sent to F. Gibbes, Esq., Northallerton, by the 20th inst.

The Burial Board, Maidstone, wish to receive Plans, Designs, Specifications, and Estimates for the erection of two chapels, a receiving-house, entrance-gates, and lodge, and a boundary fence, and for laying out the land, with roads and foot-paths, for the new burial-ground. Premium 80 guineas. Particulars can be obtained on application to Mr. R. Holmes, Clerk to the Burial Board, High-street, Maidstone. Plans to be sent in by the 29th instant.

Plans and estimates are required for the rebuilding the Parish Church of Bowden, near Altrincham, Cheshire. The ancient type to be preserved, and restored, as far as possible. The church consists of a nave, with clerestory, western tower, north and south aisles, south porch and north door, chancel with north and south chapels. The monuments to be preserved and reinstated. The roof to be raised, and the seats rearranged, so as to increase the accommodation as much as possible. Estimates are required, allowing for the use of such old materials as may be suitable. The drawings to be prepared without colour or tinting of any kind, to the scale of 8 feet to an inch, and to be sent in addressed to the Vicar and Churchwardens of Boden, near Altrincham, Cheshire, on or before the 21st May next. Sixty guineas will be awarded to the most approved design, and 30 guineas to that considered next in merit. Further particulars may be obtained of John Mort, Churchwarden, Altrincham.

Designs are invited from artists of all countries for a Monument to be erected in St. Paul's Cathedral, to the memory of the late Duke of Wellington. The cost, with all expenses, not to exceed 20,000*l.* Premiums of 700*l*, 500*l.*, 300*l.*, 200*l.*, and five of 100*l.* A ground-plan of the cathedral, and the site of the proposed monument, &c., will be forwarded, on application to Mr. Alfred Austin, Office of Works, Whitehall. Designs from artists residing in the United Kingdom to June 1st, 1857; from artists residing abroad to the 25th of the same month.

Designs are invited for a statue in marble of the late Lord Plunket, to be placed in the Hall of the Four Courts, Dublin. Information of Colman M. O'Loghlen, 20, Merrion-square South, or Robert Johnston, 3, Henrietta-street, Dublin, Secretaries.

Designs for a church to be erected at Berne are invited from architects of all countries by members of the "Catholic parish of the city of Berne." The cost not to exceed 6000*l.* The first prize is 60*l.*; four medals, gold and silver, are also offered.

The Committee of the Bristol Lunatic Asylum Competition have awarded the First Premium of 100*l.* to Mr. T. R. Lysaght, of Bristol; the Second of 50*l.* to Messrs. Medland and Maberley, of Gloucester; and the Third Premium of 25*l.* to Mr. J. H. Hirst, of Bristol. There were 27 competitors. The cost of the approved plan is guaranteed at under 20,000*l.*

The design of Mr. Bird, architect, of Manchester, has been accepted for the Hebrew Synagogue, to be erected on the site chosen for the building opposite the Town-hall, Cheetham, Manchester.

The Wellingborough Burial Board have awarded the premium to Mr. E. F. Law, of Northampton, who has received a commission to prepare the necessary drawings and specifications for carrying out the buildings.

Nineteen Designs were sent in for the Chatham Workhouse. That by Messrs. Fred. Peck and E. W. Stephens, of Birmingham, has been selected as the best, and that of Mr. E. Holmes, also of Birmingham, as the second best.

Eight Designs were received for the Bromsgrove Cemetery Buildings, the estimates varying from near 600*l.* to 1900*l.* The Board decided upon accepting the plan submitted by Mr. C. H. Cooke, of London, whose estimate was 575*l.*

NEW PATENTS.

PROVISIONAL PROTECTIONS GRANTED UNDER THE PATENT LAWS AMENDMENT ACT.

Dated November 21.

2768. A. Clark, Gate-street, Lincoln's-inn-fields—Improvements in the application and construction of revolving window shutters and blinds, and metal window sashes

Dated December 26.

3064. A. J. B. L. de Marcescheau, Paris—Improvements in the modes of communicating or transmitting motion to propelling apparatus, engines, or machinery

Dated December 29.

3085. W. R. Bowditch, Wakefield, York—Improvements in the manufacture of a compound to be used as a varnish for water colours, and as a carrier for water colours or paints

Dated January 16.

132. S. Haycraft, Birmingham—Improvements in anchors
133. T. J. M. Townsend, Searby, near Brigg, Lincoln—Improvements in drain pipes, and in machinery for producing the same
134. J. Edridge, Birmingham—Improvements in 'safety pins' for dress and other similar purposes
135. H. H. Henson, Parliament-street, Westminster—Improvements in treating animal and vegetable fibre and fabrics for preserving or waterproofing the same
136. G. S. Moore, Monkwearmouth, Sunderland—Improvement in combining steam engines and boilers when used with screw or stern propellers of ships or vessels
137. G. T. Bousfield, Sussex-place, Loughborough-road, Brixton—Improvements in sewing machines. (Communication)
138. J. H. Johnson, Lincoln's-inn-fields—Improvements in scutching machines. (Communication from C. Leyherr, Laval, France)

Dated January 19.

154. J. Haswell, Vienna—Improvements in the construction of railway carriages, which improvements are also applicable to locomotive steam-engines

Dated January 20.

160. F. Walton, Haughton Dale Mills, Manchester—Improved plastic composition, and in the application of machinery for manufacturing the same

Dated January 22.

190. R. A. Brooman, Fleet-street—Improvements in the preparation of oil for lighting, and in lamps, wicks, and chimneys. (Communication)

Dated January 24.

213. T. Ayles and R. A. Ayles, jun., Weymouth—Improvements in the construction of ships, and other vessels navigating on water
214. P. A. Sharkey, Liverpool—Improvements in the construction of scale beams or balances
215. J. Whines, Pimlico—Improvements in machines for dovetailing, grooving, slotting, and rabeting
216. J. Harris, Hanwell, Middlesex—An improved method of stopping or retarding railway carriages and trains, locomotive and stationary engines and machinery, together with certain apparatus which may be employed therein
217. J. Walton, Bradford—Improvements in looms for weaving
218. C. J. Wiggs, Chester-street, Kennington—An improved apparatus for feeding or supplying steam-boilers with water
219. D. Green, Vauxhall—Improvements in potters' kilns
220. A. McOnie, Glasgow—Improvements in the construction of centrifugal machines or "hydro-extractors" used for the manufacture of sugar and other purposes, and in the arrangement of appliances to give motion to such machines by steam-power
221. H. Bessemer, Queen-street-place, New Cannon-street—Improvements in the manufacture of iron and steel
222. W. Stubbs, Liverpool, and J. Burrows, Wigan—Improvements applicable to water-closets

Dated January 26.

223. F. Constance, Paris—An improved apparatus for casting and finishing types and vignettes used for printing
224. J. Fortescue, Charles-street, Middlesex Hospital—Improvements in the construction of the furnaces of bakers' ovens for the purpose of consuming smoke, which improvements are also applicable to the consumption of smoke in other furnaces
225. J. Haile, Warren, Rhode Island, U.S.—Improvements in machinery for the manufacture of nails
226. A. Hensel, Stafford-place, Pimlico—The manufacture of German yeast from flour
227. W. L. Tizard, Plymstock, Devon—Improvements in fermenting, cleansing, and attemperating apparatus to be employed in brewing
228. R. A. Brooman, Fleet-street—Improvements in the preparation of woollen hats, bonnets, and bodies for hats and bonnets. (Communication from M. De Clermont and Co.
229. R. A. Brooman, Fleet-street—A method of lubricating and preventing the heating of axles, journals and bearings in railway engines and carriages. (Communication from S. Laurent)
230. W. H. Brown, Portsea—Improvements in coffins
231. F. Hamilton, Acton, C. Burrell, Thetford, Norfolk, and J. Boydell, Gloucester-crescent, Camden-town—Improvements in combining ploughs with locomotive engines
232. E. Highton, Gloucester-road, Regent's-park—Improvements in electric telegraphs
233. J. H. Johnson, Lincoln's-inn-fields—Improvements in sewing machines. (Communication from J. E. A. Gibbs, Virginia, U.S.)

Dated January 27.

235. J. S. Crosland, Openshaw, Manchester—Improvements in locomotive and other steam-engines
236 T. Watson, Baxenden, near Accrington, and T. Singleton, Over Darwen—Improvements in looms
237. J. Dangerfield, West Bromwich, Stafford—Improvements in the manufacture of chains
238. W. A. Turner, Clarges-street, Piccadilly—Improvements in the manufacture of starch
239. G. L. Doelling, Rue Drouot, Paris—Improvements in machinery or apparatus for forming screw threads.
240. G. T. Bousfield, Sussex-place, Loughborough-road—Improvements in coating iron or other metals with tin. (Communication)
241. D. Y. Stewart, Glasgow—Improvements in moulding or manufacturing cast-iron pipes

Dated January 31.

290. H. Whittles, Vicar's Moss, and R. Schofield, Nuttall-street, Rochdale—Improvements in the construction of the slide valves of steam engines, and in the mode of working the same, for the better regulation of the vacuum in the cylinders thereof, economising fuel, and for ensuring safety and steadiness of such machines whilst in action
291. W. E. Newton, Chancery-lane—Improvements in the manufacture of buttons. (Communication from J. F. Bapterosses, Paris)

Dated February 4.

322. F. Moreau, Paris—Recovering the fatty matters from coom or dirty axle-grease and lubricating oils, thereby rendering them fit to be used again

Dated February 11.

397. J. T. Pitman, Gracechurch-street—Improvements in the mode of making metallic hames for horses. (Communication from a citizen of the United States)
398. J. T. Pitman, Gracechurch-street—Improved system of working metallic ores and their products, both metallic and mineral. (Communication from a citizen of the United States
399. A. C. Daudraut, Rue Neuve des Petits Champs, Paris—Preserving organised animal and vegetable matters, especially alimentary substances
400. W. Todd and J. Todd, Heywood, Lancaster—Improvements in power looms for weaving
401. W. G. Armstrong, Newcastle-upon-Tyne—Improvements in ordnance
402. R. D. Kay, Accrington, Lancaster—Improved method of using or applying a certain colouring matter, either singly or in combination with other colouring matters, to woven or felted fabrics, yarns, or threads, either in the white or dyed state. (Communication)
403. J. Poole, Riley-street, Chelsea—Improvements in safety or other valves, and in mechanical appliances thereto
404. J. Macintosh, Euston-square—Improvements in the manufacture and discharge of projectiles
405. J. S. Hendy, Essex-street, Strand—Improvements in chimney tops or cowls
406. G. Chappellpotts, New Oxford-street—Improvements in cleansing casks

Dated February 12.

407. J. Horton, jun., Brierley Hill, Stafford—New or improved machinery for regulating the generation and pressure of steam in steam boilers, and for preventing the explosion of steam boilers
408. J. Langford and J. Wilder, Birmingham—New or improved signal and alarum
409. W. B. Adams, Adam-street, Adelphi—Improvements in buildings and other structures
410. P. H. Desvignes, Lewisham, Kent—Improvements in machinery for preparing flax, hemp, and other fibrous materials
411. D. Baker, Glasbro' Alum Works, Yorkshire—Improvements in the manufacture of compounds of alumina and of magnesia
413. W. Wilkins, Camberwell—Improvements in flushing apparatus
414. I. Blackburn, Islington, and R. Blackburn, Edinburgh—Improvements in engines or implements to be employed in agriculture, applicable also to the transporting of heavy bodies, to the traction of carriages, and to the conveyance of passengers
415. E. Maynard, Brooklyn, New York—Improvement in calks for the shoes of animals

Dated February 25.

547. W. Wood, Monkhill House, near Pontefract—Improvements in machinery or apparatus used in the manufacture of carpets and other pile fabrics
548. W. Wood, Monkhill House, near Pontefract—Improvements in machinery or apparatus used in the manufacture of carpets and other pile fabrics
549. J. Fenton, Low Moor, near Bradford—An improved method of connecting the feed pipes of locomotive engines and tenders
550. J. Mead and G. Mead, Bethnal-green—Improvements in metallic packing boxes or cases
551. L. Piand, South-street, Finsbury—Improvements in ventilating and preventing inundations in coal mines
552. W. E. Newton, Chancery-lane—Improved machinery for making preparings from waste silk, cotton, wool, flax, hemp, and other fibrous materials. (Communication from M. A. L. Warnery, Lyons)
553. L. E. O. Degrand, Paris—Improved lenticular glasses for lighting and reflecting or refracting
554. C. Schwedersky, Railway-place, Fenchurch-street—Improvements in floating ships or vessels
555. J. H. Johnson, Lincoln's-inn-fields—Improvement in apparatus or instruments for measuring distances and elevations. (Communication from E. A. Crandall, Friendship, Alleghany county, New York)
556. J. H. Johnson, Lincoln's-inn-fields—Improvements in carding machines. Communication from E. Lhuillier, Louviers, France)
557. M. H. Picciotto, Crosby-square—Improvements in preparing flax, hemp, and other fibrous substances
416. W. E. Newton, Chancery-lane—Improved machinery for turning articles of irregular forms in the direction of their length. (Communication)
417. W. E. Newton, Chancery-lane—Improved machinery for cutting metals or other hard substances. (Communication)
418. E. Bowcock, Manchester—Improvements in the manufacture of cords to be used in skirts and petticoats
419. G. Gimson, Staleybridge—Improvements in steam engines
420. T. Wingate, Glasgow—Improvements in screw propellers and in adjusting the same

Dated February 13.

421. C. W. Williams, Livespool—Improvements in increasing the draught and promoting the combustion of the fuel in furnaces
422. C. Crossley, D. Leeming, and J. Crossley, Halifax—Improvementl in apparatus for heating and in taps to be employed in combination therewith, which taps are also applicable for general purposes
423. W. H. Harrison, Ty Mawr, Pontypridd, Glamorgan—Improvements in the machinery or apparatus as at present employed for raising water from mines
424. W. Richardson, Ranelagh-grove, Pimlico—Improvements in the use of iron or any other metal, by itself or in combination with other materials for structural purposes
425. F. H. Sykes, Cork-street, Piccadilly—Improved apparatus for supplying or feeding boilers with water, applicable to raising and forcing liquids for other purposes
426. D. A. Lamb, Berwick-upon-Tweed—Improvements in water-closets, and in apparatus connected therewith
427. W. S. Clark, High Holborn—Improvements in machines for grating substances. (Communication)
428. W. S. Mappin, Birmingham—New or improved method of constructing doors and windows for the prevention of burglary, which method of construction is also applicable to other articles where strength is required
429. N. C. Smith, Churton-street, Pimlico—Improvements in the disc engine
430. M. W. Hallett, St. George's-road, Eccleston-square—Improvements in apparatus for securing window and other openings in buildings
431. J. Lawson and S. Cotton, Leeds—Improvements in machinery for roving, spinning or twisting flax, cotton, wool, and other fibrous substances
432. G. Hardstaff, Skegby Colliery, near Mansfield—Improvements in apparatus for actuating and applying the breaks of carriages used on railways and for coupling such carriages
433. R. Houchin, jun., Bridport Place, New North-road, Hoxton—Improvements in alarums
434. T. Robottom, Atherstone—Improvements in locomotive engines chiefly adapted for the purposes of common road or street traction, and the working of agricultural implements
435. J. Cocker, Liverpool—Improvements in, and apparatus for, the manufacture of wire, part of which improvements is applicable to the annealing of other metallic articles
436. J. Williams, Port Madoc, Carnarvon—Improvements in apparatus for lowering and stopping anchor chains on board ships and for other similar purposes

Dated February 14

437. A. B. Walker, Liverpool—An improved apparatus for heating fluids
438. H. H. Fulton, and T. B. Etty, Queen-street, Westminster—Improvements in the generation and application of steam power for propelling, hauling, driving, or conveying, particularly applicable to farming purposes
439. A. Forrest, Birmingham—Improvements in the construction and ornamentation of belt or band fastenings, and other dress fastenings
440. J. Cruikshank, Princes end, near Tipton, Stafford—An improvement or improvements in rolling iron and steel wire
441. J. Firth, Flush Mills, Heckmondwike, and J. Crabtree, Mill Bridge, York—Improvements in power looms for weaving fancy goods
442. A. Smith, Princes-street—Improvements in machinery for the manufacture of wire rope and other ropes
443. J. Taylor, Upper-street, Islington—Improvements in the preparation or manufacture of manures
444. C. R. Moate, Old Broad-street—Improvements in the permanent way of railways
445. W. Cooke, Cornhill—Improvements in apparatus for ventilating

Dated February 16.

446. J. M. Letestu, Paris—Improvements in signals
447. W. R. Jackson, Baltimore, U.S.—An improved railway break
448. W. E. Newton, Chancery-lane—Improved machinery for manufacturing nuts and washers. (Communication)
449. J. Crawley, sen., Wood-street, Cheapside—Improvements in collars and wristbands
450. T. Newcomb, Crowley-place, Commercial-road, Peckham—Improvements in machinery for manufacturing nails
451. W. E. Wiley, Great Hampton-street, Birmingham—Improvements in the manufacture of metal pens and pen holders
452. J. Quick, jun., and A. Fraser, Summer-street, Southwark—Improvements in apparatus for regulating the drawing off and the supply of water and other fluids
453. A. Parkes, Bath-road, Birmingham—Improvements in the manufacture of nails
454. J. H. Johnson, Lincoln's-inn-fields—Improvements in machinery or apparatus for the manufacture of pasteboard. (Communication)
455. W. Clark, Chancery-lane—Improvements in the manufacture of railway chairs. (Communication)

Dated February 17.

456. T. Ball, Hyde-street, Bloomsbury—An improved portable oven for baking bread and other articles of food, in the camp, the field, or the house
457. H. Green, Liverpool—An improved stove to be heated by gas
458. C. Cowper, Southampton-buildings, Chancery-lane—Improvements in making drains, and in machinery for that purpose. (Communication)
459. J. Goodman, Pall-mall—Improvements in apparatus for holding together letters, music and other loose sheets. (Communication)
460. W. Burslem and J. Bruslem, Cheadle, Chester—An improved "picker," to be used in power looms for weaving
461. J. Bennett, Birmingham—A new or improved joint for fishing rods, the rods or handles of parasols, and for other rods
462. T. Withnall, Manchester—Improvements in the manufacture of copper, brass, or other metallic rollers or cylinders
463. E. Alcan, Fore-street—Improvements in machinery for twisting, doubling, and spinning cotton, silk, and other fibrous materials. (Communication)
464. H. Barber, Belgrave, Leicester—Improvements in knitting machinery
465. J. B. Pascal, Lyons, France—Improved engine with rotary piston applicable to various purposes
466. A. Kaltwasser, Grove-street, Camden-town—Improvements in the action of horizontal piano-fortes
467. F. B. Houghton, Upper Gloucester-place, Dorset-square—Improvements in the preparation of materials used in the manufacture of paper
468. R. B. Cooley, Nottingham—Improvement in the manufacture of knitted fabrics
469. W. Young, Queen-street—Improvements in fire-places or stoves
470. J. Naylor, Winterton, near Brigg, Lincolnshire—Improvements in horse hoes

Dated February 18.

471. C. de Bergue, Dowgate-hill—Improvements in marine steam-engines
472. J. Green, Philadelphia, U.S.—Improvements in furnaces for burning combustible gases under pressure in the manufacture of glass, iron, and other metals
73. H. Christie, Salford—Improvements in finishing and polishing threads and yarns
474. R. Best, Birmingham—Improvement or improvements in illuminations
475. J. Rylands, Warrington, Lancaster—Improvements in annealing wire
476. J. Blanc, Rue St. Louis, Batignolles, near Paris—Improvements in making bread and buiscuits. (Communication from P. Hanns and L. Girard)
478. J. Moule, Seabright-place, Hackney—Improved apparatus to be used for burning pyrotechnic compositions or preparations for producing artificial lights of various colours
479. D. Cheetham, Rochdale—Improvements in machinery or apparatus for preparing, spinning, and reeling cotton and other fibrous materials
480. S. Dyer, Bristol—Improvements in ships' windlasses, capstans, bumpkins, gins, and cranes
481. L. L. Foucher, Petite Rue Taranne, Paris—Improvements in apparatus for the manufacture of type and other articles used in letter-press printing

Dated February 19.

483. G. F. L. Meakin, Albion-street, Hyde-park—Improved method of applying breaks to railway carriages
484. D. L. Price, Beaufort, Brecknock—Improvements in electric apparatus for giving signals, and appliances connected therewith
485. W. Halsall and W. Hayhurst, Bury, Lancaster—Improved self-acting "temple," to be employed in power looms for weaving

Dated February 21.

504. E. Adler, New York, United States—Improvements in spring bed bottoms, saip bottoms being applicable to other descriptions of furniture
505. A. T. Blakely, Tonbridge Wells—Improvements in ordnance
506. J. Elce, aud S. Hartley, Manchester—Improvements in machinery for moulding
507. J. Feilding, Ashton-under-Lyne—An improved apparatus applicable to steam-pipes or cylinders used for heating and drying, which said apparatus may be similarly employed wherever steam is used for such purposes
508. J. Whitehead, Preston—Improvements in boilers
509. F. H. Thompson, Glasgow—Improvements in the manufacture of iron
510. J. H. Johnson, Lincoln's-inn-fields—Improvements in spinning machines. (Communication from J. Smith, Northbridge, Massachusetts, United States)
511. J. Barber, Manchester—Improvements in compound printing maundrills
512. J. Middleton, Hyde, Chester, and W. Stent, Fairfield, near Manchester—Improvements in railway chairs, and in the jointing of rails for railways
513. J. Turner, Syresham, Northampton—Improvements in the process of manufactuing bread, and in the component parts of the same
514. V. Touche, Rathbone-place, Oxford-street—Improvements in the manufacture of paper from bass or bast
515. J. Williams, Wigginton, Oxford—Improvements in common road vehicles
516. M. Grouse, Oxford-street—An improved apparatus for giving stability to life boats and other boats
517. G. Phillips, Hammersmith—Improvements in stationary cabinets, and in envelopes to be used therewith
518. W. Gossage, Widnes, Lancaster—Improvements in the manufacture of soda and potash
519. A. Quidde and C. Mayet, Biala, Galicia, Austria—Improvements in propelling

Dated February 23.

520. E. R. Wood, Stonthall, Swansea—Improvements in labels
521. W. Footman, Bodney-street, Pentonville—Further utilizing the illuminating properties of gas, by improvements in burners and shades or reflectors
522. C. A. Bourdier and V. Masselon, Trafalgar-square, Charing-cross—Improvements in obtaining and applying motive power
523. J. J. Bannister, Southwark—An improved watch and property protector pocket
524. J. Brown, Aldgate—A method or methods of preparing paper to enable it to receive an impression from an engraved block or plate, type, or other printing agent, while in a dry state
525. F. C. La Croix, New York, United States—An improvement in reducing and reefing the topsails of vessels
526. G. Devincenzi, Maddox-street—Improvements in producing figures and designs upon plates for printing from
527. J. E. Shearman, Pimlico—Improvements in saddles and collars for horses and other animals
528. J. Kirkham, Tonbridge-place, New-road—Improvements in the construction of furnaces, ovens, or kilns, for drying, baking, or burning pottery or earthenware, bricks, tiles, or other similar articles, and in the means of collecting and condensing or carrying off the smoke, gases, or vapours evolved from such or other fuanaces or fireplaces, or that escape or arise from the retorts and other parts of the apparatus used in the manufacture of gas
529. W. E. Newton, Chancery-lane—An improved furnace for locomotive and other boilers. (Communication)
530. C. H. Murray, Oakley Cottages, Old Kent-road—An improved construction of chain pump
531. J. H. M. Maissiat, Paris—Improvements in dibbling machinery for depositing grain and manure
532. A. Koch, Belfast—Improvements in machinery for breaking and scutching flax, hemp, and other fibrous substances
533. L. Laurot, Rue Foutaine St. George's, Paris—Separating the different solid fatty (acides gras, acids from the liquid fatty ones
534. G. Barnett, Aldersgate-street—Improvements in fasteners for parts of garments
535. J. Milnes, and W. Thompson, Sutton Mill, Kildwick, York—Improvements in looms for weaving

558. J. Spence, Park-terrace, Brixton-road—An improvement in the manufacture of artificial coral
559. A. Godet, Bordeaux—Improvements in reefing sails

Dated February 26.

560. J. H. Glew, Charlotte-street, St. Pancras—An improved method of fastening ladies' and gentlemen's boots and shoes
561. T. G. Shaw, Great St. Helens, Bishopsgate—An improved thrashing and winnowing machine, which he calls flail thrashing machine for corn and other grain
562. W. E. Wiley, Birmingham—Improvements in ever-pointed pencil cases
563. D. O. Edwards, Cambridge-villa, Gilston-road, West Brompton—Ventilating and removing the products of combustion of fuel and of respiration from the apartments of dwelling-houses, and from public buildings
564. J. Hoy, sen., Islington—Improvements in apparatus for distributing sand on railway rails
565. A. P. How, Mark-lane—Improvements in machinery or tools for drilling and boring
566. C. Bruton, sen., C. Bruton, jun., F. J. Bruton, and S. R. Bruton, Manchester—An improved azure blue for domestic purposes
567. J. S. Edwards, Blackfriars-road—The preparation and novel application of a certain foreign fruit or vegetable as an article of food, confectionary, or to be used in brewing or distilling, or for the manufacture of sugar and gum
568. W. Mills, Lower Craven-place, Kentish-town—An improvement in the action of upright piano-fortés
569. B. Hodgson and J. Carter, Halifax—Improvements in looms for weaving Brussels carpets and other terry fabrics
570. V. Cassaignes, Queen-street, Golden-square—Improvements in the manufacture of metallic pens and pen-holders
571. W. Macfarlane, Glasgow—Improvements in moulding or manufacturing cast-iron pipes
572. N. J. Amies, Manchester—Improvements in machinery or apparatus for polishing and finishing yarns or threads

Dated February 27.

573. G. Ermen and F. Spencer, Manchester—Improvements in the manufacture of bands, straps, or belts for driving machinery, and for other purposes
574. D. Davies, Wigmore-street, Cavendish-square—An improvement in steps for carriages
575. W. Robertson and J. G. Orchar, Dundee, and J. Menzies, Ordie Mill, Perth—Improvements in machinery or apparatus for winding yarns or threads
576. W. Wilkinson, Nottingham—Improvements in lighting, and in lamps
577. E. Mucklow, Bury, Lancaster—Improvements in apparatus to be employed for the purposes of cooling and evaporating
580. J. R. Field, Fore-street, Cripplegate, J. Goodman and L. Goodman, Great Prescott-street, Goodman's-fields—Improvements in trowsers
581. S. Draper, Lenton, Nottingham—Improvements in apparatus for retarding and stopping carriages on railways, and in cocks or taps used for such and other purposes
582. A. V. Newton, Chancery-lane—An improvement in springs for railroad carriages and other uses. (Communication)
583. W. E. Newton, Chancery-lane—Improved valve gear for reciprocating steam engines whose power is applied directly by the piston without employing a rotary shaft. (Communication)

Dated February 28.

584. F. Stubbin, Bawtry, York—Improvements in propelling vessels.
585. E. Heale and M. A. Heale, Albion-terrace, Hatfield New Town, Hertfordshire—The treatment of vegetable and other substances
586. A. H. A. Durant, Conservative Club, St. James's-street—Improvements in apparatus for ascertaining and indicating the number of, and distance travelled by, passengers in public carriages, and the fares paid
587. J. Briggs, Newsted Mill, Pudsey, near Leeds—Improvements in looms for weaving
588. C. W. Harrison, Woolwich—Improvements in obtaining light by electricity
589. T. Horton, Birmingham—An improvement or improvements in the manufacture of mottled or variegated soaps
590. G. Wilson, Glasgow—Improvements in weaving
591. J. E. M'Connell, Wolverton—Improvements in railway breaks
592. H. W. Tyler, Norfolk-crescent, Hyde-park—Improvements in the permanent way of railways
593. P. A. le Comte de Fontainemoreau, South-street, Finsbury—Improvements in window shutters. (Communication)
595. R. A. Brooman, Fleet-street—An improvement in the manufacture of sulphate of soda. (Communication from L. Meadach, Paris)
596. H. D. P. Cunningham, Bury, Hants—An improvement in sails, and in the reefing and furling of sails, and setting and taking in of sails
597. T. H. Jennens, Hunters-lane, Birmingham—A new or improved manufacture of rollers or cylinders for printing fabrics

Dated March 2.

598. J. Murphy, Newport, Monmouth—Improvements in securing screw nuts on their bolts, and bolts in plates
599. S. Wright, Halstead, Essex—Improvements in gas regulators
600. C. J. Parry and W. Briddon, Manchester—A certain improvement in the manufacture of shirt collars
601. T. Parker, Sitwell-street, Derby—Improvements in railway wheels
602. F. D. Jones, Tavistock-street, Covent-garden—An improvement in the construction of the bits of horses. (Communication)
603. W. Pedder, Savage-gardens, Tower-hill—Improved methods of strengthening metallic and other structures
604. E. F. Jones, Redcar, York—Improvements in the manufacture of pig and bar iron.
605. W. H. Smith, Philadelphia, U.S., J. Cadman, Maestig, Glamorganshire, and J. Cadman, Sandersfoot, Pembrokeshire—An improved method of manufacturing solid and hollow bricks, pipes, and other hollow and solid ware, from clay, shale, and other mineral substances
606. T. Rose, jun., Botany Bay Farm, Hilgay Fen, Norfolk—Improvements in apparatus for cutting or disintegrating vegetable substances
607. F. W. Mowbray, Bradford, York—Improvements in weaving
608. C. Pauvert, Chatellerault, France—Improvements in manufacturing iron.
609. C. Pauvert, Chatellerault, France—Improvements in manufacturing cast steel
610. C. Pauvert, Chatellerault, France—Improvements in manufacturing steel and cast steel
611. W. Poupard, Wych-street—An improvement in buttons and means of fastening buttons to garments and fabrics
612. R. A. Brooman, Fleet-street—Method of constructing and heating buildings and apparatus for the winding of silk from the cocoon. (Communication from F. Rignon)
613. D. Patridge, Woolwich—Improvements in steam boilers
614. W. Brown, Gresham-street—An improved mode of preparing tapes for the marks
615. J. Anderson, West Bromwich—An improvement in the process generally termed "gathering," used in the manufacture of certain kinds of glass
616. T. Gray, Rose-lane, Stepney—Improvements in separating vegetable fibres from mixed fabrics

Dated March 3.

619. J. Banks, Northampton—A new description of life-preserver, adapted also to the preservation of property
620. W. Leuchars, Piccadilly—Improvements in locks for travelling bags, portfolios, despatch boxes, and such like depositories.
621. G. Danré, P. F. V. Mouillard, and P. A. Mercier, Paris—An improved method of, and apparatus for, heating by gas
622. E. Lindner, New York, U.S.—Improvements in cartridges and bullets, together with an apparatus for producing the same.
623. T. Ball, Nottingham—An improvement in the manufacture of warp fabrics suitable for the manufacture of gloves
624. W. E. Newton, Chancery-lane—Improved means for preventing the forgery or imitation of bank notes, bills, certificates, cheques, bonds, deeds, and other like articles. (Communication)
625. W. E. Newton, Chancery-lane—Improved machinery for removing snow from railways. (Communication)
626. W. E. Newton, Chancery-lane—A preparation of materials for coating roofs or other portions of buildings to render them impervious to wet. (Communication)
627. W. Taylor, How Wood, Renfrew—Improvements in the manufacture of iron and steel
628. W. Adam and J. S. Templeton, Glasgow—Improvements in weaving looped and pile fabrics
629. R. Mair, Edinburgh—Improvements in apparatus for protecting articles worn on the person

Dated March 4.

631. G. Ralston, Tokenhouse-yard—Improvements in fire-arms, and in balls or projectiles. (Communication)
633. W. Hartley and T. H. Farrar, Bolton, Lancaster—Improvements in looms
635. H. L. De Zeng, Geneva, Ontario, New York—Improvements in marine and fog signals, for reefs and other locations
637. J. W. Heinke, Great Portland-street—An improved construction of diving bell
639. G. W. Dyson, Tinsley, near Sheffield—Tilting iron and steel, or any other malleable substance, by perpendicular motion
641. W. Muir, Glasgow—Improvements in generating steam for marine purposes
643. S. Sutcliffe, and J. Stocks, Manninghain, near Bradford—Improvements in means or apparatus in connection with steam boiler and other furnaces to facilitate the consumption of smoke therein
645. H. Greaves, New Palace Yard, Westminster—Improvements in the mode of coupling or connecting pipes, columns, and conduits in the machinery for manufacturing the hoops to be used in connecting such pipes and columns, and in the shape of such pipes, columns, and conduits, whereby they become adapted for the support and conveyance of vehicles
649. G. Bower, St. Neots, Huntingdon—Improvements in apparatus for manufacturing gas
651. W. Travis, Crompton, Lancaster—Improvements in furnaces
653. J. K. Cheetham, and T. Southworth, Rochdale, Lancaster—Improvements in the use or application of certain substances for sizeing or finishing yarn or thread; also applicable for sizeing or stiffening woven and other fabrics
655. R. A. Coward, Laurence Pountney-lane—Improvements in screw or submerged propellers

Dated March 6.

657. F. A. Calvert, Manchester—Improvements in machinery for ginning cotton, and for cleaning and carding cotton and other fibrous materials
659. L. Barton, Ison-green, near Nottingham, and E. S. Brookes, Nottingham—Improvements in the manufacture of knitted fabrics
661. W. Petrie, Woolwich, Kent—Improved means of, and apparatus for, creating or increasing draughts and currents.

Dated March 7.

663. R. M. Ordish, Saint Mark's Crescent, Regent's Park—Improvements in suspension bridges
665. J. Parkes, Great College-street, Westminster—An improved apparatus for locomotive purposes
667. C. Langley, Deptford Green Dockyard—An improved mode of constructing dry docks and basins for the stowage of ships
669. G. A. Tabourin, Lyons, France—An improved rotative engine

Dated March 9.

675. C. Sharp, Birmingham—A new or improved manufacture of ships thimbles and other metallic fittings used for rigging and sails and rope gearing in general
679. G. Davies, Serle-street, Lincoln's-inn—An improved self-inking stamp for printing cards, labels, and other articles. (Communication from W. H. Elliot, Plattsburg, New York)
681. S. Faulkner, Manchester—Improvements in machinery or apparatus for carding cotton and other fibrous substances
683. H. R. Smith, Wellingborough, Northamptonshire—Improvements in manufacturing and purifying gas made from coal or other bituminous substances for illumination
685. C. C. Dennett, Nottingham—A new construction of floors and ceilings of buildings
687. W. E. Newton, Chancery-lane—Improved machinery for cutting screw threads. (Communication)
689. A. V. Newton, Chancery-lane—An improved construction of rudder. (Communication)
691. A. Knox, Mile End, and T. Robson, Aldersgate-street—An improved gas regulator
693. W. C. T. Schaeffer, Stanningley, near Leeds—Improvements in treating the waste waters of woollen and other mills
695. J. E. Duyck, West Farleigh, Kent—An improvement in treating cotton seed, in order to extract color from the oil obtained therefrom

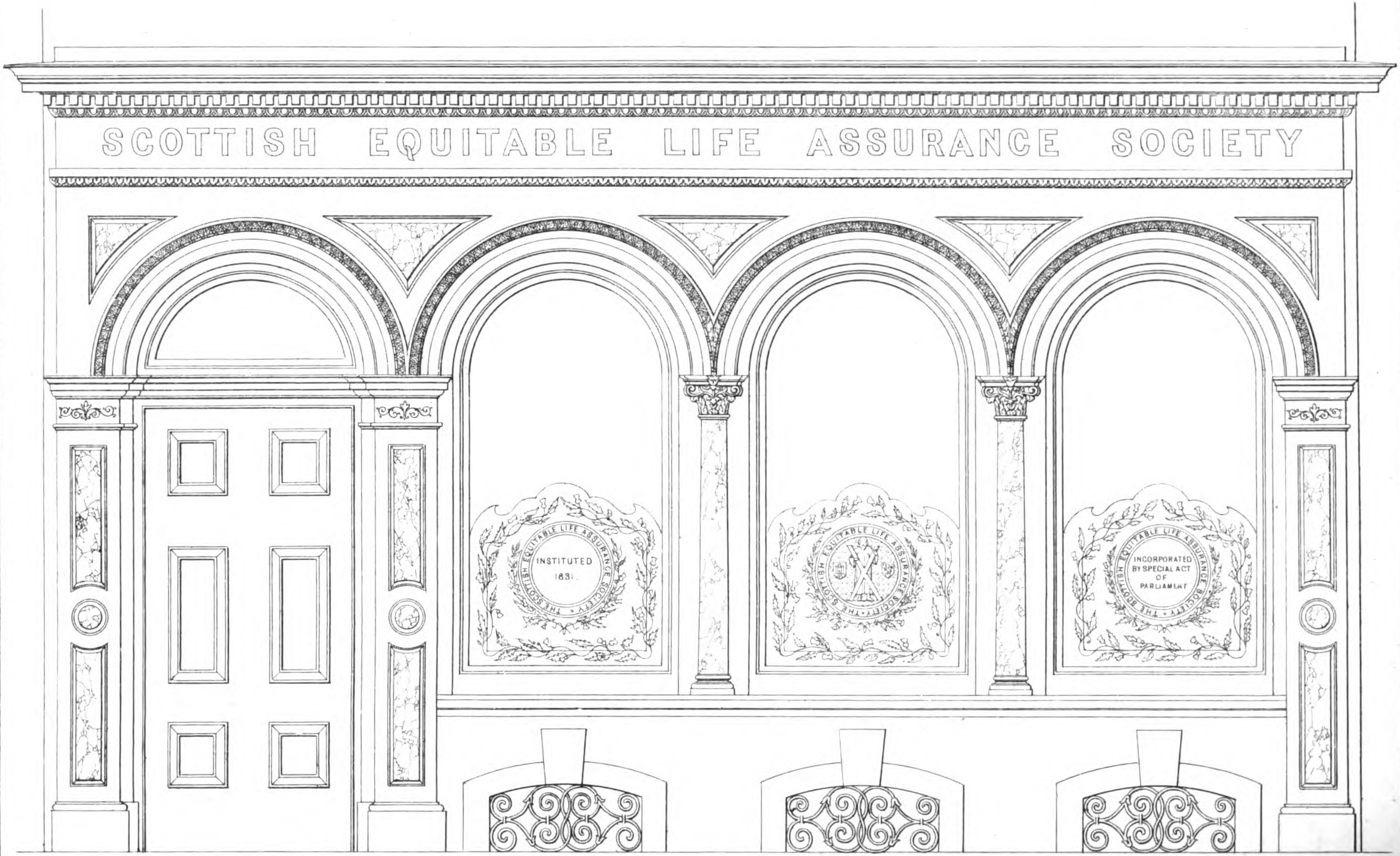
Dated March 10.

697. J. Neuenschwander, Albion Wharf, Kensington Basin—Improvements in the process of preserving milk
699. C. Reynaud, Catherine-street, Strand—Improvements in the application of india-rubber springs to mattresses, sofas, chairs, and other cushions or articles of furniture. (Partly a communication)
701. C. Baylis, Poultry—An improved method of constructing and arranging roads and ways particularly applicable to populous cities and crowded thoroughfares

PATENTS APPLIED FOR WITH COMPLETE SPECIFICATION.

647. T. Burstall, Southall, Middlesex—Improved machinery for manufacturing bricks and tiles from clay alone, or mixed with other materials—March 5, 1857.
674. G. Philcox, Stebon-terrace, Stepney—Improvements in marine and pocket chronometers and other time keepers—March 9, 1857.
696. N. A. Dyar, Massachusetts, U.S.—A new and useful composition to be applied as a covering to the sides and roofs of buildings, and for various other purposes—March 9, 1857.
735. W. Pidding, New Kent Road, Surrey—Improvements in machinery or apparatus for the manufacture of piled fabrics, whether plain or figured—March 16, 1857.

Erratum.—In the last sentence of our notice of Prof. Faraday's lecture on "Conservation of Force," in our present number, for the term "implication," the reader is requested to substitute "complication."



THE SCOTTISH EQUITABLE OFFICES, Nº 26 POULTRY

J. WORNHAM PENFOLD, ARCHT

0 1 2 3 4 5 6 7 8 9 10 20 FEET

J. R. Jobbins

THE SCOTTISH EQUITABLE LIFE ASSURANCE SOCIETY.

(*With an Engraving, Plate* XI.)

This Society, which is one of the oldest and most respectable of the Scotch offices, have within the past year removed their place of business, for the London agency, from 126, Bishopsgate-street, to the more prominent position No. 26, Poultry, where the small but elegant front which forms one of our illustrations of the present month has been erected from the designs of Mr. J. Wornham Penfold, of Charlotte-row, Mansion-house.

T he columns supporting the arches, together with the spandrils and panels of the pilasters, are of polished Peterhead granite, and form an agreeable contrast in colour and material to the remainder of the stonework; and this mode of introducing granite is now we perceive being carried out in various buildings in progress in the City. The plate-glass to each window opening is in one entire square, and is enamelled with the arms of the Society, the date of incorporation, &c. The offices on the ground-floor have been fitted up in wainscot, French polished throughout, and consist of the public office, manager's room and medical room, with lavatories, &c. on the basement, and house-keeper's rooms at the top of the house. The works reflect much credit on the builder, Mr. G. Smith, of Pimlico. The gas fittings were executed by Messrs. Tucker, of the Strand, and the paperhanging by Messrs. Williams and Cooper, 85, West Smithfield, with their accustomed skill and excellence of material.

It is to be regretted that the upper portion of the house had been rebuilt prior to the Scottish Equitable obtaining possession of the premises, as a small additional height on the ground-floor would have added much to the effect; but with the limited space at command we think much credit is due for the attractive front produced.

REVIEWS.

Designs for Parish Churches, in the Three Styles of English Church Architecture. By J. Coleman Hart, Architect. New York: Dana and Co. 1857. pp. 111. Plates.

We are so apt to associate with our own country all the interest that attaches to Gothic architecture, or at least to circumscribe it within European limits, that one is scarcely prepared to learn that its principles are taking steady root in the far Western world. Yet such appears to be the fact, if the volume before us be deemed a criterion; for it manifests throughout an appreciation of the true elements of Pointed architecture and a nicety of discrimination which, it may fairly be presumed, could emanate only from a mind thoroughly imbued with the subject, and be palatable to readers already in some degree advanced in the study. To our English ears, the title of 'Designs for Parish Churches' is a very familiar sound, and we might be disposed to dismiss the matter at once, under the impression that nothing new could be added to what has been over and over again already written; but a very cursory dip into the contents of this book will convince us that the mine is not quite exhausted, and that even *we* may receive, if we will, wholesome hints from our transatlantic neighbours.

"The vital principle of the study of Gothic architecture," says our author, "as divided into the three great periods, namely, the Early English, the Decorated English, and the Perpendicular English, is the embodying either one of them in a complete design, unadulterated, and free from admixture with the preceding or succeeding period. No author that I am aware of, in this country, has as yet issued a publication based on this principle. The want, with all the beautiful material at hand, should be relieved. It is hoped that the student may find some hints of value to him in this volume, which is a simple effort to supply a deficiency in the area of architectural publications."—In pursuance of this motive, the work comprehends a complete analysis of this style of architecture, principally derived from English sources, and includes an examination into the origin of the English Gothic,—its nomenclature, as advocated by different writers (that of Rickman being ultimately preferred),—and the several phases which it successively assumed: interspersed with these is a copious description of the various items of church furniture, æsthetically and practically considered. It must in justice be added, that the whole "getting up" of the book is everyway praiseworthy: in the letter-press the author has painstakingly compressed a goodly amount of matter, and the typography is perfect, while the numerous lithographic illustrations are more than equal to the usual stamp of such publications in England. To say, however, that the subject-matter of these plates is equal to the subject-manner, would be unduly to exalt it, since with all the evident good intentions of the designer, there is something in almost every deviation from recognised old examples the propriety of which is open to question, either on the grounds of consistency with principles advocated, or of harmony with their development. Do not let us be misunderstood in this remark; we do not mean that *every* thing that is "old" is good; but it so happens that the author has in the present instances praiseworthily selected such only as his models as must come under the approving designation, and so truthfully has he borrowed from these sources that in almost every one of his views we can recognise the outline grouping of some well-known building, and, in his annexed details, the service rendered by Brandon's 'Analysis,' Paley's 'Manual,' and other standard publications.—No allusion is made to the primitive features of the art, nor to those of its declining age; but two specimens are given of each of the intermediate eras, in the shape of designs suited to their respective characteristics, and accompanied by plans and the necessary parts at large in elucidation, besides a succinct description. In speaking of the Early-English style, it is remarked: "It was during the prevalence of the Early English style that a great impetus was given to architecture, and probably to the projection and erection of a greater number of ecclesiastical edifices than in any former or subsequent period. Its greater flexibility and easier adaptation to the ecclesiastical wants of those times, the reduction of what was heavy and cumbrous, and the almost total disuse of any architecture that partook of a pagan character, soon firmly established it as purely Christian and, as it were, indigenous to the soil of the Church." After treating of the doorways, ironwork, windows, piers, and arches, as developed in the earlier ages, the subject of "buttresses" is thus briefly but clearly introduced:—

"In the Norman style, in which the walls were very thick, the buttresses were merely flat projections, apparently built out of the wall, more for the purpose of relief, than as a distinct erection necessary for support or resistance. A continued reduction of the thickness of the wall, and an increased projection consequently given to the flat buttress, eventually made it a distinguishing feature in the future styles.

"Early English walls are not so thick as those of the Norman works, and the omission of the tie beams in the construction of their roofs, rendered it necessary that greater resistance should be given by the walls to the pressure from the roof. It was effected by the buttress. At first this buttress was but a slight improvement on that of the Norman, but it gradually received greater projection, with a reduced width; the inclination of the set-offs is very acute, the lowest member sometimes continued laterally around the buttress when allowed by the reduction of the upper stage; the stages are few, most frequently two in number, with the angles of the buttress sometimes chamfered, plain sloped, or ornamented at their terminations.

"The pinnacled, gabled, and arch buttress were not in general use in this style, and were mostly confined to large buildings. The gablet, which evidently suggested the gabled buttress, was commonly placed on the sloping weathering of a buttress, coping to gables, &c. One particular worthy of notice is that the walls of a majority of the Early English churches, and their buttresses, are devoid of all base moldings, or any approximation to a base."

Design I. represents a small church to accomodate 200 worshippers; its plan is correctly proportioned and well arranged; nor are the elevations in the main amiss, except the porch, which in some others of the designs also is very meagre and faulty. The nave is proposed to be extended westward beyond the aisles, so as to provide a space for the organ. This, however, is a situation which in modern practice is not much countenanced. A simple stone gabled bell-turret rises on the west wall. The second design, also Early English, is an advance in importance on the former one, and provides for more accomodation. A tower and spire are here proposed to occupy the west end of the north aisle, and to range nearly with the external walls of that side, and of the west end: thus far the plan is simple enough; but in the elevations this simplicity is disguised by an affectation of gables, two of which rise higher than the others, and though springing, flush, from the same wall, appear intended to look like pseudo-transepts. Moreover the windows inserted in them are lancet-triplets, contrary to an almost universal canon, which the author himself has noted, of confining them especially, under such circumstances, to the east end. "The triplet window," says he, "the most remarkable combination and peculiarity of this style, is chiefly confined to the east end of the chanel, and it is in this position that its symbolism is most suitable." The method suggested for the framing of the roofs has a rude and unfinished look, but is not without ingenuity. Though there are ranges of pillars down the nave, these carry no arches, but the beams of the roof and the valley pieces of the gables pitch directly on to them. It is open to question how far this unusual juxtaposition would produce an agreeable result.

In the two designs illustrative of the "Decorated" style, the one, as before, is simpler than the other, the chiefly distinctive feature being, as in the former cases, a bell-turret or a properly developed steeple. In the former we have a small slender octagon, rising as a square from the ground, and capped with an attenuated spire, something like an ancient example at Sedgeborrow, near Evesham. The second of these designs has evidently been founded on the model of our elegant Shottesbrook: which in outline it palpably resembles, yet in the parts which fill up the composition a great mixture is discernible, shewing that the author is better acquainted with characterestic massing than with legitimate detail. He has duly provided a large traceried west window (a feature which prevailed in this style) copied exactly from an old one at Boughton, in Kent. His east window is of five lights, from an equally familar example in another part of the country, and the other windows also are from ancient examples, not always precisely consistent in date. The plan of this church is that of a cross, with a tower and stone broach spire at the intersection. The chancel and transepts are long in proportion to the nave; but, externally, this is partially masked by the side chapels to the former, and the aisle on each side of the latter. In regard to the accommodation, so large a central area as is thus secured may be deemed an advantage, but much of this is necessarily interfered with by the piers which have to carry the tower. The explanatory plates to this design, as in the others, have the objection previously noticed, of being faultily and coarsely rendered where any deviation has been made from good authorities. A stone altar appears to be indicated, with sundry ritual and symbolic arrangements, but no niches, or soaring turrets, or pinnacles, which constitute so distinguishing a beauty in "Decorated" structures, such as St. Mary's, at Oxford, where—

> "Spire, tower, and pinnacle, a dim array
> Whose wizard shadows in the moonlight sway,
> The stony muteness of whose massy piles
> Now silver'd o'er by melancholy smiles,
> With more than language, spirit-like appeals
> To the high sense impassion'd nature feels
> Of all that gloriously in earth or sky
> Exacts the worship of her gazing eye?"

The remaining style discussed is the "Perpendicular," also illustrated by two examples; one, on plan forms a perfect Greek cross, with a low square tower rising from the intersection,—a design in which the beautiful little church of Poynings, Sussex, has evidently served for a model, though the superadded battlements are anything but an improvement on the original;—the other is of the ordinary stamp, with an orthodox nave of five bays, chancel, aisles, porches, vestry, and square tower and spire, attached to the west end; altogether quite of the Lincolnshire or Northamptonshire type. In this, as before, we must complain of the faultiness of the details, and also object to the introduction of three-light square-headed, domestic-looking windows into the clerestory. In his description of the "Perpendicular" style the author thus speaks, and with a degre of candour not always observable in modern writers:—

"If the Decorated style be the acknowledged perfection of Gothic architecture, the summit of architectural excellence attained in the middle ages—and such an opinion has long since been received—we cannot expect to find in a transitional style, as the Perpendicular must then be deemed, the purities, beauties and excellencies which pertain to but one perfect Gothic style. The Early English is, in the same manner, but a transition. It is assisted in the perfecting of another style. It is the incipient state of Gothic art; yet it is not on this account to be depreciated, since it contained in itself the germ which was subsequently expanded and developed into the Decorated style. So with the Perpendicular. Deriving its character from the purest source, its prolonged transition gradually led to a debasement, perhaps not so deplorable as that chaos of art from which the Early English Gothic first issued.

"The Perpendicular style may have more modern advocates than the Early English and the Decorated; yet to disparage these styles, for the purpose of exalting the former, can only argue the advocates' ignorance in art. Not more judiciously can the beautiful intricacies of the Perpendicular style be sacrificed to the grand simplicity of the Early English or the graceful combinations of the Decorated. Some of its works, executed even during the period of its most debased state, still remain to

"'Shame the weak efforts of art's latest stage.'"

Nothing is said respecting the cost of carrying out any of these designs, nor of the materials contemplated. The walling, however, appears to be uniformly of stone in small courses roughly dressed and irregularly quoined,—the only mode of preserving the true feeling of the style. As it was well laid down some years ago by the Camden Society, "No one can have failed to observe how seldom the ancient Gothic architects used either large stones or fine joints in their masonry. To find this peculiarity at a time when no cost was spared, and when the extreme delicacy of workmanship in minor details was unsurpassed by that of any other age, is to convince us that it was not destitute of a sound practical reason. Modern builders boast of their superior skill and greater neatness of workmanship in these two respects.......Now-a-days buildings are constructed of very large squared stones, with joints of almost impreceptible fineness: the ancient, of hammer-dressed ashlar, with mortar a quarter of an-inch thick between every layer. This old system of constructive masonry seems to have been designed to take into account those trifling settlements which are almost unavoidable, and which for the most part take place shortly after the erection of a building, often before the mortar has become hard."

Our author manfully opposes the unworthy system of *shams*. Incidentally alluding to this subject when describing the proper character to be given to "pulpits," he writes:

"Although it is desirable that the pulpit should be of stone, the least perishable of all building material, yet it might be deemed an inconsistency to advise its use in the designs contained in this volume, to the exclusion of wood. The principle of having every thing the best of its kind that we can afford, will not be attained until we build more in accordance with our circumstances, and dare publish the practice to the world by our works.

"If twenty thousand dollars, the amount of ready money which a parish may possess or subscribe, will erect an unostentatious church, in the Early English style, with chancel-screen, doors and seats of veritable oak, and font and pulpit of carved stone, and the windows with their symbolical painted glass from the best artist's hands, it is truly more honest, more churchmanlike and more consistent with the dignity of architecture, than to build the same church in the elaborate Decorated style, with altar, pulpit, chancel-screen and doors of pine, grained in imitation of what they should be, and costing in the end the same amount of money. Nay, the evils of this ambitious hypocrisy do not always end here; it is too common to find the church at its completion, greatly involved in debt, a constant drain upon our parish resources, and a fit subject for Sunday alms-begging sermons; while it stands as a monument of untruths, a preacher of falsehood in wood and stone. Therefore I say, if, taking all these things into consideration, a stone pulpit cannot be afforded, one of veritable pine, or cedar or oak, can be and ought to be chosen."

It is unnecessary to quote from the rules laid down as to Ornamental decorations, or from the very timely observations regarding the canons of Gothic composition, which are freely extracted from Mr. Paley. Much that is useful is also hinted respecting chancels, choirs, galleries, pews, sedilia, &c., and lecterns; there is also a short, but good practical chapter on warming and ventilating.

Facts and Fallacies of the Sewerage System of London and all large Towns. By JASPER W. ROGERS, C.E. London: Atchley and Co. 1857.

If the statements made in this publication be "facts," there can be little doubt of the "fallacies" of the sewerage system; but the question is, are they facts? Is it possible, after all we have heard and read of the "flushing" of sewers in order to remove the filth of the multitude of London, that flushing has no such effect?—after all the expense incurred to increase the supply of water for such purposes, that it is of no avail? Is it possible, that the old Board of Health has been creating disease, in place of remedying it, by the street trapping of the sewers? which it appears clearly enough drives the foulness from the filth back into the houses; although it keeps it from the street, sends it into the very places where it could most effectually do its evil work.

Is it possible, that the "egg-shaped" sewers, respecting which there has been so much *cackling* for so long a time, hold filth within them equally as the old flat-bottomed sewers, which have been voted as old monstrosities? And is it possible, notwithstanding all the money expended by the various Metropolitan Commissions in constructing sewers, which were to make London healthful by carrying off through them all the filth, that in place of doing so, they have been making monster cesspools throughout the length and a good part of the breadth of every street in the metropolis to contain noxiousness of every conceivable kind, and hold it there until it has exhaled all its poisons to be breathed by the inhabitants? Are these statements "facts," or are they "fallacies?" If they are fallacies, the authorities should expose them; if they are facts, we do not hesitate to say the authorities should be exposed. We must confess they appear to be "facts," for we find in the report of the Registrar-General of the 16th August last (given in this publication), the following:—

"The diseases stated are natural to man, but their ravages are greatly aggravated by the physical impurities of the atmosphere. The dirt of the streets may be got rid of, the smoke of the manufactures may be rendered less dense, but the third class of impurity is invisible: it arises from the long retention of the excrement of London under the houses and in the sewers. Under the present arrangement some hundreds of thousands of tons of this matter lie in store in London, putrifying in cesspools and percolating the streets, while the residue is thrown into the Thames at great cost."

Here is an authority which can scarcely be questioned. We should like to hear what the Metropolitan Commissioners will say in reply.

Assuming the author's statements to be capable of verification, the question then arises—should the present system be continued? If not, what is the best remedy, or what should be substituted? Would it be a remedy for the hundreds of thousands of tons of human excrement lying in store in London under the houses and in the sewers, to *tack* to the end of these sewers another sewer of 100 miles in length, to be filled in like manner, and which evidently could not remove one particle of the stuff which gradually collects and remains lying under the streets? It appears to us to be no remedy at all, and that such a course would be indefensible in every way—a prodigious outlay without any good in return.

Then comes the question—Is the remedy proposed by the author, feasible? Can a metal main be laid through the existing sewers to receive the whole water-closet filth of London; and can such mains be made to discharge their contents, without choking, into tanks or receptacles as proposed,—to intercept the matter, converting it into a manure,—and permitting the water to pass away in a pure state into the river?

This is simply what the publication suggests; and which we must say we cannot now see any reason for rejecting. The *modus operandi* appear to be simple and philosophical; and we do not hesitate to recommend the work to the careful perusal of all who are interested in sanitary improvement—and who is not? We believe it to be a question of paramount interest to every inhabitant of all large towns.

THE LEADING POINTS OF GEOLOGY.

Professor Phillips recently concluded a course of lectures at the Royal Institution, on "The Leading Points of Geology," in which he brought before his audience the main facts of geological science, and explained the most popular theories which have been propounded for the explanation of the successive phenomena that have occurred during the creation of the globe. The succession of strata, the progressive variations of animal life, and the changes in the physical condition of the globe, were considered in three great divisions of the subject. We do not propose to follow closely the course pursued by Professor Phillips, but we shall take this occasion to present a general view of geological phenomena, availing ourselves of Mr. Phillips's guidance so far as serves that purpose.

The stratified rocks of which the crust of the globe is composed are assumed to have been deposited from aqueous suspension, sometimes at the bottom of the sea, and in other cases in the estuaries of great rivers which in the course of geological changes have ceased to flow, the very lands which they drained having been again and again submerged in the ocean. The fact that these immense sedimentary deposits—several miles in thickness—must have been originally in horizontal positions may be taken for granted, from the very nature of their formation. The subsequent elevations of the strata at all angles of inclination, and their evident contortions and compressions, show that long after their deposition from water they were acted on by some internal forces which raised up the mountain ranges, as from central lines of force, and inclined the superincumbent rocks towards the centre of elevation for distances extending over many hundreds of miles. A general upheaving of the strata by the action of such a force is exemplified in the geology of England and Wales, the elevation of the mountain ranges of Cornwall, Wales, and Cumberland having produced a general inclination of all the strata towards the west, which influence extends to the easternmost parts of our island. The convulsions of Nature during which these violent disturbances of the crust of the globe occurred, are supposed to have been accompanied, if they were not caused, by the action of intense heat, which reduced the lower rocks at least into a state of fusion. That the rocks were subjected to igneous action is manifest from their crystalline structure, and from numerous instances of the evident changes they have undergone by heat, independently of the evidence afforded by extinct volcanoes, the lava of which has been covered by subsequent deposits.

The deposition of the coal formation marks an important epoch in geological history. Those strata occupy a position in relation to the whole known geological series at a depth from the surface of about one-third that of granite. After they were deposited, the crust of the globe seems to have been agitated by a vast number of internal forces. These convulsions displaced the strata, sometimes merely locally, and at other times they produced disturbances over a great extent of country, throwing the whole mass down in one direction, and raising it up in another, thereby occasioning variations in level of several hundreds of feet. These convulsive actions must have left great inequalities on the surface, but however much the rocks may have been thus rent and torn, and piled upon one another, no indication of such disturbance remains on what was then the surface of the ground. Some levelling operation must have followed those convulsions before the subsequent strata were deposited, which swept away the protruding rocks and filled up the hollows, and left a comparatively smooth undulating area whereon the secondary strata, consisting of upwards of two thousand yards of sandstone, lias, oolites, chalks, and clays, were deposited.

The causes by which vast masses of rocks and entire mountains have been swept away are among the mysteries of geological science, nor did Mr. Phillips in the course of his lectures enter into an explanation of the phenomena. Not unfrequently, for instance, on the opposite sides of a range of mountains the same succession of rocks will be found the edges of which have been brought to the surface and exposed, and the underlying rocks protruded. The intermediate spaces between the same rock on the opposite sides of the mountain range are far greater than would have been occasioned by disruption and separation during the elevation of the primary rocks beneath, and there must have been immense masses of rocks carried away by some unknown agency, of the action of which there are no remaining traces. The excavation of valleys is a phenomenon of a similar kind, and though apparently explicable by the erosive action of running water operating during countless ages, such a course was shown by Mr. Phillips to be quite inadequate to explain the excavations of deep valleys; and even for that phenomenon no satisfactory solution has yet been afforded. The circumstances attending the deposits that have been made by the rivers that flow into the lakes of Geneva and of Keswick were adduced by Mr. Phillips as proofs that the action of rivers running through valleys is not sufficient to account for their excavation. Where the Rhone enters the lake of Geneva there are large deposits brought down from the mountains, but they reach over only a small portion of the area of the lake, and before arriving at the point where the river again issues forth into the lower valley of the Rhone all indication of deposit disappears. It may thus be inferred that the *débris* brought down by the upper Rhone have been deposited in the lake, and the quantity is altogether inadequate to account for the excavation of the valley.

The fossil organic remains found in the different rocks and strata afford evidence of another kind of distinct depositions at successive periods of geological time. In granite, and the other igneous rocks lying immediately upon it, there are no traces of organic remains. On ascending higher in the series there are found fossils imbedded throughout the structure of the rocks, showing that the animals lived in the muddy waters during the whole time that the formation was gradually deposited.

The first traces of life consist of the remains of animals of a low degree of organisation, and whose hardened cases and shells were able to sustain the action of heat and pressure to which they were exposed; whilst the remains of more delicate organisations, such as the sponges, were, it is supposed, effaced by the violent actions of fire and mechanical force to which the lower rocks were subjected. A most interesting fact disclosed by these fossil remains is, that at successive periods of creation successive classes of animals lived in the waters, and that they became extinct and were succeeded by others of different, and generally of higher, organisations. These changes are observable again and again as the strata succeed each other towards the surface. In the lower sedimentary rocks all the organic remains are those of marine animals and plants exclusively; nor are there any distinct indications of dry land on the globe until we arrive at the coal formation. At that period, however, vegetation must have been very luxuriant. The beds of coal are entirely composed of vegetable matter accumulated under circumstances most favourable for the growth of plants. The remains of such plants as are commonly found in coal are sufficiently preserved to show that they belong to tropical climes, and that trees of prodigious size occupied the forests that are now converted into coal. As the carbon which constitutes the substance of all plants is supposed to be entirely derived from the atmosphere, the mass of carbon contained in a seam of coal only one yard in thickness would have required ages for its accumulation; and assuming that the constituents of the atmosphere of that ancient period were the same as at present, it is calculated that it would have occupied two hundred and fifty thousand years to form the coal deposits of England and Wales.

The remains of land animals do not occur till we reach the tertiary strata. The vast quantities of them found in the gypsum beds near Paris, which correspond in geological time with the deposition of the London clay, first drew the attention of Cuvier to the subject of fossil bones, and tended materially to stimulate geological investigations. One of the most interesting facts which those investigations have brought to light is, that the nearer the successive strata approach to the surface, the more closely do the fossil bones resemble those of existing species; but that even in the uppermost of the series of geological deposits—after scraping away the vegetable mould—organic remains are found of animals that have become extinct; and in no instance have any fossil human bones been discovered. The inquiry into the different species of shells imbedded in the tertiary formations has proved so attractive as to have diverted the attention of geologists, in a great measure, from the consideration of the structure of the rocks of which the crust of the globe is composed, and geological study has consequently been too exclusively directed to fossil conchology. The great mineralogical collection at the British Museum affords a warning example of this tendency; for whilst there are being continually added to the collection numerous specimens of minute varieties of shells, there is not—or, at least, there was not a short time ago—a single specimen of granite, on which the whole superstructure of geological and mineralogical science is based.

Though geologists are for the most part agreed respecting the deposition and order of succession of different strata, there are several leading points in geology on which they are still at variance. The cause of the great changes of temperature of the globe which have occurred at different geological periods is one of the questions on which they are not agreed. Mr. Phillips, after noticing different explanations of the admitted phenomena, attributed the higher temperature to the internal heat of the globe, the surface of which has since been cooled; but he did not assign any cause for the great diminution of temperature in what is called "the glacial period." Whether the elevation of mountains and the dislocation of strata are to be attributed to extraordinary convulsions, or whether they were produced by causes still in operation, is another point in dispute; Mr. Phillips being inclined to take the progressive view of such changes. Another, and still more important, question in geology is—Whence was the matter that composes the different rocks derived? If we assume granite to have been the original rock from the disintegration of which all others were formed, it should contain the constituents of all. But that is not the case. The silex, the alumina, and the potass, which form nearly all the chemical constituents of granite, will not account for the immense limestone deposits; and even if we assume them to have been the result of animal secretions, the question whence the lime was obtained remains unanswered. These, and some other difficult problems in geology, were but slightly noticed by Mr. Phillips; nor did he allude to the disputed causes to which the phenomena of volcanoes are attributed. Much as geological investigations have accomplished, there remains still a vast field to be explored and ample scope for speculation.

A striking instance of the disagreement of geologists on some of the leading points of the science was presented at the Royal Institution, last Friday evening, the 24th ult., when from the same spot where Professor Phillips had recently declared that the tropical climate of ancient geological periods was attributable to the internal heat of the globe, Professor Ramsay announced that the climate would not have been affected by internal heat even the half of a degree. The evidence he adduced in confirmation of that opinion, certainly possessed considerable force. On the borders of Wales, for instance, masses of the lower rocks are upturned almost perpendicularly, so as to bring within observation strata upwards of two thousand yards in thickness. Now, if the temperature of the globe increases at the rate at which it has been asserted, there would have been a very perceptible difference in the action of heat between the deposition at one end of the series and at the other, but no such difference is observed; therefore Professor Ramsay infers that the rocks could not have been within the range of igneous action. Another point which Mr. Ramsay endeavoured to establish was, that there have been at least two "glacial periods:" viz., the one generally admitted by geologists to have occurred during the deposition of the upper tertiary strata, and a previous one, immediately after the deposition of the coal measures. He adduced in proof of that opinion the grooved, striated, and scratched angular pieces of rock found in the beds of magnesian limestone, which are exactly similar to the marks found on rocks acknowledged to have been borne by floating icebergs from the mountains, and deposited on the bottom of the sea. The evidence in one case, he asserted, is exactly the same as in the other, and if glacial action be admitted to have caused the deposition of those fragmentary rocks in recent geological time, it must equally be admitted as the cause of the deposition of angular striated fragments immediately after the formation of the coal measures. Mr. Ramsay further showed that during the deposition of any stratum, whilst the land was either gradually elevated or depressed, the character of that stratum must have varied in its constituents and in its organic remains, and thus the same continuous deposit may differ essentially in different positions. This view of the formation of strata he said had not, to his knowledge, been previously taken by any geologist, and he announced it for the first time on that occasion.

THE NEW READING ROOM AND LIBRARIES OF THE BRITISH MUSEUM.

The new Reading-room of our National Museum and Library is now nearly completed. It does not occupy the entire quadrangle within the main building, there being unavoidably a clear interval of from 27 to 50 feet all round, to give light and air to the surrounding buildings, and as a guard against possible destruction by fire from the outer parts of the Museum. The dome is 140 feet in diameter, its height being 106 feet. In this dimension of diameter it is only inferior to the Pantheon of Rome by 2 feet; St. Peter's being only 139; St. Maria in Florence, 139; the tomb of Mahomet, Bejapore, 135; St. Paul's, 112; St. Sophia, Constantinople, 107; and the Church at Darmstadt, 105. In other particulars the new dome is far superior. The new Reading-room contains 1,250,000 cubic feet of space; its surrounding libraries 750,000. The building is constructed principally of iron, with brick arches between main ribs, supported by 20 iron piers, having a sectional area of 10 superficial feet to each, including the brick casing, or 200 feet in all. This saving of space by the use of iron is remarkable; the piers of support on which our dome rests only thus occupying 200 feet, whereas the piers of the Pantheon of Rome fill 7477 feet of area, and those of the Tomb of Mahomet 5593. Upwards of 2000 tons of iron have been used in the construction. The weight of the materials used in the dome is about 4200 tons—viz., upwards of 200 tons on each pier. The first standard was only fixed in January 1855. The framework and scaffolding upon which the dome rested were removed on the 2nd of the following June. No subsidence or "set" of material was observable on the wedges being removed. The entire dome was roofed in and copper covering laid in September 1855. The roof is formed into two separate spherical and concentric air-chambers, extending over the whole surface; one between the external covering and brick vaulting, the object being the equalisation of temperature during extremes of heat and cold out of doors; the other chamber between the brick vaulting and the internal visible surface, being to carry off the vitiated air from the Reading-room. This ventilation is effected through apertures in the soffits of the windows, and partly by others at the top of the dome; the bad air passing through outlets provided around the lantern. In order to obviate the effects of condensation, all the skylights, lanterns, and windows throughout the building are double. The quantity of glass used amounts to about 60,000 superficial feet. In order to guard against the consequences of an avalanche of snow falling from the dome on to the surrounding libraries, the building has been carried up outside perpendicular to such a height above the spring of the arch as to form a gallery 9 feet in width, provided with proper outlets by which the snow is intercepted.

This vast dome contains ample and comfortable accommodation for 300 readers. Each person will have a separate table, 4 ft. 3 in. long. He is screened from the opposite occupant by a longitudinal division, which is fitted with a hinged desk graduated on sloping racks, and a folding shelf for spare books. In the space between the two, which is recessed, an inkstand is fixed, having suitable penholders. Thus the whole table-top is free from writing implements or other embarrassments, and every precaution is taken to preserve the books if the readers will but use common care.

The framework of each table is of iron, forming air-distributing channels, which are contrived so that the air may be delivered at the top of the longitudinal screen division, above the level of the heads of the readers, or, if desired, only at each end pedestal of the tables, all the outlets being under the control of valves. A tubular footrail also passes from end to end of each table, which may have a current of warm water passed through it at pleasure.

The Catalogue tables, with shelves under, and air-distributing tubes between, are ranged in two concentric circles around the central superintendent's enclosure or rostrum, the latter being fitted with tables, ticket-boxes, and with dwarf partitions surmounted by glass greens, dividing a passage leading to the surrounding libraries. The pedestals of the tables form tubes communicating with the air-chamber below, which is 6 feet high, and occupies the whole area of the Reading-room. It is fitted with hot-water pipes, arranged in radiating lines. The supply of fresh air is obtained from a shaft 60 feet high, built on the north side of the north wing about 300 feet distant, communicating with a tunnel or sub-way, which has branches or "loop-lines" fitted with valves for diverting the current either wholly through the heating apparatus, or through the cold-air flues, or partly through either, as occasion may require. The air-channels are of sufficient capacity to admit a supply of fresh air for 500 persons at the rate of 10 cubic feet per minute, and at a velocity not exceeding 1·0 foot per second.

In the new libraries two lifts are placed at convenient stations for the purpose of raising the books to the level of the several gallery floors. The bookcases are of novel and simple construction, the uprights or standards being formed of malleable iron galvanised and framed together, having hard wood inserted between the iron to receive the brass pins upon which the shelves rest. The framework of the bookcases forms the support for the iron perforated floors of the gallery avenues, and which are generally eight feet wide, the central six feet being appropriated to the perforated floor, and the remainder being a clear space between the back of the books and the flooring, and by which contrivance the light from the skylights (in all cases extending to the full width of the avenues) is thrown down the back of the books on each story, so that the lettering of the backs may be easily discerned throughout the book ranges.

The shelves are formed of iron galvanised plates, edged with wainscot and covered with russet hide leather, and having a book-fall attached. They are fitted at each end with galvanised iron, leather covered, and wadded pads placed next the skeleton bookcase framing, to prevent injury to the binding when the books are taken out or replaced. Between these pads the skeleton framing of the cases forms an aperture, by which a current of air may pass and ventilation be kept up throughout. The shelves rest upon brass-pins, the holes for which are pierced at three-quarters of an inch apart from centre to centre but by a contrivance in cranking the shaft of the pin, which may be turned upwards or downwards, this interval is practically halved, and the position of the shelves may be altered three-eighths of an inch at a time. There are 2,750,000 of these holes!

For convenience of access to the galleries the staircases have been placed so that, throughout the building, they are within 40 feet of each other. The building contains three miles lineal of bookcases, and which in all the cases are eight feet high; assuming them all to be spaced for the averaged octavo book size, the entire ranges form 25 miles of shelves.

The cost, about 150,000*l.* includes the fittings and furniture and the necessary shelves for the working of the existing library establishment.

The decoration of the interior dome is happily an exception to the monotonous and dingy shadows usually adopted in this country. Light colours and the purest gilding have been preferred. The great room, therefore, notwithstanding its circular shape, has an illuminated and elegant aspect. The inner surface of the dome is divided into 20 compartments by moulded ribs, which are gilded with leaf prepared from pure gold, the soffits being in ornamental patterns, and the edges touching the adjoining margins fringed with a leaf-pattern scolloped edge. Each compartment contains a circular-headed window, 27 feet high and 12 feet wide, with three panels above, the central one being medallion-shaped, the whole bordered with gilt mouldings and lines, and the field of the panels finished in encaustic azure blue, the surrounding margins being of a warm cream colour. The details of the widows are treated in like manner,—the spandril panels blue; the enriched column and pilaster caps, the central flowers, the border moulding and lines being gilded; the margins cream colour throughout upon the tops of the main ribs' rests. The mould rim of the lantern light, which is gilded and overcoated to correspond, is 40 feet diameter. The sash is formed of gilt moulded ribs of a ray-like pattern, emanating from a central medallion, in which the royal monogram is alternated with the imperial crown.

The under cornice, from which the dome springs, is suitably massive and almost wholly gilded, the fringe being formed into panels bounded by lines terminating at the ends with a gilt fret ornament. Each compartment of the cornice is marked by a bold enriched gilt console, which forms at once the support of the main rib and a base for statuary. The feet of these ribs is designed for colossal marble statues, the advent of which art we ardently invoke.

ARCHITECTURAL IMPROVEMENTS OF LONDON.

No. X.—Our Streets.

Taking leave of New Cannon-street, City, we may remark that on its southern side, extending east from what are termed Unity-buildings to King William-street, several very fair examples of elevations have been erected of a similar class, but not quite so ornamental in character, as some of those previously noticed. We shall be excused if we bestow a word or two of well merited praise upon the colossal statue of William IV. and its circular pedestal, which stands at the junction of New Cannon-street and King William-street, and immediately facing London-bridge. This, as may be readily conceived, is a most admirable situation for such a work of art, inasmuch as it may be viewed all around in every direction. Both statue and pedestal were cut from the solid in grey Aberdeen granite, by the ill-fated and ill-requited young sculptor Nixon, and exhibit an enduring monument of his great ability, energy, and untiring industry; the work displays in a decisive manner the great superiority of stone over bronze for sculptured works placed in the open air in London: for, whilst the former maintains to a great extent its colour, and light and shade, the latter exhibits black, dismal, melancholy objects, that instead of beautifying our metropolis, disfigure it, and afford subjects for deprecatory comment from foreigners who visit us.

Continuing our subject, as regards the architectural embellishment of our streets, we may observe, without anything like invidious comparison, that our City merchants, speculators, and shopkeepers, are far in advance of our West-end men in this respect; and we rejoice to be enabled to say that within the last few years many highly praiseworthy examples have been built in various parts of the City, that might in their day have done honour to even Rome or Venice in their palmiest days. The spirit of improvement, instead of abating, is decidedly on the increase, as the very numerous works now in progress sufficiently prove. Amongst those of earlier date is the building which forms the south-eastern corner of Bartholomew-lane and Threadneedle-street, designed for the Sun Fire Office Company by Professor Cockerell. This structure illustrates in an eminent degree what may be accomplished with the elements of Greek architecture, when placed in the hands of an accomplished master and freely treated. Of course we are not about to contend that the building is perfect—far from it, as we could readily point out in it some blemishes and excesses in detail; but what we wish to urge is, that the elevations of this edifice evince unmistakeably what might have been produced had the true feeling of Greek art in all its refinement been judiciously followed out, instead of having failed in its successful adaptation in England, as it has unquestionably done, and given place to a style of more meretricious splendour, but one which does not call forth the higher attributes of genius, as illustrated in the working of Phidias, Ictinus, and their contemporaries in the Periclean age of ancient Greece. This failure is attributable, not from the Greek style being inapplicable to our climate and wants, but from the fact that we had no man or men at the right period who had the genius to make a judicious amalgamation of Greek and Italian elements, so as to produce a satisfactory and vigorous whole, instead of the tame and formal insipidities of the elder Wyatt, Stuart and Rivett, Soane, and Sir Robert Smirke. Professor Cockerell led the way to a better state of things; but unfortunately he stood alone, and had no followers who possessed the main qualifications for the task — those of originality of thinking, and the spirit and ability to abandon all direct copyism. Do not let us, however, despair when we know that we have able, very able, men amongst us at the present time who are doing great things in the Italian and French Renaissance styles, notwithstanding the false dogmatisms of the late Augustus Welby Pugin, and the sophistries of Ruskin, that happily are now becoming rapidly exploded; for every one must admit, however reluctantly, that Italian architecture after all is somewhat better than "rotten rags," and that in course of time some of our streets will present pictures of architectural beauty worthy of the great city in which we live.

In the same line, in Bartholomew-lane, we may also notice three other buildings—not for their good design, but the reverse. The first of these is the Alliance Insurance Company's Office, the façade of which is formed of a plain ground story, surmounted with a large pediment, supported by four attached fluted columns, having capitals adapted from those of the Temple of Tivoli. Next to this edifice, and as if squeezed between it and the large Auction Mart, is a humble-looking structure faced with yellow bricks, which cuts an odd figure amongst its larger brethren in Portland stone. The Auction Mart has externally a *Roman Doric* ground-floor with a superstructure presenting the inconsistency of fluted columns, with *Greek Ionic* capitals, supporting a pediment. On the Threadneedle-street side of the Sun Fire Office, a plain three-storied compoed building abuts against it, the parapet of which reaches only to the soffits of its upper windows; and next this is the North and South American Coffee House, which is one of the ugliest edifices in London. On the parapet, backed by a chimney, and supported by iron stays, is the representation of a huge gilded cock, some eight feet in height, forming, as a whole, the most absurd spectacle that can well be imagined. These two buildings should assuredly be removed, and rebuilt in a style and size corresponding, in some degree, with the Fire Offices, which added to other desirable improvements in this locality, previously noticed, would form another group having some claim to the character of architecture, instead of remaining as they do, a disgrace to this part of the city.

On the northern side of Cornhill, the English, Scotch, and Australian Chartered Banking Company have recently erected large new business premises, the street façade of which is in the Italian style, designed by Mr. Henry Baker. The materials are Portland stone, red granite, and Minton's and encaustic tiles very judiciously blended. The granite, which is highly polished, is applied to the ground-story, and forms the piers and arched head of the window and entrance doorway, and also the columns which form the vertical divisions of a large window in the first floor of the elevation. The plain facings of the front, together with the dressings of the windows and principal cornice at the eaves, are all of Portland stone; in which material also, are the various carvings with which the edifice is embellished, including the crests and mottoes of Sidney and Melbourne, with pendant wreaths suspended from them, representing the fruits and flowers of Australia, executed by Mr. Bolton, with his usual ability. Minton's coloured tiles are inserted in the reveals of the window dressings, and also in the frieze of the upper cornice, by which a partial introduction of colour is diffused from the bottom to the termination of the building at the eaves, producing a very satisfactory result. It may be remarked that the principal cornice of this edifice looks somewhat heavy and excessive in its projection; but it has been designed for extension, as the adjoining property, belonging to the same owner, is destined ere long to be rebuilt in a corresponding style, which is very desirable.

Passing from Cornhill to Leadenhall-street, on the northern side of the latter is a well-designed modern structure, worked out with very good effect. It comprises four stories in height above the curb level of the street, and illustrates, with a considerable amount of embellishment, a judicious mode of obtaining a large quantity of light in a somewhat narrow public thoroughfare. The whole of the windows of the façade are of wide proportion, divided in three lights, vertically, and recessed between piers of small projection, which are tastefully rusticated with vermiculated and channelled work. The entrance to the building is in the centre of the front, by a semicircular headed doorway, flanked with Doric columns, in pairs, having enriched capitals, surmounted by an appropriate entablature, the frieze of which is composed of triglyphs and guttæ, and is continued, very judiciously, on each side of the doorway, to the bounding quoins of the edifice, so that the projected entrance has not the appearance of being stuck against the main wall, as is too often the case. Over this entrance doorway is a segmental curved pediment, the tympanum of which has a shield in its centre, and on each side foliage very vigorously executed. The windows of the ground floor are segmental-headed, having carved faces as key-stones, and spandrils filled with very effectively modelled ornaments. However good the effect of this building is, unluckily its appearance is in a great measure spoiled by the mean-looking houses that abut against it on each side, which are entirely beneath all criticism. In this street, other improvements, on a small scale, have been recently effected at Nos. 125 and 145; but we fear all hope of general good architectural effect must be abandoned until a settled plan is adopted by Parliament, which will enforce some degree of uniformity in building, and also correct the highly imperfect and eccentric lines of most of our streets, so as to reduce them to something like geometric form, instead of the uneven zig-zag appearance they now present. In most of our city streets, we find some of the houses in a straight line, adjoining to which, others branch from them at an obtuse angle; then in many instances the next batch is recessed, and its neighbouring building projected, the whole presenting an irregular, higgledy-piggledy mass, totally outraging all rules of harmonious design.

Another building, designed with the idea of obtaining as much light as possible in a narrow thoroughfare, is now in progress on the northern side of Fenchurch-street, although not designed in such good proportion, nor finished with so much taste as the one to which we have adverted. This structure, however, demands attention as containing some novelties of construction, particularly in the application of iron. The edifice is to be let for offices and chambers, and has a street frontage of 57 feet, and a depth of 128 feet. Its height from the footpath level to the principal cornice at the eaves is 44 feet, above which, in the centre of the elevation, is an additional story of 10 feet in height by 34 feet in width, carried up on the same plane as the main front, with a dormer at each end inserted in the sloping line of the roof, which is covered with slates, arranged lozenge-wise. The whole of the windows in the elevation are divided vertically by iron stanchions; those of the ground and first floors are square-headed, above which the remainder are semicircular, with moulded spandrils and key-stones in their arches. The blank surfaces of the building are faced with Portland stone, and the whole of the windows are intended to be glazed with plate-glass. Internally this structure has the peculiarity of being built in three distinct blocks, each of which is ventilated by a square shaft or area, extending from the level of the basement through the roof. The plain surfaces of these shafts, as well as the reveals of their windows, are lined with Minton's white tiles, and, consequently, will aid very materially in the distribution of light to the various apartments with which they are connected.

REPORT ON THE STATE OF THE RIVER THAMES FROM PUTNEY TO ROTHERHITHE.*

By Edward Burstall, Commander, R.N.

Having been supplied with the plan made by Mr. Giles, under the direction of Mr. Telford, in 1823, I confined my observations to those parts of the river on which he then made transverse sections, in order to ascertain the changes that have taken place since that period; in addition to which I have made a careful examination of the bed of the river above and below the cut-waters of each bridge, showing also a transverse section at each of those positions.

I beg now to call your attention to the various changes that have taken place, and in order to have correct comparisons, the same datum has, in every instance, been referred to, viz., that of Trinity High Water, as established by Act of Parliament in 1800, and registered on a large stone at the lower side of the Hermitage entrance to London Docks, and transferred from thence (by levelling) to the cast-iron plates which are let into the various wharves and bridges.

The first change I would mention is the great alteration in the low-water surface of the river above London Bridge, which is, doubtless, in consequence of the removal of the old structure in 1832, which with its large starlings, performed in a great measure the part of a dam to the river, obstructing the free action of the stream. The present low-water surface at springs, compared with that of 1823, will be seen by referring to the following table:—

	1823. Low-Water Surface below Trinity Datum. ft.	in.	1856. ft.	in.
London Bridge	15	4[1]	18	11[1]
	20	3[2]	19	4[2]
Southwark Bridge	15	0	19	0
Blackfriars Bridge	14	9	18	3
Waterloo Bridge	14	4	17	11
Hungerford Market Wharf	14	4	17	9
Westminster Bridge	14	5	17	4[1]
			17	8[2]
Nine Elms Pier	13	4	15	6
Cadogan Pier	13	4	15	11
Wandsworth	14	2	15	8
Putney Bridge	12	8	14	1

[1] Above Bridge. [2] Below Bridge.

With respect to the surface level of high water, I find from numerous observations made from Blackwall to Putney, when the weather had been for a long time so dry as not to have the river swollen by freshes, that the tidal wave attained at all intermediate stations nearly the same level.

By comparing the time and height of high water at London Docks and Battersea with that of 1823, it appears that in 1856 the time of high water at Battersea Bridge is 28 minutes later than at London Docks, and the surface attains nearly the same level; whilst in 1823 the time was 38 minutes later, and the surface 5 inches lower.

The bed of the river is the next subject to which I would beg to call attention. It will be seen on the sheet of transverse sections from Putney to London Bridge, that the river bed has considerably deepened since 1823; the average deepening at each section, and the mean of all between certain points, will be seen by the following table:—

	Deepening of the River.
Between Putney and Wandsworth	5½ feet.
Wandsworth and Battersea Bridge	3 "
Battersea Bridge and Cadogan Pier	4 "
Cadogan Pier and Grosvenor Canal	5 "
Grosvenor Canal and Vauxhall Bridge	4 "
Vauxhall Bridge and Penitentiary	2 "
Penitentiary and Westminster Bridge	3½ "

Arches from Middlesex side of Westminster Bridge:

	3rd,	4th,	5th,	6th,	7th,	8th,	9th,	10th,	11th,	12th,	13th.
Feet...	5	10	8	8	7	7	7	5	7	7	4

Between Westminster and Hungerford Bridges	5 feet.
Hungerford and Waterloo Bridges	9½ "
Waterloo and Blackfriars Bridges	5 "
Blackfriars and Southwark Bridges	7 "
Southwark and London Bridges	4 "

The above (being but an average deepening of the whole breadth of the river) is not sufficiently correct for ascertaining the extent of scour that has taken place in the navigable channel; for instance, near the Grosvenor Canal there are places where the deepening has been 13 feet; at Westminster Bridge, 10 feet; Hungerford, 11 ft. 5 in.; and above Southwark Bridge, 14 feet. I beg therefore to refer you to the longitudinal section which is made through the deep-water channel, and over a line closely assimilating that made by Mr. Giles in 1823; the line of deepest water following nearly the same course now as it did at that period; from which it will be seen that the greatest changes that have taken place are from Cadogan Pier to Chelsea Hospital, from one-eighth mile above Westminster Bridge to midway between Hungerford and Waterloo Bridges, and from Somerset House to Southwark Bridge.

In the vicinity of London Bridge there were in 1823 and 1830, by Captain Bullock's survey, deep holes or gulleys extending to 45 feet below Trinity datum, which is 13 feet below the bed of the Pool, and of that between Southwark and London Bridges; it was therefore deemed necessary to fill those holes up with rubble stones and chalk to such a level as would assimilate the bed of the river above and below London Bridge. From two cross sections made on the site of the old bridge, it appears that the whole of its piers and foundations have been removed to a level of 29½ feet below Trinity datum, in a line with the centre arch, which corresponds with the depths at the present bridge, and as far as Allhallows Wharf above it, and 2 feet higher than the general depths in the Pool 600 feet below it; from these facts, and from the solid nature of the material of which the old foundations are composed, it appears evident that the natural scour of the river has been arrested at and near this point, consequently the safety of the present structure been preserved. Notwithstanding this, the ebb stream is so strong in the Pool as to cause a small scour, as will appear by the sections, and which may probably be deemed sufficient for purposes required for the navigation.

The greatest change that has taken place in the river bed amongst the bridges is at Westminster and Blackfriars; a strong disposition to the same is evidenced at Southwark by the great depth of the sections immediately above that bridge.

The bed of the river in 1823 at Westminster Bridge, and one-eighth mile below it, was 18 ft. 6 in. below Trinity datum. Had London Bridge been removed, the river would have been nearly dry there at low water, with a fall of 11 feet in the intermediate space of two miles; and considering the great depth of water there was between Lambeth Palace and the Penitentiary, viz., 29 feet below datum, it is not unreasonable to suppose that the scour would be very great as soon as vent was given to the river stream by the removal of Old London Bridge and the shoal below it, as also by the combined action of river steamers and dredging.

The extent to which the natural deepening of the river bed will ultimately attain at Westminster Bridge may be assumed by comparing the sections above Lambeth Palace (where no deepening has taken place) with the sections above Hungerford Bridge, which is nearly the average level of the Pool, or 31 feet below Trinity datum; a line drawn between these points intersects a depth of 5 feet below the present bed, or 29 ft. 6 in. below datum, which is (I believe) about one foot below the surface of the London clay.

It is probable that the scour of this point will not be in the same ratio as it has been for the last 33 years, because at the time of the removal of Old London Bridge this was the highest part of the river bed in a space of seven miles; consequently, as soon as vent was given for the free action of the stream, the first effort of it would be to clear a channel for the immense weight of water by removing the obstructions; this was doubtless principally effected shortly after the removal of London Bridge, and has been going on in a smaller degree up to the present time; but not having any reliable observations made meanwhile at this spot to enable me to make comparisons, this is the only conclusion I can arrive at; if, however, the river should ever be embanked or quayed, so as to contract the channel, the stream would be stronger than it is at present, and, consequently, the bed of the river likely to be still more deepened by increased scour.

* Report to the First Commissioner of Works, dated January 27, 1857.

SUPPLY OF PURE WATER TO THE METROPOLIS.

Sir—If there be one point of more vital importance to the inhabitants of London than the speedy removal of the sewage now deluging the Thames, and its proper utilisation, it is the necessity of providing an abundant supply of wholesome, soft, clear water, at a moderate rate, not only for domestic purposes, cleansing streets, sewers, &c., but for protection from fire.

In the able report furnished by the Superintending Inspectors of the General Board of Health, referring to the suspended works of the Artesian Well borings at Kentish-town, by the Hampstead Water Company, it is remarked, "that it would be of importance to the cause of science, if any means could be found for the continuation of the work." Such means can undoubtedly be found, if engineering skill be combined in the right way with capital; the materials are abundant, only awaiting the application and a determination to succeed. I have for many years watched the progress of Artesian Well sinking and boring in this country, and also in France, where success has been the result of perseverance, and I feel certain that this is all that is wanted in England. It is a fact that an immense water-bearing area extends around London within a radius of about 70 miles, resting on the lower greensand, which if reached by sinking or boring to a depth ranging from 1700 to 2000 feet from the surface, would afford a copious supply of pure soft water, which by simple gravitation would throw itself at least 150 feet above the surface, affording every facility for the establishment of high-pressure hydrants or stand-pipes in our streets and roads, so as to throw a continued stream in case of fire, over the loftiest buildings, before it was possible for fire-engines to arrive and get to work. At Kentish-town Well a depth of 1302 feet only has been achieved, and the work is now discontinued. I venture to assert that a fourth, or say a third, increased depth of boring would have been successful; but if one-half extra depth were tried, it would not be thrown away, as proved by our French neighbours. A Well is now boring by simple mechanical apparatus, with every promise of success, by Monsieur Kind, the celebrated French engineer, (under the patronage of the Emperor), at the Bois de Boulogne, where 1456 feet have been sunk in 18 months, being an average of 80 feet per month; and at a much less cost than the Kentish-town Well. Another Well completed, at Grenelle, extends to a depth of 1770 feet (540 metres), and took seven years to execute; but determination and perseverance were fully rewarded. Another well is in progress, under Monsieur Kind's direction, for the Iron Works Company, Creuzot, Soane et Loire, and has, after 31 months' work, reached (in August last) the depth of 2808 feet, being at the rate of 90 feet per month; and it is determined to sink still further, to a depth of 1000 metres, or 3278 feet, before abandoning the object. Such perseverance is highly creditable to the French, and well worthy of imitation.

I have previously called public attention to my dovetailed blocks—see *Journal*, vol. xix. (1856) p. 404—and I have no hesitation in stating that Monsieur Kind's apparatus and my blocks combined, in a telescopic tube diminishing gradually downward, would enable a depth of from five to six thousand feet to be accomplished, by sinking and boring, with perfect safety, speed, and economy.

A reference to the description of my ring of blocks, before mentioned, will show the simple but efficient contrivance for Well walling, mine and coal-pit shafting, light-houses, tunnels, and sewers; and which blocks, combined with iron ring base curbs, toothed or serrated (see accompanying woodcut), would render the process safe and easy for sinking or driving to any depth or length. Refuge towers or light-houses, and sea boundary walls, could thus be firmly planted on the Goodwin Sands, extending along the edge or boundary and enclosing the whole area (upwards of 4000 acres), which treacherous quicksand now engulphs every ship which is thrown on it. It is also suitable for the Madras surfs, affording in the latter case, by the addition of bridging tubes or girders, a safe landing-pier at Madras, now considered impossible to be achieved or obtained, simply because the right method has not been suggested before.

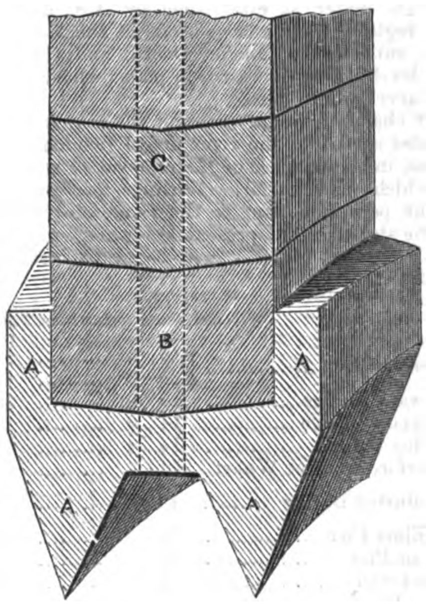
To return to the subject of water supply by means of Artesian Wells, instead of drawing water from the Thames with all its impurities, arising from sewage discharges into it, at Oxford, Reading, Maidenhead, Windsor, &c., and which will not be decreased or remedied for some years to come, unless more energetic action is adopted than at present prevails, and talking gives place to working. I would strongly recommend the formation of a series of district Artesian deep Wells, say from 40 to 60 in number, whereby an immense supply of pure, soft, wholesome water could be obtained, equal to, if not more than sufficient, for a liberal supply to every inhabitant of the metropolis, the source from the lower greensand being inexhaustible.

Hoping these observations may meet the approbation and concurrence of a few practical men possessing energy, determination, and influence, combined with capital, seeking profitable investment, and that such men and means will ere long be brought together, and by a trial test the truth of my assertions, is the great wish of

Your obedient Servant,

W. Austin, C.E.

10, *Upper Portland-place, Wandsworth-road.*



Description of Engraving.

A—Cast-iron ring margin or footings, troughed and double-fanged, constructed in one or more compartments or divisions, and forming the base curb or immovable footing; for light-houses, bridge-piers, mine-shafts, deep wells, &c.

B, C—The stone blocks, rising alternately in firmly secured beds, dipped for increased strength, and bored (shown by dotted lines); these orifices to be filled in with concrete, and iron cables, bars, or rods of wood or iron, as vertical ties, so as to secure immense strength and resistance to expansion, contraction, or shifting, even in quicksands, such as the Goodwin Sands, &c.

The blocks to be of an imperishable concrete, cast in iron moulds, to any required shape or size, with or without orifices. For protection from the action of sea water, the blocks to be indurated.

DEVON AND CORNWALL BANK, ST. AUSTELL.

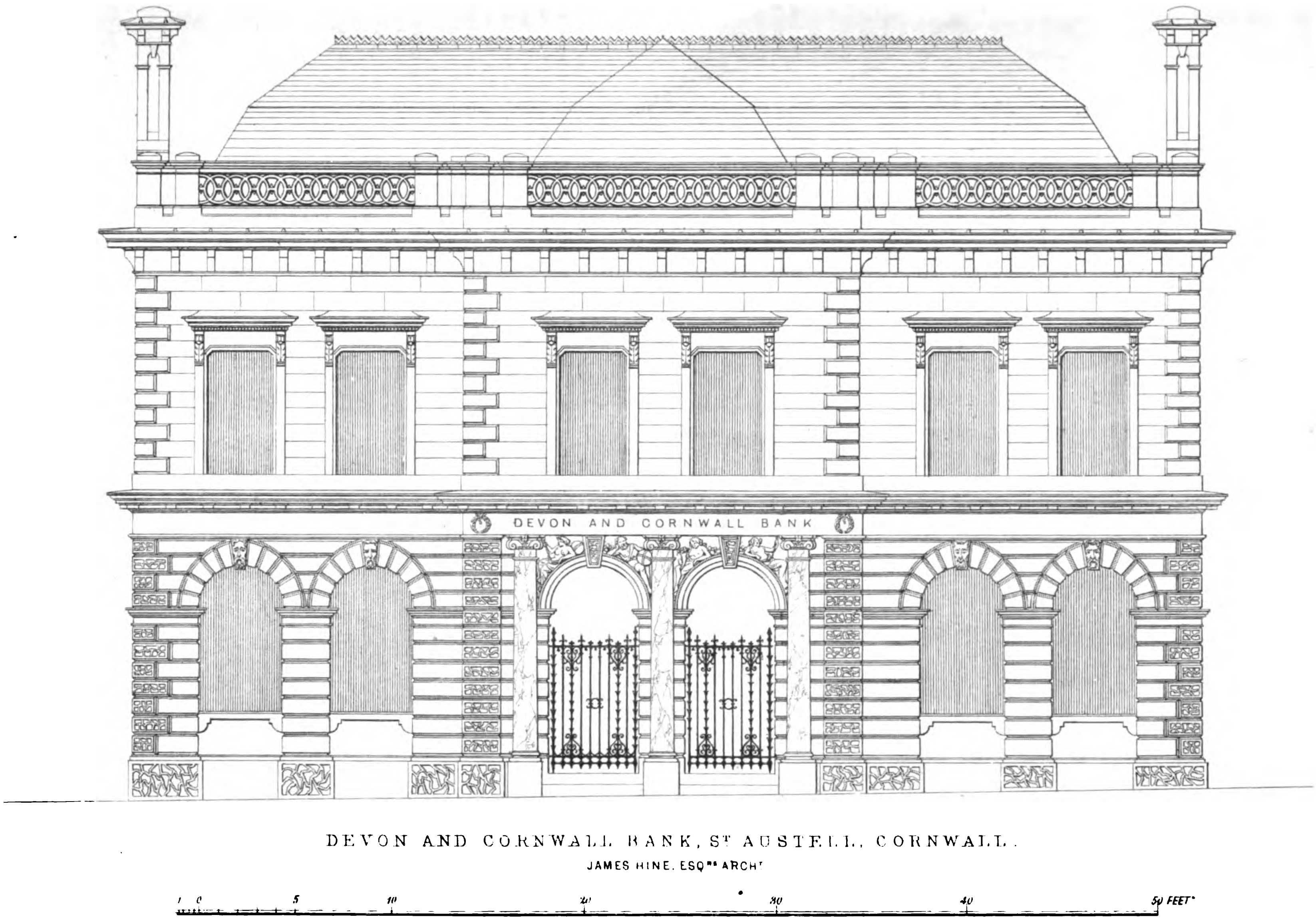
(*With an Engraving, Plate* XII.)

The accompanying drawing represents the south elevation of a banking house now in course of erection at St. Austell, a town situate about halfway between Plymouth and the Land's End.

The walls are of wrought freestone, with granite plinths; the Ionic shafts of polished Devonshire marble.

There will be a large banking-room, a consulting-room and strong-room, and nine other rooms, forming a residence for the manager. The banking-room windows will be fitted with Bunnett's revolving shutters.

Mr. Hine, of Plymouth, is the architect; and Mr. Giles, of St. Austell, the contractor.



DEVON AND CORNWALL BANK, ST AUSTELL, CORNWALL.

JAMES HINE, ESQre ARCHT

J R Jobbins

ON CIVIL CONSTRUCTION.*

By Captain FRANCIS FOWKE, Royal Engineers.

(Concluded from page 120.)

Foundations.

Several modifications of Messrs. Saunders and Mitchell's screw piles were exhibited full size, and attracted considerable notice from continental engineers. The ordinary screw pile is entirely of wrought-iron, and consists of a pile about 6 inches in diameter, with a disc about 4 ft. 6 in. in diameter at its lower extremity, forming a single turn of a screw, and terminated by a screw or gimlet point of the diameter of the pile. Another form is that which has been employed at Portland, and in which the pile itself is wood, the screw termination only being of iron, and somewhat different in form to that just described; in this the screw has four turns, and begins at about 2 ft. 6 in. from the extremity, with a diameter of 2 ft. 3 in. and is gradually reduced to nothing at the point of the pile. Two models, which are described further on, are exhibited to illustrate the application of the screw pile to the construction of lighthouses, viz., the Gunfleet and Maplin Sand lighthouses.

Cofferdams do not seem to be represented in the Exhibition, but in several of the works caissons have been used, perhaps the most important in size being that of the sluice or lock at Stockholm; and in connection with the same work may be mentioned the apparatus used by Mr. Ericsson the engineer, in cutting off the piles to the proper level; it consists of a hollow cylinder of wood, which is let down over the pile, and into which the top of the pile enters; a short thick curved saw with four teeth is fastened inside the cylinder by a pivot through one end, and furnished with a strong spring to press it forward against the pile, which is itself pressed against the saw by a similar spring acting in a contrary direction; these springs being released, it only remains to give the cylinder a horizontal rotary motion till the pile was cut through; the time necessary for the operation being somewhat less than an hour for a pile 12 inches in diameter, and the number of men employed, six.

As an example of the employment of metal cylinders for constructing foundations may be cited the Terrace Pier at Gravesend, a model of which is exhibited by Mr. Redman, C.E. The cast-iron columns of which the pier is composed are bolted down to a block of stone, resting on a pier of brick set in cement, and these foundations were executed by the aid of cast-iron cylinders 6 feet in diameter, which were placed one over the other in rings 5 feet deep, and loaded, until the lower cylinder was firmly imbedded in the chalk, having passed through the successive strata of mud, sand, gravel, and boulders, of which the bottom is composed, the weight necessary to drive them being from 5 to 20 tons; the water and mud being then removed from the interior, the masonry was completed, and the cylinders, with the exception of that at the bottom, withdrawn; at the head of the pier, where a greater depth of excavation was necessary, a second cylinder 7 feet in diameter was used outside of the other, to relieve the latter of the pressure consequent on the increased depth.

Pneumatic apparatus for submarine foundations are almost all treated of in other classes, under the head of diving bells, diving dresses, &c., and do not offer much of novelty, if we except the apparatus made use of by Mr. Brunel for the centre pier of Saltash viaduct; in this case it was necessary, to arrive at the solid rock, to descend 64 feet below low water, passing through a stratum of mud 10 feet thick; and to execute the masonry at this depth, a cylinder of plate-iron 35 feet in diameter, and of sufficient height to reach the surface of the water, was sunk at the spot determined on; this cylinder was separated into two parts at about a third of its height by a hemispherical partition, the lower part having a second cylinder inside dividing it into a circular chamber, and an annular space, each communicating with the surface by separate tubes or shafts; the water is expelled from the latter of these spaces by pumping air into it, and the masonry is executed under a pressure of from three to four atmospheres.

Works relating to Maritime Navigation.

The only model of a harbour entered in the French catalogue is that of Calais, which, although classed with civil engineering, comes rather under the head of mechanical toys, and is of no value whatever as a model of a work. England sends two well-executed models of docks or harbours, one of Great Grimsby docks by Mr. Rendel, and the other (which was unfortunately much injured in transit) of the new harbour and docks at Sunderland by Mr. John Murray, so well known for his admirable and successful translation of the lighthouse at the same place. The superficial content of the new basin at Great Grimsby is 25 acres, with an additional five acres for timber; it is surrounded by extensive wharfs, on which are laid lines of railway, affording easy communication between the warehouses, ships, &c.; the cranes on the wharfs are all worked by hydraulic pressure, for which a handsome square tower, 300 feet high at the entrance of the dock, serves as an accumulator. There is an outside harbour, protected by two wooden jetties, whose superficial content is about 15 acres.

The Sunderland docks consist of six basins, whose united areas amount to 60 acres, the wharfs and quays by which they are surrounded occupy an area of 70 acres, the entire space being thus 130 acres, of which 110 acres have been reclaimed from the sea; the depth of the principal basin is 24 feet at high water; railways are carried along the quays in every direction.

Models of lighthouses are to be found in both the French and English parts of the Exhibition, the latter containing three samples, all by Messrs. Walker and Burges, viz., the Bishop's Rock lighthouse in masonry, and those of Gunfleet and Maplin Sand, constructed of iron on screw piles. One of Mr. Gordon's cast-iron lighthouses, of which several have been erected in the colonies, would have been a valuable addition to this branch of the subject, of which the entire Exhibition could only number four examples.

The Gunfleet and Maplin Sand lighthouses are constructed on Saunders and Mitchell's screw piles, and are types of a class of which several others have lately been erected in different parts of the kingdom and colonies, that on the Maplin Sand having been the first. It is supported on nine screw piles, 30 feet long, which are driven 22 feet deep in the sand, one in the centre and one at each angle of an octagon 40 feet in diameter. At the surface of the sand the piles are surrounded by a timber grating covered with fascines and ballasted with stone. The piles are prolonged by hollow cast-iron pillars connected with each other by wrought-iron tie-rods; these pillars are carried up vertically to high-water mark, from which point they converge inwards till they reach the bottom of the platform, 22 feet in diameter, upon which the light chamber stands. The total height from the lower end of the piles to the top of the light chamber is 86 feet, and the elevation above high-water mark is 48 feet. In the Gunfleet lighthouse the wooden grating is dispensed with, and the piles are simply connected by cross ties of iron. The screw pile lighthouses have generally been erected to replace light vessels or to afford a refuge for pilots at the entrance to ports and harbours; and where they have been tried, are said to have produced a considerable saving in the yearly expenses.

The only other lighthouse in the Exhibition is in the French department, and of which there are three admirable models, one showing the edifice complete, a second being a vertical section, and the third a horizontal section through the foundation, showing the method of construction and the arrangement of the stones in each course of masonry.

The lighthouse of the "Heaux de Brehat" is erected on the rocks of the same name, which are situated off the coast of Brittany, at about ten miles from the town of Lazardrieux; it shows a fixed light on Fresnel's system, which can be distinguished at a distance of 20 miles. The rock on which it is built is covered at high water to a depth of 15 feet, so that the whole of the foundations and lower part of the edifice were necessarily tide work, the rock, which is an extremely hard black porphyry, having been excavated to a sufficient depth to secure a perfectly solid surface; an annular cutting of 2 feet deep by 4 feet wide, and with a diameter of 45 feet, was made in the rock to receive the outer stones of the first course of masonry. The masonry of the lower part of this lighthouse is not solid throughout, nor are any iron cramps employed, as in the Eddystone and other English lighthouses, to the former of which it has been compared by some French engineers, but with which the totally different circumstances of position forbid all analogy. In the first four courses, or to a height of about 6 feet, the masonry consists of one exterior ring about 7 feet thick, containing 48 voussoirs, which fourth one of which runs in radially to a length of 15 Denis, the the face, dividing the ring into 12 equal segments, and l lava; the

* Abstract of Report to the President of the Board of Trade, on the Paris Universal Exhibition.

it to an inner ring about 3 feet thick and 13 feet interior diameter, the spaces between the rings, as well as the centre of the inner one, being filled in with concrete about the height of 6 feet. From this level the two rings are carried up in one ring of about 12 feet thick, and the centre filled in with concrete up to the level of the entrance door, which is 3 feet above high-water mark at spring tide, or 18 feet from the rock. The 12 keys in each course are joggled by granite joggles to the course below, and are sunk at the joints to receive corresponding projections in the adjacent stones of the course, so that each segment is tied in separately; this method was adopted so that each segment, being perfect in itself, might be completed and secured in one tide. This mode of construction was continued up to a level of 18 feet above high water spring tides, above which the walls were carried up in ordinary ashlar work, care having been taken to employ only the best materials both of granite and cement. The stones employed varied from one to three and a-half tons in weight. Granite was used for the entire construction with the exception of the vaults of the several stories, which were turned in brick. The work was much facilitated by the circumstance that a small part of the adjacent rock was uncovered at high water, and that a depôt was thus obtained at which the materials could be collected close to the work, and at which cranes could be erected to aid in their disembarkation, &c.

The diameter at the base is 45 feet, which diminishes to 30 feet at a height of 25 feet, with an elliptical profile; above that it is carried up nearly perpendicularly to a height of 60 feet, where it is terminated by a bold cornice and ornamental stone parapet, the diameter at this point, exclusive of the cornice, being 28 feet. From this springs a tower 21 ft. 6 in. in diameter at the base, 19 ft. 6 in. at the top, and 90 feet high, surmounted by a machiolated cornice and stone parapet. The masonry base of the lantern, 13 feet diameter and 6 feet high, springs from the gallery thus formed, above which rises the lantern itself, 10 feet diameter and 18 feet high, thus making the total height above the rock 175 feet, and from high-water spring tides 160 feet. The building is divided into eight stories exclusive of the lantern, and is ascended by a small newel stair at one side. Its construction occupied five years.

A drawing of the port of the Joliette at Marseilles, the models of the New Holland and Gravesend piers, and a small model, unaccompanied by any description, of a floating dock in the French part of the Exhibition, complete the list of objects that come under the head of this section. The pier of New Holland on the Humber, opposite Kingston-on-Hull, has been constructed by Mr. J. Fowler for the Manchester, Sheffield, and Lincolnshire Railway; it is constructed principally of wood, and is the largest construction in carpentry in the Exhibition. The Terrace Pier has been already alluded to in speaking of the foundations, and is besides so well known in this country as to render any further description superfluous.

Works relating to Inland Navigation.

There is only one work exhibited by England, the aqueduct on the Aire and Calder canal, which is connected with the subject of inland navigation, while the French collection, on the contrary, is especially rich in this class of construction, more particularly in dams or barrages across navigable rivers, of which there are several models on a good scale from the "Ecole des Ponts et Chausseés." The cast-iron aqueduct over the river Calder, by Mr. Leather, is represented in a very carefully executed model by Mr. Salter of Hammersmith (who is also the constructor of most of the other English models, including the minutely intricate one of the New Holland pier, the Saltash and Chepstow bridges, &c.); and perhaps none of the English works attracted more admiration from the profession in France, not so much for its beauty in an engineering point of view, as for its "happy application of Greek architecture." This is the more strange, as it is the one point in which the true principle of architectural fitness has been rather lost sight of.

This aqueduct, which is of but one span or arch, is composed of two ribs of cast-iron, from which the trough, also of cast-iron, is suspended by wrought-iron rods, after the manner known as the bowstring bridge; it has a span of 156 feet, and carries a canal 9 feet deep and 24 feet wide, and on each side a tow-path 3 feet de. The weight of water supported is 950 tons, and the total f iron employed is 770 tons.

'el of the head works of the great Ganges canal, sent homason College at Roorkee, in the north-west of India, may be said to come into this section. Canada, always represented in every class, has also some models of lock-gates, with improvements in the working of the valves or sluices, and a model of the locks and basin on the Lachine canal at Montreal, which were constructed in 1846, and are capable of receiving a vessel 180 feet long, 44 feet beam, and 16 feet draught of water; they are executed entirely in granite ashlar.

From Holland there is a model of a floating dock, unfortunately without explanation, as well as one of the sluice at Flushing, as reconstructed in 1848, and of a caisson for closing the entrance to a dock or basin, the peculiarity of which consists in its being furnished with a pair of gates in the centre, so that small vessels can be admitted without the necessity of removing the caisson.

Sweden also contributes some very beautifully executed models, one of the falls and locks of Trowhatta, which is, however, necessarily on such a small scale, from the extent of country which it takes in, as to be more valuable in showing the natural difficulties overcome than as any record or illustration of the engineering works themselves. A second model illustrates a peculiar kind of drawbridge for canals, invented by a M. Hanson; and the third and most important one represents the new lock at Stockholm, which forms the communication between the Moelaren Lake and the Baltic; it was undertaken in 1847, to replace a former one of insufficient size, and finished in 1850, under the auspices of Mr. Ericsson, brother of the well known inventor of the air-engine in New York.

The new lock measures 150 feet in length from gate to gate, and is 32 feet in width at the gates, and 37 ft. 3 in. wide midway between these points, the side walls being curved outwards to that extent; at each end of the lock, on the outsides of the gates, drawbridges are constructed to afford communication between the opposite banks. The difference of level between the lake Moelaren and the Baltic is only 2 ft. 6 in., a circumstance which relieved the engineer of much difficulty; in the construction of the lock more serious obstacles, however, presented themselves, in the general character of the ground, which was found to be composed of blocks of stone, sand, debris of masonry, &c., and in the difference of level between the different parts of the bottom, of which the highest point was only 2 feet below the water level of the lake, while some points of the site reached a depth of 30 feet below the same level. The ordinary modes of proceeding with the construction of foundations having been rendered unavailable by the nature of the soil above mentioned, Mr. Ericsson conceived the idea of building the entire lock with its foundations, floor, gates, and retaining walls in one great caisson of woodwork, a method which has many times been adopted for piers of bridges, but of which the magnitude of the present case rendered the attempt somewhat bold.

The soil was first removed in that part of the site which was above the proposed level, and the lower part raised to that point by means of large piles driven as close together as possible, cut off to a level and filled in with the excavation from the upper part; the extremity of this embankment towards the Baltic was protected by a sea wall of rough pieces of rock, and towards the lake was driven a row of sheet piling extending across the entrance of the lock.

The caisson, which was built in a dry dock, measured 262 feet in length, 55 feet in width, and 21 feet in depth, the timbers of which it was composed being 12 inches square; it was floated out like a ship, and towed into its destined position over the piles, the masonry was then commenced and carried up in the interior (care being taken to secure a regular and level sinking of the caisson), beginning with the floor, and then the retaining walls and other parts of the lock.

The drawbridges are alike in every respect; they have each 26 ft. 6 in. width of roadway, and are divided in the middle, each half rising on a horizontal axis, the ribs of iron of which it is composed being carried out to the rear, to serve as a counterpoise, which is made variable by means of heavy weights slung to the ceiling of the vault in which the counterpoise moves by chains of different lengths, and which consequently are lifted in succession by the counterpoise, and gradually increase its weight as the bridge approaches a horizontal position.

We next come to the French collection, and first, both in the size of the model and the importance of the construction itself, stands the aqueduct of Roquefavour, which is one of the principal works on the line of the canal that supplies the city of Marseilles with water; this canal was originally undertaken for the purposes of irrigation, and was afterwards diverted to its present use; its total length is 60 miles 5 furlongs, in which course the difficult nature of the country through which it passes rendered necessary the construction of no less than forty-five tunnels of various lengths, besider numerous aqueducts, the principal of which is that which spans the valley of Roquefavour, and which has a total length of 1420 feet, and a height above the lowest water level of the river of 272 feet, its breadth at the base is 46 ft. 10 in. and at the level of the water course 14 ft. 10 in.; it is composed of three different stories or ranges of arches one over the other; in the two lower ranks the piers are directly over each other, forming bays of the same width from centre to centre of the piers, the arches of the lower rank having a somewhat less span than those of the second, owing to the increased thickness of the piers between them. In the third or upper row there are three arches to each bay of the two lower stories, every third pier being a continuation of that of these other ranks; the dimensions are as follows:—In the lower rank, 12 arches with a span of 49 ft. 6 in. each; in the second rank, 15 arches with a span of 52 ft. 10 in. each; in the third rank there are 53 arches of 16 ft. 6 in. span, which support the conduit. The heights are as follows:—

	ft.	in.	ft.	in.
From the low-water level of the river to top of plinth	16	6		
From top of plinth to springing of lowest arch	61	0		
From springing to crown of do.	24	9		
From crown of arch to level of first stage ...	11	6		
From water to coping of first stage ...			113	9
From first stage to springing of second arch	77	6		
From springing to crown of do.	26	6		
From crown to coping of second stage ...	14	10		
Height of second stage			118	10
From water level to coping of second stage			232	7
From coping of second stage to springing of third arch	13	2		
From springing to crown of do.	8	3		
From crown of upper arch to coping of conduit	13	3		
Height of third story			34	8
Height from water level to coping of conduit,			267	3

The piers are perpendicular on the faces, and of the same dimensions from the springing of the upper arches to the coping of the lower story or stage, measuring in the transverse section of the aqueduct 14 ft. 10 in. by 16 ft. 6 in. in a longitudinal direction; at the latter level the transverse measurement is increased by an offset at each side to 18 ft. 2 in., and from the springing of the lower arch the inner faces have a batten of 10 inches each, making the dimensions of the pier at the top of the plinth 18 ft. 2 in. by 16 ft. 6 in. The piers are each strengthened by counterfort 9 ft. 9 in. wide, with a projection of 11 ft. 6 in. at the plinth, and battering inwards until it dies out under the upper cornice of the second stage. The conduit carried by this enormous mass of masonry is 8 ft. 3 in. in width, and the depth of the water in it is 4 ft. 8 in. The preparatory works of this aqueduct were undertaken in 1840, but the actual construction did not commence until 1842, and it was finished in 1847. There were employed in its construction 42,000 cubic feet of wood, 640 tons of wrought-iron, 180 tons of cast-iron, and the stone used amounted to 580,000 cubic feet of rubble masonry, and 750,000 cubic feet of ashlar, and the total expense was 148,000*l.*

The piers all rest on solid rock, some of them having been excavated for to a depth of 35 feet. The cut stone was brought from a quarry four miles distant by a railway, and was drawn by a waterwheel up an inclined plane to the level of a second railway, which ran the whole length of the bridge; this was supported by the centres until the first set of arches was turned, after which it was carried along on the top platform of the first story, and in like manner for the remaining two stages of the work. During the building of the piers a moveable flying bridge was established, by which a communication by a railway was maintained from pier to pier. The arches are all semicircular, the masonry is ashlar, rough, hammer-dressed on face, and with rusticated joints: the blocks employed varying from 35 to 200 cubic feet or from 2½ tons to 15 tons in weight. The conduit is formed in brick and cement. The pressure on the foundation of the highest pier is stated to be about 30 tons on each square foot, and the ratio of the mass to the weight supported is nearly as 600 to 1. Besides a large model of a portion of the aqueduct as completed, a second, of one arch only, on a still larger scale is exhibited, for the purpose of showing the details of the centerings, and the construction and method of working of the small railways mentioned above; this last model is much more useful and explanatory than such things generally are, as it is almost what might be termed a working model, and the scale cannot be less than one-tenth of the actual size. The other aqueduct, of which a model is shown, is a moveable aqueduct over the Libron, which is so constructed that the trough, which is only just above the level of the water, can be removed at pleasure; which arrangement was rendered necessary by the torrential nature of the small river Libron.

Of dams or barrages, the most important is, perhaps, that of the reservoir of Gros-Bois, on the Canal de Burgogne, a large drawing of which appears among the models; it is entirely of masonry, and consists of a revetment with a batter of 1 in 20 on the face, and with five steps or offsets at the back, where it is further strengthened by a series of counterforts nine in number, and filled in behind with earth. The total length of the wall, from one side of the valley to the other, is 1795 feet, of which a length of 320 feet at one end and 316 at the other are left without counterforts; the first two of which at either flank are 200 feet apart, and the remainder at intervals of 130 feet. The height of the wall over the footings, at the highest part, is 73 ft. 6 in., the height of the footings is 17 feet, and the breadth 52 feet. The thickness of the wall is 42 ft. 9 in. at the bottom, and 21 ft. 6 in. at the top, there being five offsets of 4 ft. 3 in. each at the back.

All the other barrages or dams are moveable, and are divided into three classes, viz., those on the system of M. Poirée, in which the dam is removed by hand in small pieces; those by M. Thenard, where counterpoises are made use of to facilitate the raising and lowering of the dam; and a third kind, invented by M. Chanoine, in which he makes use of the raising of the water itself to lift and so open the dam, which is thus made self-acting. In a model of a barrage on M. Poirée's system, the fixed or permanent part consists of a sill of wood at the bottom of the river, reaching from side to side, which is kept in its place with masses of hydraulic mortar, and to the upper side of which is attached a small projecting ledge of iron throughout its entire length; another frame or sill, supported at intervals by stanchions firmly strutted in rear, is carried across the river parallel to the first, and at a height of some feet above the water; and the dam is formed by a number of small baulks of timber which are placed vertically, the lower ends resting against the iron ledge, and the upper part being supported by the upper frame or sill; the baulks are lashed together in sections of six or eight, for convenience of handling and removing. Another model shows a moveable barrage made of plate iron of two thicknesses, with cellular divisions between them; it is curved in the arc of a circle, to the centre of which it is connected by iron radii, or it may be better understood by supposing it to be a segment of about 60° of a vertical wheel on a horizontal axis, and its motion in being raised or lowered is a circular motion on its axis. Another kind of dam is exhibited by M. Louiche des Fontaines, and there are besides in this section a model of the scouring sluice at Dunkirk, of the lock of St. John at Havre, of the lock near the Mint in Paris, and of a drawbridge without a counterpoise by M. Davaine.

Roads and Railways.

Several of the French models and drawings, and almost all the remaining English works, may be referred to the sub-division of this section which treats of railroads. The material for the construction of common roads has already been noticed under the general head of materials. There are no drawings of special systems of road making, and the only apparatus for sweeping and cleaning roads and streets is that of Mr. Whitworth, which is well known in this country, and of which he exhibits a small working model. Under the head of finger-posts may be mentioned some very good labels for the names of streets, which are exhibited by Madame Hachette, Faubourg St. Denis, the material of which they are made is called enamelled lava; the names are very plain and clear, and the labels are similar in appearance to those used in Paris, viz., with white letters on a ground of a clear bright blue, and which are much better looking and more legible than any in use in London.

As the subject of more rapid communication between the remote parts of London and other large towns in this country is at present to a considerable extent occupying the attention of engineers and the public generally, it may not be out of place to introduce here a short account of a street railway which, though not actually represented in the Exhibition, was yet in such close proximity to one of the buildings, viz., the "Annexe," as to afford every opportunity of not only fully examining into its construction, but also of judging of its general working under different circumstances, as to weather, &c., and its effect upon the ordinary traffic of the road. The railroad in question reaches from the Place de la Concorde to Passy, one of the suburbs of Paris, a distance of more than a mile and a half, and is now being continued as far as the village of Boulogne, and is traversed by a large kind of omnibus holding 50 people each, more than half of whom are accommodated on the roof, to which access is gained by a small stair at each end. These are drawn at the rate of from eight to nine miles an hour by two horses, which can be hooked on to either end of the omnibus to avoid the necessity of turning. A detailed account of the method of construction of this and two similar railways in New York and in Nantes, with an estimate of the cost, is given in a French work, called 'L'Ingénieur,' from which the following particulars are extracted, and to which I am indebted for much information concerning the French works in this class.

The railway consists of a single line of rails, with a short length of a double line at the extremities and in the centre, for the convenience of passing; the curves are in no case of less radius than 55 yards, and the gradients are in general less than 1 in 100, except where it crosses the approaches to bridges or paved crossings, in some of which cases the slopes are as steep as 7 or 8 in 100 for a short length of from 20 to 30 yards. The top of the rail is level with the surface of the road (which is macadamised), and has an indent or groove to receive the small flanges of the wheels of the omnibus.

The line is close to the edge of the footpath, partly on the right and partly on the left side of the road; the rails are spiked down to longitudinal wooden sleepers, which are notched into transverse sleepers buried in gravel or sand well rammed, at distances of 6 ft. 6 in. The rails are in lengths of 20 feet, and weigh 13·3 pounds to the foot; the sleepers are about 6 feet long and 4 inches by 2 inches. The following is given as the cost of construction per yard run on a macadamised road:

	s.	d.	£	s.	d.
Materials.					
Iron.—Two rails, weighing 80 pounds, spikes, and joint plates	11	9			
Wood.—Longitudinal timbers and sleepers and wedges	4	0			
Gravel for making good road, at 7*d.* per foot cubic	0	10			
Total materials			0	16	7
Labour.					
Boring holes in sleepers	0	7			
Framing, carpenters' work, &c.	0	6			
Transport of materials	0	2½			
Opening trenches, 1 ft. 4 in. deep, for sleepers	0	11			
Taking away surplus excavation	0	11½			
Fixing sleepers and rails, ramming, &c. ...	1	1			
Total labour			0	4	3
Taking up and and making good pavements, curbs, extra work in curves, points, reduced to the yard run			0	0	10
Total per yard run ...			£1	1	8

A street railway has lately been constructed at Nantes by the Orleans Railway Company, to connect their terminus with the quays, of which the following particulars are given. This line of railway is nearly two miles in length; it follows the line of quays, crosses the most crowded thoroughfare of the town and the approaches to three bridges, and is entirely open to the public, presenting no obstacle to foot passengers, and being open to carriage traffic for a great part of its length. The length of single line is 1370 yards, and of double line exactly a mile, giving a total of 4895 yards of line, of which 2530 is on road used by foot passengers only, and 2365 yards crossings of streets, &c. on the level, and on roads liable to be traversed by carriages. The rail employed is a bridge rail, weighing 18 pounds per foot, fixed by galvanised iron screws 3 inches long, to longitudinal timbers 10 inches wide by 4¼ inches deep; the rails are connected together by transverse bars, weighing 17½ pounds each, having the ends turned up so as to fit into the hollow of the rail; two of these are used for each rail of 16 feet long, but experience has shown that half the number would have sufficed. The ends of the rails are joined and kept in the same line by a small dowel of compressed wood in the hollow of the rail. For the crossings of streets, &c., and where liable to be traversed by carriages, a flat iron bar, 9 pounds to the foot, is screwed in a vertical position to the inside of the timber. Without going into the details, the cost of this line may be stated as follows:—

	£	s.	d.
For a yard run of single line on road, where liable to foot traffic only, including paying all the woodwork with three coats of marine glue	0	16	6
And on crossings of streets, &c. for carriage traffic, per yard run	1	3	8

This system of street railway seems to have been first used in the streets of New York, and is now employed in several of the cities of the United States with good results. The American mode of construction differs but little from that first described; the curves are, however, very much sharper, coming down to a radius of 45 feet, for which latter cast-iron rails are employed, the outside rail being flat, and the inner one grooved for the reception of the flange of the wheel.

Under the head "railway viaducts," are included some of the most important works in the Exhibition, both from France and England; and, beginning with those from the former country, we have a model, accompanied by a water-colour drawing, giving a general view of the bridge or viaduct of Tarascon, which carries the railway from Marseilles to Avignon (Chemin de fer du Midi) across the Rhone, between the towns of Tarascon and Beaucaire, and which was built by M. Talabot. It consists of seven segmental arches of equal span, of cast-iron, springing from masonry piers. The piers are 70 feet by 30 feet, with an average height of 80 feet; and their foundations are placed at from 25 feet to 35 feet below the level of low water, each on a mass of concrete, surrounded by a double row of piles, the space between the two rows being filled with regular blocks of cut stone of an average weight of 6 tons; a slope or bank of rough blocks on the outside of the second enclosure serves to protect the piles without much diminishing the waterway of the bridge. This mode of foundation was adopted to meet the difficulties arising from the nature of the bed of the river, being liable to be constantly worn away and undermined by floods, which undermining has sometimes taken place to a depth of as much as 45 feet. The piers are at distances of 224 feet from centre to centre, leaving a waterway of 198 feet between them; each pier is corbelled out 3 ft. 6 in. at each side below the springing of the arch, so that the actual span of the arches is 204 ft. 6 in. and their versed sine is 16 ft. 6 in. The piers are terminated at each end by semicircular projections, which are continued up to the level of the parapet; and each pier is of sufficient solidity to stand the lateral thrust of the arches on one side of it, in the event of an arch falling. Each arch is composed of eight ribs of cast-iron 5 ft. 6 in. high, and having the extrados and intrados concentric. The distance between the ribs is 4 ft. 1½ in. with the exception of the outside ones, which are 4 ft. 6 in. from those next to them, thus giving a breadth of arch of 29 ft. 7½ in. from out to out. Each rib consists of 17 voussoirs, of an average thickness of 3 inches, strengthened at the top, bottom, and neutral axis by concentric or parallel flanges; they have also a flange 16 inches in width at each end, by which they are bolted together by wrought-iron bolts 2 inches in diameter. The ribs rest upon the piers upon large plates or chairs of cast-iron, fixed to the granite skewbacks, by which means the pressure of each arch is distributed over nearly 200 square feet, and double wedges are introduced into the joints for the purpose of tightening up the ribs to an equal pressure. Two sets of cross braces, or struts, at the line of the upper and lower flanges of the voussoirs, provide for the lateral stability of the ribs, and keep them at their proper distances apart; those at the upper rib are tightly wedged up against the voussoirs with iron wedges filled in with iron cement, those at the lower flange being very light, and so disposed as to leave each voussoir independent of the adjacent ones in the same rib. From the top of each rib spring a series of frames formed of vertical standards of cast-iron, each strengthened by longitudinal flanges or feathers, and with braces in the form of a St. Andrew's cross between the uprights; these fill in the spandrils with as much rigidity as if they were solid, and being bolted together help to distribute the load more uniformly over the arch; they are kept in their places at the level of the extrados of the arch by coffers or frames of cast-iron 7 inches deep, ½-inch thick, and with an average length of 2 ft. 6 in., arched to a height of 3¼ inches, bolted together and resting upon the stanchions and frames of the spandrils, and over the crown of the arch on the voussoirs themselves. On these is spread the ballast, with a mean thickness of 2 feet, reduced over the crown of the arch to 1 ft. 6 in., and enclosed at a distance of 2 ft. 6 in. from each side by a brick dwarf wall, on the exterior side of which rises a cast-iron plinth and balustrade; the weight of each arch complete is 1670 tons, and the permanent load on each is 967 tons. The materials employed in the construction of each pier were 84,000 cubic feet of concrete, 60,000 cubic feet of ashlar, 2625 cubic feet of granite, 49,000 cubic feet of rubble masonry, and 8 tons of wrought-iron. Taking the weight of the arch ballasted at 1700 tons, and that of two trains of goods at 300 tons, it follows that the maximum pressure on the foundation is 10,224, or rather more than 4½ tons on each square foot of surface.

The next bridge or viaduct in the list, viz., that over the Seine at Bercy, a suburb of Paris, and called the "Pont Napoleon," is for the double purpose of road and railway, having been constructed to connect the "chemin de ceinture" with the terminus of the Orleans railway, and in addition, to give increased facility for the ordinary traffic between the two banks of the river. It is a stone bridge of five segmental arches, having each a span of 115 ft. 6 in. with a versed sine of 14 ft. 9 in.; each arch is faced with 89 voussoirs 4 feet high, the rest of the arches being turned in very small rough rubble masonry set in cement, and the spandrils built with the same material, the body of the arch being 4 feet in thickness throughout. The spandrils are carried up internally to the level of the extrados of the arches by seven small parallel longitudinal vaults which are covered with cement and asphalte. The foundations are on timber gratings and concrete, and the entire bridge was open to the public in nine months from the time of its commencement, exclusive of the time when the works were interrupted by the height of the river. The great peculiarity in this system of construction is the substitution of small rough stone and cement for ashlar work, thus trusting almost entirely to the cement; the rapidity with which such a structure can be carried out seems greater than in the more common method of construction, but as the cost is not given, a material element is left out in comparing the merits of the two systems. The constructor of this bridge is M. Couche, ingénieur en chef des ponts et chaussées.

The next bridge we come to is also in the suburbs of Paris, and carries the St. Germain railway over the Seine at Asniéres; it is remarkable as being the first attempt to introduce the system of tubular wrought-iron girder bridges into France, and was designed by M. Flechat, engineer in chief of the St. Germain railway, and President of the French Society of Civil Engineers. The original bridge having been destroyed by fire in 1848, a temporary wooden bridge was immediately substituted, and the present bridge was afterwards constructed on the same site without a single day's interruption of the service of the railway. This bridge is composed of five bays, the two nearest the banks having a span of 102 ft. 6 in., and the remaining three of 108 feet; it consists of five parallel wrought-iron tubular girders, each 560 feet long, 7 ft. 6 in. deep, and 3 ft. 3 in. wide, except the two outside ones, which are only 2 ft. 7 in. wide; the plates composing the sides of these tubes are 27 feet long, 2 ft. 3 in. wide and ¼-inch thick; those of the top and bottom are 20 feet long, 3 ft. 3 in. wide, and with a maximum thickness of ½-inch. The tubes are kept in their places laterally by means of transverse wrought-iron rectangular frames, and diagonal braces or St. Andrew's crosses, which are placed alternately between the tubes throughout the whole length of the bridge, and the upper sides of these transverse frames serve to support the rails, of which there are four separate lines, one in each interval between the tubes and on a level with their upper sides. At the parts of the tubular girders at which they rest on the piers and abutments, a cast-iron plate is bolted on to the under sides of the tube, which slides on a grooved cast-iron chair secured to the stone work, and kept profusely lubricated with oil.

The tubes are simple rectangles in section, without any cellular chambers at top or bottom, and the iron of which the top and bottom plates is composed varies in thickness throughout their length, the amount of variation having been determined by considering each tube as a continuous girder supported at six points, and sustaining a load whose position in relation to the points of support is constantly varying; the breaking weight was then calculated for each position of the load, and a curve was constructed representing the different values so obtained, and from this curve the thickness of the plates was determined.

One of the conditions imposed on the engineers in constructing this bridge was, that the traffic of the railway (being as great as six or seven trains an hour) should not be interrupted, and as the new bridge was to be built on the site of the temporary wooden one, this was a matter of no small difficulty, and not the least interesting part of the history of its construction is the description of the method in which this was effected.

The wooden bridge consisted of four ribs supporting three lines of railway, and in constructing the iron one to carry four lines a fifth girder was introduced, so that three of the iron girders should go in the spaces between the wooden ribs, and the remaining two outside of the two extreme ribs. These two latter girders then could evidently be placed in their position without in any way interfering with the temporary bridge. In order to introduce the other tubular girders between the wooden ribs, it was necessary partly to cut away the cross bracings by which these were connected, and which consisted of diagonal braces or St. Andrew's crosses laid horizontally at the upper and lower sides of the ribs, and of a third series placed vertically at intervals. The iron girders, being considerably less in depth than the wooden ribs, permitted the former to be placed without being obliged to disturb the roadway or upper set of braces above mentioned; the lower and vertical series of braces having been removed for a certain distance at a time, the iron girders were introduced from below between the wooden ribs, in lengths of about 50 feet, placed end to end, and riveted in their positions. The roadway of the temporary bridge was then supported from the iron girders by means of wedges, and the wooden ribs removed; nothing then remained to be done but to lower the lines of rails to their new level, viz., 4 feet below that which they held on the temporary structure, and to adjust them in the intervals between the tubular girders,, the whole of which was accomplished in three operations, each operation being completed in less than a night. The entire weight of ironwork in the bridge is about 1000 tons, and the construction, exclusive of raising into place, was undertaken at 23*l*. 3*s*. 1*d*. per ton.

The viaduct of the Durance was constructed to carry the railway from Lyons to the Mediterranean over the river of that name, and is situated about 2½ miles from Avignon; it is entirely of masonry, and was constructed by the engineer of the Tarascon viaduct, M. Talebot. The principal difficulties to be overcome in its construction resulted from the extremely rapid nature of the river, and its liability to become violently flooded, consequently to produce sudden changes in the form and position of its bed; at the site of the viaduct the inclination of the water is 25 in 100, and such is its increase by floods that its volume, which in a normal state is about 1700 cubic feet per second, becomes at such times as much as 200,000 feet per second, or nearly 120 times its original quantity. This rendered the greatest care necessary in the foundations, and they were accordingly formed in one continuous mass of masonry and concrete from one side of the river to the other, 5 feet thick and 66 feet wide, projecting 11 ft. 6 in. beyond the piers at the upper side, and 25 ft. 6 in. at the lower side of the bridge. Under twelve arches out of the twenty-one of which the viaduct is composed, viz., the six nearest each bank, the foundation is carried across as a flat surface 2 feet below the lowest water level; but under the remaining nine arches, inverted arches with a versed sine of 5 feet are formed, which are carried out to the extremities of the masonry. This foundation rests on the gravel of the bed of the river, which was dredged away to the necessary depth by a 15-horse power dredging machine; it is bounded above and below the bridge by walls 6 feet thick, and 8 feet and 5 feet respectively in height, and covered with flagging, between which the concrete was thrown, and afterwards paved on top with rubble intersected with bonding courses of ashlar. The viaduct, as stated above, consists of 21 arches, each of 72 ft. 6 in. span, and with a rise of 22 feet; they are 5-centred, elliptical in form, and at each side of the bridge the springing of the arch is raised, so as to present in elevation a segmental arch of 6 ft. 4 in. rise. The piers are 11 feet thick, and are of sufficient solidity to stand the lateral thrust in case of a rupture or failure of one arch; the abutments are pierced by arches through which the towing-path is carried. The total length of the bridge is 1760 feet or a third of a mile; and the width of waterway 1386 feet; the width is 28 feet extreme measurement, and 24 ft. 9 in. between the parapets; and the height of the rails above the low water level is 31 ft. 10 in. The arches and piers are faced with ashlar, and filled in with rubble masonry; the centres of each arch were fixed and struck in one piece (the striking being performed by double wedges), from eight to ten days after the completion of each arch.

The viaduct of the Bouzane is on the railway from Chateauroux to Limoges, over the river of that name, and was constructed by M. Borel, engineer in chief. It consists of 16 semicircular arches of 52 feet span, the total length is 1012 feet, with a breadth of 27 ft. 4 in., and an elevation above the low-water level of 124 ft. 6 in.; the foundations were laid on the solid rock, of which the river's bed is composed, by means of cofferdams; the piers have a batter of $\frac{1}{10}$th of their height, and the cutwaters are carried up to the level of the parapet to form stations for the guards along the line; the arches are 9 ft. 9 in. thick at the springing, and diminish to a thickness of 3 feet at the crown; the railway is carried on three longitudinal vaults, over which the ballast is 2 feet thick, and there are weepers or gargoyles in the spandrils to carry off the surface water. There were employed in the construction of this viaduct 110,000 cubic feet of masonry, and the total expenditure was 45,057*l*.

Among the models of railway viaducts in the English section, the most important is that of the Britannia Bridge, a structure so well known in this country that any description of it would be quite superfluous. Mr. Brunel's great Saltash Bridge, now in process of construction, and which has been already alluded to under the head of Foundations, may be said to come next, as the span of its two largest openings approaches within a few feet of those of the Britannia; in principle it is a sort of combination of the arch, tubular girder, and suspension systems, the roadway being suspended from a wrought-iron tube of an elliptical section forming a segmental arch with a rise of about a fourteenth of its span, and the horizontal thrust of which is counteracted by having its ends connected by a chain, which is also attached to the vertical rods by which the roadway is suspended from the tube, as well as to the roadway itself. The trapezoidal spaces formed by each two verticals, the tube and the chain, are braced diagonally, as are also each pair of verticals themselves. The two centre bays which are thus constructed have each a span of 458 feet, the height of the road above the water being 100 feet, and they are connected with the banks by two viaducts of ten and seven bays respectively, formed of iron girders resting on masonry piers, and the total length from shore to shore is 2200 feet.

The Chepstow viaduct on the same principle, also by Mr. Brunel, was exhibited and described in the Exhibition of 1851.

A tubular girder bridge, erected on the Manchester, Sheffield, and Lincolnshire railway at Gainsborough, by Mr. Fowler, is the only remaining specimen of an iron viaduct in the Engish collection. It crosses the Trent at an angle of 50°, and has two spans of 180 feet; it is carried by two tubular girders, which form, as it were, the parapets of the bridge, and which are further strengthened by having a wrought-iron arc or rib inserted in each tube; the tubes rest on a masonry pier in the centre, and are connected with the bank at each side by an arch in masonry.

Two wooden railway bridges are sent, one by Captain Moorsom over the Nore in Ireland, on the American lattice principle, and the other by Mr. Brunlees, to show a method of removing a portion of the bridge for the purposes of navigation, in which the moveable part of the bridge is made to run back by rack and pinion work, similarly to the mangle or rolling drawbridge in use in fortifications, the only difference being that this runs back above the roadway, while in that of Mr. Brunlees the end is lowered by a screw to a sufficient depth to permit it to pass underneath the standing part of the bridge.

The only other model of a railway bridge is in the Canadian collection, viz., that of the Great Victoria Bridge across the St. Lawrence at Montreal, and which, although occupying a space of some 30 to 35 feet in length, is still on so small a scale that little of the detail of the work is represented, and it is to be regretted that it was not accompanied by a model of a portion of the bridge on a larger scale, from which the methods of joining the tubes together, supporting them on the piers, and other matters of detail might have been gathered. The Victoria Bridge is by Mr. Stephenson, and is on his tubular girder or Britannia principle; the length of the tubular part is 6138 feet, the length of the masonry abutments is 484 feet, and the embankments at both sides give an additional 2366 feet, thus making the entire length of the work across the St. Lawrence 8988 feet. The tubular part, or bridge, properly so called, consists of 25 bays, the centre having a span of 330 feet, and those at the sides 242 feet; the height of the tube above the water is 60 feet in the centre, and 36 feet at the abutments; the tubes, instead of passing through the piers as in the Britannia Bridge, rest on the top of them and abut together end to end, so that the side elevation of the bridge will present one unbroken tube of nearly a mile and a quarter in length, the ends being received in a tunnel of masonry in each abutment. The weight of the iron used in the construction will amount to 10,500 tons, all of which will be transported from England, and the masonry will be not far short of 3,000,000 cubic feet.

Drawings of several of the most recently constructed railway stations in France are shown along with the models already described, from the Ecole des Ponts et Chaussées, but are more remarkable as architectural drawings, of which they are beautiful examples, than for any apparent novelty in design or detail. They consist of plans of the Paris and of the Lyons stations on the Paris and Lyons railway, bird's-eye view, section, and three elevations of the Bordeaux terminus, and similar drawings of the terminus of the Orleans railway at Nantes.

Bridges.

The greater number of the bridges of which models or designs were exhibited have already been dealt with as coming under the head of viaducts or railways, and this applies more particularly to England, where comparatively few bridges of importance have of late years been constructed, with the exception of those connected with the different railways: and it is, probably for this reason that a model of the Victoria Bridge over the Clyde at Glasgow, by Messrs. Walker and Burges, and some projected bridges by Mr. Rennie, are the only models of masonry bridges contributed from this country.

From France there is a photographic drawing of the Pont de l'Alma, situated close to the machinery building, and which was almost entirely constructed during the period of the Exhibition, and of which the principle of construction was similar to that already described in speaking of the Pont Napoleon at Bercy, namely, the use of small rubble work, set in cement, for the entire work, with the exception of the piers and facing, which are of ashlar; the piers of this bridge are founded on concrete and masonry, laid by means of caissons, and such was the rapidity with which the rubble work of the arches and spandrils was executed, that, as it is stated on the drawings, but three-and-twenty days elapsed from the time of commencing the springing of the arches until the opening of the bridge to the public; it must, however, be borne in mind that this opening for traffic took place before the ashlar facing was applied (this not having been carried up simultaneously with the rubble), before the centres were struck, the foot-paths paved, or the parapets commenced, all of which were unfinished at the close of the Exhibition, in part owing to the failure of the foundation of one of the piers, which necessitated the removal of part of the superstructure for its relief. One of the most interesting points in connection with the construction of this bridge is the method employed for striking the centres by means of cylinders filled with sand; the employment of this method does not produce the slightest change in the construction of the centering itself, as the cylinder is simply substituted for the wedges on which the centres are supported. The apparatus consists of a cylinder of wrought-iron, 12 inches in diameter and 12 inches high, which is placed in a vertical position on a wooden platform, on which it is prevented from slipping by a circular piece of wood, $\frac{3}{4}$-inch thick, nailed to the platform, and fitting the interior diameter of the cylinder. Near the base of the cylinder, at four equi-distant points of its circumference, are bored holes 1 inch diameter, which are stopped by corks introduced from the interior of the cylinder, which is then filled to within 2 inches of the top with sand previously dried and passed through a fine sieve; and into the space thus left is fitted a solid piston or plunger of wood, coinciding exactly with the interior diameter of the cylinder, and about 10 inches high; the whole apparatus, which is thus about 20 inches in height, is then introduced under the centres in lieu of wedges; and M. Bouziat, by whom this method has been invented and applied, gives the following account of the process of striking the centres:—"In striking centres, at a given signal the corks closing the orifices in the cylinders are withdrawn by an iron rod a foot long and ·31 of an inch in diameter, pointed at one of its extremities, and flattened and turned up at the other; the sand then issues slowly until it has formed a little cone opposite each hole, and stops. When everything is ready, the engineer gives the order to lower from 1½ to 2 inches; then, by means of the iron rods, the men remove the cones of sand, and help its escape with the curved end in the event of its having got wet during the process of the work, until the piston shall have descended the distance required, which will be noted by a scale attached to each piston. The workman then allows the little cone of sand to accumulate, and waits a fresh signal, and in this way the centre descends gradually, and detaches itself uniformly from the arch without shaking it. It will be seen that, being completely master of the operation, leisure is given to make all necessary observations, so as to be assured that all goes on well, or to take measures should the contrary be the case. At the Pont d'Austerlitz, commenced the 20th May 1854, and opened for traffic on the 8th November, the centres were struck in two hours, and it might have been performed in still less time by placing a man to each of the cylinders, so as to lower all the centres simultaneously. Each arch of the bridge was supported by 36 principals, and the enormous weight of both the masonry of the arch and the metal of the roadway bore on the centres, they not having been removed until after the opening of the bridge to the public."

One of the most important of the French masonry bridges in the Exhibition is that of Dinan, by M. Fessard of the "Ingenieurs des Ponts et Chaussées," which was constructed for the purpose of carrying the high road across the valley of the Rance, which it crosses at an elevation of 132 feet above the level of the tow-path. The bridge, which is entirely of stone, is 660 feet in length; and its extreme height, including foundations, is 165 feet, and that of the abutments at each end, 82 feet; it consists of ten semicircular arches, each of 52 feet span, and supported by piers 15 feet thick. The width of the bridge between the parapets is 23 feet, containing a roadway of 16 ft 6 in., and two footpaths of 3 ft. 3 in. each; the parapets are one foot thick, and 3 ft. 3 in. high. The piers are founded on the solid rock, the foundation being put in in ashlar work in hydraulic mortar, which was also used in turning the arches, the rest of the work being in common mortar; the piers are entirely of cut stone, the interior of the spandrils and abutments alone being filled in with rubble. The roadway is supported by two parallel semicircular vaults running the entire length of the bridge above the extrados of the arches, separated by a wall 3 feet thick, and having each a span of 4 ft. 6 in.; they are in granite rubble set in hydraulic mortar. There have been used in the construction of this bridge more than 57,000 cubic feet of masonry, and 26,000 cubic feet of wood; and the total expense was 42,150*l*.

The bridge of Pontiffroy, at Metz, is exhibited in model for the purpose of showing, not its construction, as that dates as far back as the 14th century, but as an example of a very successful restoration and enlargement, which has been carried out on the original bridge by M. Lejoindu, in which the whole bridge has been widened 10 feet, and the old work entirely covered with concrete, at an expense of 3400*l*., or 6*l*. 1*s*. per foot run.

The widening has been accomplished in three different ways; first, by the construction of a set of stone ribs on each side of the bridge outside the original arches, and springing from the old piers, which are carried up 6 feet above their original height, so as to throw the new part of the arch into a flat segment instead of being semicircular, as is the case with the old ones, and thus reduce the weight of masonry in the spandrils; secondly, by carrying out a corbelled cornice beyond the face of the masonry; and thirdly, by the substitution of iron railings for the stone parapets.

The new ribs above mentioned are merely tied to the original work by three iron cramps in each arch, one over the crown and the other two at the haunches. The total length of the bridge is 560 feet, the waterway of its 11 arches is 415 feet, and its total width, as increased, is 35 feet. The period occupied in the work was ten months, during which time the bridge was never closed for foot-passengers, and only for two months (namely, during the laying of the concrete) for carriage traffic.

In the class of bridges constructed wholly or in part of wood, specimens are shown by England, Canada, Austria, and France; of the two in the English collection, one by Captain Moorsom has already been mentioned, in the last section, as being for the purpose of carrying a railway. A model of a project for a wooden bridge is sent by Mr. Rose, of Leith, which exhibits a very ingenious method of framing short timber into the form of an arch; the bridge consists of a number of wooden ribs or principals side by side, each rib being formed of baulks placed end to end in the position of the sides of a polygon, the alternate ribs breaking joint with each other, so that the angles of the polygon in each case are over the centre of the sides adjacent to them; the ribs are connected together by transverse pieces of timber, which are laid across the centre of the timbers of one set of ribs, and pass under the salient angles of the alternate ones; the roadway is supported from the arch by upright timbers with diagonals between them. The model of a wooden bridge exhibited by Canada is a project for a bridge with a span of 300 feet; it is supported by two girders, one on each side of the roadway, which is 22 feet wide; each girder is 28 feet high, and consists of an upper and lower sill, each of five thicknesses of timber bolted together side by side, the upper and lower sills being connected together by two rows of upright wooden stanchions and diagonal tie-rods in wrought-iron; those diagonals on which the compressive strata falls are doubled in each bay, and in the two bays at each side nearest the abutments are replaced by wood; the ends of the stanchions rest in cast-iron chairs or shoes. The girder thus formed is further strengthened by a strong wooden arc or rib springing from the abutment 10 feet below the lower sill, passing between the timbers of the sill and between the double row of stanchions and diagonal braces, and rising at its crown as far as the underside of the top sill, to which it is attached by bolts and nuts as well as to the lower sill, and to all the stanchions which are crossed by it. A bridge exactly similar in every respect has been executed at Rock Island, near Stanstead, in Canada, but with a span of 150 feet only, for, as is stated, a sum of 750*l*.

From Austria we have a model of a wooden bridge by a Venetian engineer, in which the roadway is supported by wooden ribs, each composed of two concentric arcs connected by vertical or rather radial pieces and St. Andrew's crosses, but it is not stated whether the model is merely an unexecuted project, or if it represents a bridge that has actually been constructed.

Under the head of bridges in metal, England is represented by one model only, viz., that of the cast-iron bridge at Leeds, by Mr. Leather, constructed in 1842, which consists of a single segmental arch of 120 feet span and 12 feet rise, composed of 10 ribs, and having the spandrils filled in with a series of St. Andrew's crosses; the mouldings and architectural details being somewhat Gothic or mediæval in character. The width of the roadway is 30 feet, and the total width of the bridge is 42 feet.

A small foot-bridge is exhibited, full size, by Belgium, in which the roadway (wooden) is supported on two light ribs of T-iron, which are connected together, and to a third rib, running under the centre of the bridge at a depth of 3 feet, by wrought-iron ties; the span is 50 feet, and the width 2 ft. 6 in.

Turning again to the French collection, we come to the Pont d'Arcole, of which a very large and beautiful detailed model is exhibited by the Ministre des Travaux Publics, is one of the most striking of the variously constructed Parisian bridges; it is by Messrs. Oudry and Cadiat, who are also the engineers of the great swing-bridge now being executed at Brest, and of which a model appears in one of the galleries of the Annexe.

The Pont d'Arcole has been built over one of the branches of the Seine, between the Island of the Cité and the main land, to replace a suspension bridge which formerly occupied the same site; it is constructed throughout of wrought-iron plates, and is particularly remarkable for the extreme lightness and thinness, even to apparent want of strength, of the centre or crown of the single arch of which it is composed.

The arch is segmental, with a span of 264 feet, and a versed sine of 20 ft. 2 in., and the entire width of the bridge between the parapets is 66 feet; the arch springs from two abutments of masonry, one of which is pierced for the reception of a towing-path. The arch consists of 12 wrought-iron ribs, placed at 4 ft. 4 in. from centre to centre under the roadway, and 11 ft. 6 in. under the footpath. These ribs are formed of a web ·47 of an inch in thickness, with flanges 1 ft. 10 in. wide, riveted to them at top and bottom by means of angle-iron ·39 of an inch thick; they are further strengthened by a certain number of vertical ribs of T-iron riveted to the web, and extending from flange to flange. The depth of the rib at the springing is 4 ft. 4 in., which is reduced to 1 ft. 1¾ in. at the crown; the ribs are strutted from one to another by straight and diagonal struts of wrought-iron and plate, and the spandrils are composed of open work, also of wrought-iron; the foundation for the roadway is formed by Barlow rails laid transversely across the ribs and upper part of the spandrils, which disposition tends in a great degree to strengthen and tie together all the ribs and other parts of the bridge; these rails are placed so close to each other as to form a bottom on which the ballast and metal of the road are deposited; the depth of the road is 1 foot at its centre and 9 inches at the footpaths, and the rise or gradient of the road from either shore is only 1·6 in 100.

The foundations of the abutments are on piles, and protected by an enclosure of sheet piling; the masonry is rubble in cement, and the dressings are of cut stone.

The arch of the bridge contains 900 tons of iron, wrought and cast; and the cost of this part of the work was 37,200*l.* The remainder of the work, namely, the foundations, masonry of abutments, roadway, footpaths, &c., cost 8800*l.*, making a total of 46,000*l.*

The swing-bridge by the same engineers is now in course of construction at Brest, over the Penfeld, and consists of two swinging or turning portions, meeting together in the centre, and opening horizontally; these semi-arches spring from circular towers of cast-iron, turning on friction rollers, and are prolonged beyond the towers to form a counterpoise to the semi-arches. The span of the bridge between the piers or pivots is 343 feet; the height, from low water to the soffit of the arch, is 98 feet, and the springing 72 feet, the rise of the arch being 16 feet. The width between the parapets is 23 feet. It is stated that with two men to each pivot the bridge will be capable of being opened or shut in ten minutes.

Water and Gas Distribution.

The only representation of works necessary when water is taken from rivers is the model of the head works of the Great Ganges Irrigation Canal, which is sent from the Thomason College at Roorkee in the north provinces, but which is unfortunately not accompanied by any detailed models or description from which any information concerning its construction might have been gathered. Conduit pipes were exhibited by several French manufacturers, among whom may be mentioned M. Paris, who sends iron pipes coated inside and out with a kind of enamel or glaze, M. Petit, M. Hermann, and M. Chameroy. In the pipes exhibited by M. Petit, which are of cast-iron, the only peculiarity consists in the joint, which is a kind of faucet-and-spigot joint kept tight by a ring of vulcanised india-rubber, being introduced between the end of one length and a shoulder formed to receive it in the end of the adjoining one. The lengths are kept close by two lugs cast on the end of each pipe, which are keyed to two corresponding lugs on the end of the next one. The operation is thus performed: the length to be laid is first keyed at the upper lug, and then held upright or at right angles to that already in position while the india-rubber ring is introduced, when, being brought down to its proper place, its own weight serves to compress the india-rubber, and it is then keyed at the under side, the entire operation for each joint occupying only about two minutes. These pipes were laid down in the machinery part of the building to convey the steam from the boilers to the various engines which drove the machinery, and however serviceable they may be as water pipes, they are certainly not adapted for the conveyance of steam, in which respect they failed miserably, and were ultimately replaced by a copper pipe with flange joints fastened together with bolts and nuts.

The pipes exhibited by M. Chameroy consist of a cylinder of thin sheet iron, covered inside and out with asphalte, that on the exterior being mixed with sand. The different lengths are joined by a spigot-and-faucet joint, and in some of the examples by being screwed together. This description of pipe is said to have been used to a considerable extent in and about Paris; it has the advantage of being cheaper than those made of cast-iron, but its durability and capability to resist any great amount of pressure seem at least doubtful.

Some pipes, in which the cylinder of sheet-iron is covered on the outside with a thick coating of hydraulic cement, are shown by Messrs. Genot and Co., which would, perhaps, be still more economical than those of M. Chameroy, but it is not stated that they have been brought into actual use, nor are any particulars given either as to their price, mode of manufacture, or of joining the pipes together.

In the joint proposed and exhibited by M. Hermann, a hollow ring of pewter of triangular section is inserted between the ends of the pipes, which are made slightly bell-mouthed to receive it, and which, on being nutted up close, press on the ring with a wedge-like action, and thus give a means of exerting a powerful pressure on the joint, the ring acting as a kind of caulking between the pipes.

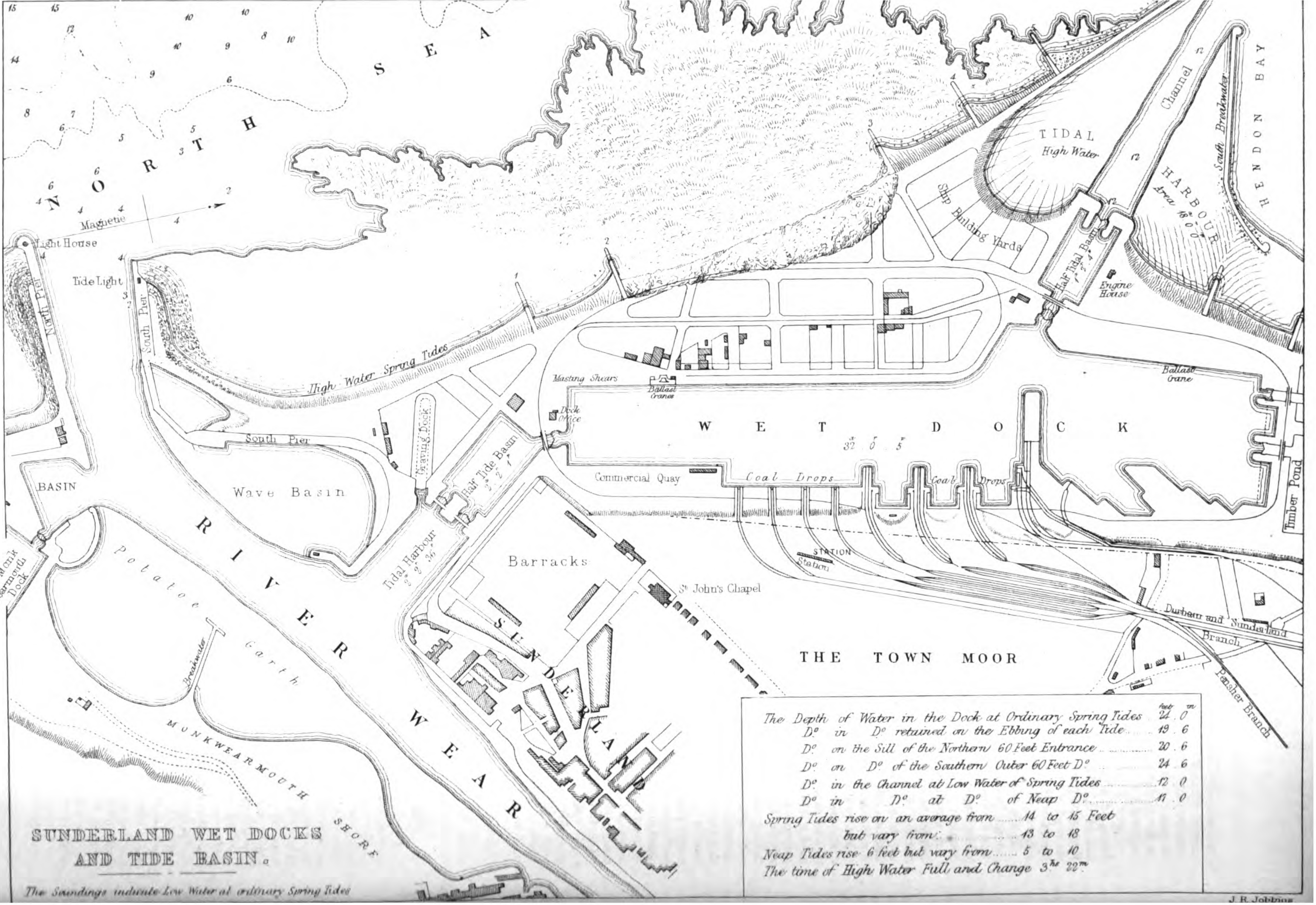
A sixth kind of pipe is exhibited by M. Schweppé, which is made of wood, covered both on the exterior and interior with a thick coating of pitch and tar, which, he contends, will have the power of preventing the wood from being acted upon by either the damp of the surrounding soil or by the water or other liquid conveyed in the pipe, and, consequently, of preserving it for a long time, or, as M. Schweppé himself says, of making it unalterable; which statement, however, does not appear to be borne out by any previous experience. These wooden pipes are made in lengths of 6 ft. 6 in., and of different diameters, the thickness of wood being in each case one-third of the interior diameter of the pipe. They are put together with faucet joints, and are offered at extremely low prices, those of 1½-inch bore costing 1*s.* a yard, and those of 12-inch bore 9*s.* a yard, or if hooped with iron 1*s.* 3*d.* and 12*s.* respectively; and the fixing is said not to exceed 1½*d.* for the length of 6 ft. 6 in. of the former, and 9*d.* of the latter dimension, this being, of course, exclusive of excavation. These wooden pipes are said to be stronger than those in asphalte by M. Chameroy, and some of those exhibited are stated to have borne a pressure of 75 lb. on the inch without being hooped.

Special Constructions.

This important section has, strange to say, but few representatives in the Exhibition, and it is to be regretted that no plans or models of any of the public buildings of this kind, of which Paris furnishes so many examples, should have been included in the admirable collection of models contributed by the Minister of Public Works.

A plan or model of the great central market which is now being erected in Paris, with its light sheds of cast-iron, its underground stores, communicating by a subterranean railway with the Chemin de fer de Ceinture, and, by this means, with all the railways entering Paris, would have formed an interesting pendant to Mr. Bunning's model of the beautifully-arranged New Cattle Market at Islington; but this great work is only represented by a couple of cast-iron columns, and the arch between them, forming one bay of the construction, and exhibited merely as a specimen of iron-casting. A large drawing, being an unaccepted design for the same building, is contributed by that most indefatigable of architects and draughtsmen, M. Hector Horeau; and if the competitors for similar constructions had followed his example, we should, probably, have had a most interesting and instructive series of subjects. England sends but three models of public buildings, viz., two of Mr. Bunning's, of the Cattle Market, already referred to, and of the City Prison at Holloway, and one by Colonel Jebb, R.E., of the Model Prison at Pentonville, all of which are too well known in this country to require any description. Canada contributes a model of the New Court House at Montreal, which, judging from the model, must be a handsome building, and highly creditable to the colony. It is a rectangular pile of building, standing on a high rusticated basement. It has both fronts alike, each consisting of an Ionic hexastyle portico, connected by a recessal portion to slightly projecting wings, surmounted with pediments. The end fronts are ornamented with Doric pilasters, and furnished with a pediment at top. Several drawings of churches, villas, public buildings, &c., are also sent from Toronto and Hamilton in Upper Canada, and afford pleasing evidence of the advanced state of civil construction in that country.

From India we have several models of native markets, courts,



	feet	in
The Depth of Water in the Dock at Ordinary Spring Tides	24	0
Do in Do retained on the Ebbing of each Tide	19	6
Do on the Sill of the Northern 60 Feet Entrance	20	6
Do on Do of the Southern Outer 60 Feet Do	24	6
Do in the Channel at Low Water of Spring Tides	12	0
Do in Do at Do of Neap Do	11	0

Spring Tides rise on an average from 14 to 15 Feet
but vary from 13 to 18
Neap Tides rise 6 feet but vary from 5 to 10
The time of High Water Full and Change 3^{hr} 22^{m}

SUNDERLAND WET DOCKS AND TIDE BASIN.

The Soundings indicate Low Water at ordinary Spring Tides

J. R. Jobbins

&c.; none of them, however, exhibit with a view to showing the construction of the buildings, but rather as illustrations of native manners and customs, and consequently not coming within the bounds of this Class; and from none of the other English colonies or foreign states do we find any contribution in this section deserving of notice.

From France there are models by M. Duvoir Leblanc, of Paris, of a pavilion of the Hospital Lariboisiere, of the great hall of the Institute, and of the kitchens of the Palace of the Elysée Napoléon; but as they are exhibited to illustrate a peculiar mode of warming and ventilating buildings, they have, no doubt, been already dealt with by Dr. Arnott in his report upon those subjects.

There are two French exhibitors of modern dwellings or lodging-houses for workmen, viz., M. Dumesnil and Messrs. Van Cauwelaert and Co., but in neither case do the models exhibited show any great departure from the ordinary type in this country.

A model dwelling-house is shown, full size, in the garden behind the Palais de l'Industrie, by Mr. G. Clark, in which a number of building contrivances and peculiarities of construction are introduced, but which have all been noticed separately in their several sections as materials, and of which any mention here would be merely a repetition.

Before finally taking leave of the subject of civil construction, it may not be out of place to notice a subject in connection with this branch of science which is represented in several instances in the Paris Exhibition, and the importance of which, in this respect, seems beginning to be acknowledged on all hands. I allude to the employment of photography for the purpose of taking drawings of works and buildings, and more particularly with reference to the transmission to a distance of drawings showing the progress of a work in course of construction; for this purpose it seems likely to be peculiarly useful, from the fact that it guarantees perfect truth, and admits of no possibility of misrepresentation; this latter qualification is happily of but small importance in this country, but it may be valuable in many cases in the construction of works abroad, where the work may be performed by contractors of unknown character, and at a distance from the superintending engineer. As examples of such progress-drawings of large works, may be cited those of Mr. Vignolle's great work, the suspension bridge at Kief, in Russia, exhibited among the English photographic drawings, which is probably the first instance of the application of photography to such a purpose. Photographic drawings are also shown by the French of the new Pont de l'Alma, and of one of the new railway stations on the Bordeaux line.

ON THE BARS OF RIVERS AND SEA BEACHES.

By Joshua Wilson.

(*With an Engraving of Sunderland Docks, Plate* XIII.)

The opinion appears to be gaining ground, that the progressive movement of a sea beach is rather to be attributed to the action of the waves, than to the scour of a coast tidal-current. The wave, when it breaks on the shore, propels the beach in the direction of its movement. Thus, an on-shore wave will cause an accumulation of the beach; but if the direction of its action be oblique, the movement of the drift will be along-shore; and this drift will form a bar across the mouth of any river that is exposed to its action. And if this tendency to accumulate detritus were not kept in check by the action of the river current, the bar would increase until it reached the high-water level. Where the transporting power of the waves becomes gradually weakened, either from the shelter afforded by sands (as at Yarmouth), or that of the opposite shore (as on the south-east coast of England), the progressive movement of the beach will be retarded, and, as a natural consequence, it will there have the greatest tendency to accumulate. The shelter afforded by an island situated near a coast where there is a travelling beach, will interrupt the transporting action of the waves, and, as a necessary consequence, the detritus will accumulate between it and the shore until an isthmus is formed connecting it with the main land. This circumstance will satisfactorily account for the origin of the Chesil bank, which connects the Isle of Portland with the main land: a similar formation connects the rocky promontory of Hartlepoolheugh with the shore.

It may be remarked, that these formations present a concave shore to the windward, proving that this is the shape best adapted for resisting the impinging action of the waves; a hint that might be beneficially acted upon in designing a coast harbour exposed to a tempestuous sea. An island situated at a greater distance from the shore will only impede the movement of the coast drift so that it may only be united to the main land at low water, of which Holy Island, on the coast of Northumberland, is an example. The drift does not appear to accumulate behind the Isle of Wight, but forms a bar across the channel, and so passes round the island.

It not unfrequently happens that a shingle drift will impound the waters of a small river, forming a bar across the entrance up to the high-water level, the river water escaping by percolation through the gravel; or a land flood will sometimes enable the river to scour a channel through the shingle bar, and which will remain open until the next gale of wind from the quarter which imparts the preponderating movement to the beach, again closes up the channel.

When a river flows into a narrow, deep estuary which gradually widens before it reaches the line of the sea coast, the drift, instead of forming a bar across the entrance, will pass up the sides, where it will be deposited as the waves gradually lose their transporting power.

The circumstance of the existence of deltas at the mouths of so many large rivers has no doubt given rise to the very prevalent opinion that bars are the result of a river deposit. But deltas generally occur where a river debouches into a sheltered bay, or where it brings down a greater amount of detritus than can be removed by the action of the waves. The shoals caused by deltas are not bars, strictly speaking, but have a similar origin and are governed by the same laws as the shallows met with in rivers.

It has been urged as an objection to the theory of the marine origin of bars, that, if it were correct, there would be a sudden accumulation of detritus on the occurrence of an on-shore gale; but this accumulative action is in a great measure neutralised by the action of the off-shore current which accompanies such a gale when the bar is composed of sand. But shingle bars are subject to more violent changes in their depth, because shingle is not so easily acted upon by the off-shore current as sand. The late Mr. E. H. Palmer, in his paper on "Shingle Beaches," noticed the fact that on a rocky shore the action of the wave gives a seaward direction to a travelling beach, arising from the circumstance that from its retiring between the hollows of the rocks, the wave possesses greater power to return detritus in an off-shore direction, than to accumulate it on its advance. In confirmation of his position, it may be remarked that after an on-shore gale, when the beach has a less inclination near the low-water mark than in-shore, it will often be found that the sand which has been removed by the action of the off-shore current from those portions of the beach where the slope is greater, will be deposited in the shape of a bar near the low-water mark, until on the return of an off-shore breeze, it will be returned, by the accumulative action of the waves, to its former position in-shore; but where the shore is rocky at the low-water mark, this detritus is carried out into deep water.

The sea outlet of the Sunderland Docks is a case illustrative of the effects of a rocky shore in giving a seaward direction to the coast drift. Doubts having been expressed as to the permanent maintenance of the present depth of water at this outlet, in the discussion which followed the reading of the paper on the "Sunderland Docks," by Mr. J. Murray, before the Institution of Civil Engineers,* it may be well to describe the facts connected with the locality, with the reasons why no bar has been formed at this outlet, while at the entrance to the old harbour (less than a mile distant) such an obstruction exists.

The preponderating shore drift on this coast is from north to south. In fine weather there is usually an accumulation of sand behind the pier to the northward of the harbour, and the river channel across the bar is then commonly to the northward, close to the north pier. When a north-east gale succeeds this interval of fine weather, the off-shore current gives this sand a seaward direction, and by the action of the waves it is driven to the southward, until it not unfrequently happens that the deep-water channel across the bar is opposite the end of the south pier, a distance of 400 or 500 feet; and this continues until the occurrence of spring tides or a land flood enables the river current to

* See *Journal*, Vol. xix. (1856), page 206.

break out a new channel to the northward, when the former state of things is restored.

A few hundred feet to the southward of the harbour, the shore consists of a mass of rocks, a portion of which has been excavated in the formation of the docks. Before the commencement of these works there was commonly a travelling beach between these rocks and the base of the cliffs, but a heavy on-shore gale would sometimes sweep away the whole of this beach, and leave the rocks bare close to the cliffs. So, in order to protect the banks from the ravages of the sea, wooden jetties were run out from the shore, which caused a considerable accumulation of beach on the north, and a smaller quantity was washed up on their south sides by the action of the south-east gales.

It may likewise be stated that there are two stone groynes run out from the new-formed shore facing the dock, and three others in front of that portion which forms the separation between the side of the new outlet and the sea. The northerly drift passes the ends of the two former groynes, but it is dispersed by the action of the wave on the rocky shore before it fills the angle behind so as to enable it to pass the northernmost groyne in front of the outlet. This portion of the shore—it being in fact the north-east pier of the outlet—is formed in a more easterly direction than that which fronts the dock itself; and since the groynes are run out from it at right angles, it necessarily follows that their south-east corners are further in-shore than the north-west side of the succeeding one to the southward, consequently the detritus is accumulated by the action of the waves on their south, instead of the north sides, as is usually the case on this coast.

In the discussion which followed the reading of the above-named paper, it was suggested that the cause of this accumulation of detritus on the south side of these groynes was to be found in the circumstance of an eddy tidal-current setting out of Hendon Bay. Now this eddy current sets into the harbour round the south pier head, and consequently the more northerly groynes would be equally subject to its influence as those in question, yet in these the accumulation is on the north sides. An inspection of this locality will convince any one that this accumulation of detritus must be caused by the action of the waves, rather than the scour of a current. It will be seen that pieces of magnesian limestone (some of them several tons weight) which were thrown over to protect the shore on the south side of the jetties, are rounded like boulders and bare of sea-weed, and also that the south side of these groynes is worn away to a depth of several inches by the attrition of these stones: while the masses of limestone which lie to the north of the groynes, from being merely sheltered from the sea, still retain their angular form and are covered with sea-weed,—all indicative of a state of rest.

The channel between the termini of the piers of the outlet was originally a hollow between the rocks, filled with shingle to a depth of 12 feet below low-water mark; and since it has been shown that the action of the waves on the rocky shore gives a seaward direction to the drift which constitutes the bar across the entrance of the harbour, there appears to be no reason to apprehend the formation of a bar across the mouth of the outlet; and this conclusion is borne out by the result hitherto, since from the period of the commencement of the outlet to the present time there does not seem to be the slightest tendency to accretion in the channel, or the least appearance of a bar. The in-shore drift appears to join the off-shore coast drift, which, according to the testimony of the pilots, passes the dock outlet at a depth of five fathoms. Upon the same authority it may be stated that the mud or silt which is brought down the rivers, or abraded from the clay cliffs by the action of the sea, and which is held in mechanical suspension by the water for a considerable length of time, is found deposited at a depth of twenty-two fathoms and upwards, showing that on this coast the transporting power of the waves ceases at that depth.

Sunderland has long occupied a first position as a shipbuilding port: on the average, upwards of a third of the tonnage built in the United Kingdom is launched at this port, registering in 1855 one thousand vessels, measuring 234,910 tons, and yielding pre-eminence only to London, Liverpool, and the Tyne. The Wear drains an area of about 500 square miles, and by an old plan of the entrance, dated 1719, we find that at that period it entered the sea through various low-water channels, and that the harbour was not provided by art with a shelter of any description.

A south pier was commenced in 1723, which was added to by various engineers until 1786, when the north pier was commenced. The south pier appears to have been carried out in order to catch the flood-tide in its passage from the north, and throw it into the harbour; but it acted as a groyne, and intercepted the shingle in its progress southward, causing a great accumulation in the entrance, so that a writer in the year 1774 complains that "vessels drawing only six or seven feet water were often prevented from getting to sea:" indeed, the usual practice at that period was to carry the coals to sea in keels or lighters, and put them aboard the vessels in the open roadstead.

This state of things was in a great measure remedied by the formation of the north pier, the good effects of which may be shown by the increase in the size of the vessels belonging to the port. In 1786 the average size was 134 tons, but in 1828 it had increased to 169 tons; at this latter date the navigation of the channel was still impeded by shoals, composed of hard limestone shingle, similar in appearance to the rocky cliffs situated about a mile to the northward of the port, a deposit evidently due to the action of the waves at a period anterior to the formation of the north pier. As this channel was gradually deepened by the dredger, the size of the vessels belonging to the port was increased until, in December 1855, it averaged 234 tons.

In 1835, a dock of about 6 acres, with a tidal harbour of 1 acre, was commenced at the north side of the river, and was finished in 1838.

The construction of the south dock was fully described in the paper before alluded to, read before the Institution of Civil Engineers; but we can now state that in an engineering point of view, the new outlet has been perfectly successful. The sill of the inner gates is 4 ft. 6 in. below the average level of Sunderland bar, and 2 ft. 6 in. below the pilots' marks for that of the Tyne; and from tidal observations taken by the dock-master, it appears that at the high-water of the lowest neap tide in the month of August last, there was 19 feet on the dock sill, and 24 ft. 7 in. on the highest springs; there has been 25 ft. 6 in. in an equinoctial spring tide. There have been sent to sea by this outlet, 2300 tons of coal in one bottom; and from its channel being formed in a south-easterly direction, ships proceeding to sea are sheltered from a north-east swell until they get into deep water, so that vessels which have taken in their cargoes in the harbour or the north dock frequently come through the south dock, in order to avail themselves of this outlet when they could not get to sea by the old entrance.

THE NEW DUNDEE HARBOUR WORKS.

The Harbour Trustees met on the 20th ult., and selected the tender of Messrs. Carstairs, Mitchell, and Company, contractors in Kirkcaldy and Montrose, who offered to execute the works for 36,133*l*.; the materials to be of the best quality and the whole of the works to be finished in the most perfect manner. The works are to commence within one month after the date of the contract, and all the masonry of the entrance lock is to be completed, and the lock ready for the fixing in of the gates, by the 1st November 1860, and the whole of the works to be completed by the 1st May 1861.

The work estimated for includes the carrying of the main common sewer (which discharges itself into the present tidal harbour) out to the river at the south-east point of the river wall; the underfooting the quay walls of the present tidal harbour; the whole of the new quay walls; the whole of the scouring tunnels; the massive masonry of the sixty feet wide new entrance lock; and the filling up between the new walls, forming quays, with the earth taken from the bottom of the new dock. It includes all that is required for converting the present east tidal harbour into a wet dock, as authorised by the new Harbour Act, and sanctioned by the Admiralty, excepting the iron gates, which will be a separate contract. It is to be hoped that the Trustees will be able to go on with the completion of the north wall of Victoria Dock, with its lock, during the progress of the works now contracted for, which would give an immense addition to the dock accommodation of the port.

Mr. Carstairs, of Kirkcaldy, is well known as the builder of the splendid railway station and viaduct at Newcastle, and Mr. Mitchell, of Montrose, enjoys equal celebrity as a railway contractor.

ON THE MANUFACTURE OF STEEL.*

By Dr. Percy.

The lecturer observed that there are two principles concerned in the production of steel. Wrought-iron bars were embedded in charcoal, and a heat applied to them nearly equal to that required for reducing copper. Openings were made in the furnace, from whence trial bars could be taken. The ordinary fuel used was coal. The iron which was mostly converted into steel was that from Sweden and Russia. In the 'Journal of the Society of Arts,' 1855, there was an elaborate paper, furnished by Mr. Sanderson, who had long been connected with the manufacture of steel, and which afforded much valuable information on the subject. There was a great mystery observed in England about the manufacture of steel. It was stated the qualities of iron necessary to make good steel depended upon the properties contained in the ores. After cementation, the steel was generally covered with blisters, or bosses; these, however, should not be too large, but uniformly distributed over the bar. Charcoal lumps and dust are used. The charcoal is never employed twice, unless with an admixture of new fuel: if they had entirely fresh charcoal, according to the opinion of the workmen, it was not so desirable; and although, perhaps, they might not be able to enter into the *rationale* of the subject, any suggestions coming from them should be received with attention. The bar of iron was stratified with charcoal; it was put in malleable, and came out extremely brittle. The transverse fracture of crude cement steel exhibits numerous fissures, sometimes of considerable size. The structure was lamellar, the surface granular, and reflected light badly. He next alluded to cast-steel. The furnaces in which this was made were of a simple nature. Stourbridge clay was used in them; this was well known, and of great repute. Derby clay, and that from Standon, had been lately employed: this was mixed with a portion of the old brown pots and some cinder. The steel was then broken up into small peices, fused, and then cast into moulds. The method of making cast-steel from the iron had been long known to the Hindoos, and Dr. Buchanan had written a very good account of it. The properties of Wootz were as follows: Carbon combined, 1·333; carbon uncombined, 0·312; silica, 0·045; sulphur, 0·181; arsenic, 0·037; iron, 98·092. The advantage of cast-steel was that it was uniform throughout. In many cases you might get the bar partly of iron and partly of steel. If 2 oz. of manganese were mixed with 28 lb. of low quality bar-steel it would greatly improve it, and give a toughness to it. One of the most important patents on the subject of steel was that of Mr. Heath, which was first patented April 5, 1839. This had been the subject of much litigation, and on it a most elaborate article had been written by Mr. Webster, the eminent patent barrister. In this case the patentee, owing to the defective state of the law, had not reaped the advantages of his invention. Mr. Heath had discovered that 1 per cent. of carburet of manganese mixed with cast steel greatly improved it, and made it weldable. The infringers of his patent used oxide of manganese, with carbonaceous matter.

Dr. Percy next alluded to the German method of making steel; this was very simple, pig-iron was placed on the hearth, and partially decomposed by a blast. The workmen contrived to remove so much of the carbon as to render it steel. Great care and attention was required in this operation. Oxide of manganese, common salt, and clay were used to improve steel in some works. As he was, however, not practically acquainted with this method, he should only allude to it. The colour of steel was various; at about 430° Fah. it was of a pale straw colour, and was then fit for razors and surgical instruments; 470° it was useful for penknives; 490° the colour was brown, and the metal was used for cutting-shears, &c.; 510° it was brown, dappled with purple spots; 530° purple; 550° bright blue, fit for swords; 560° blue, fine saws; 600° dark blue, hand pit saws. A description of the method of making tin plates, together with the qualities of iron necessary to be employed, as well as the alloys used, were then given. He would next refer to some of the metals which were not so generally known. In a previous lecture he had spoken of tungsten, and he regretted to say that as yet no practical application had been made of it. He had mentioned Mr. Oxland's process, and had referred them to Aikin's 'Dictionary of Chemistry,' where an identical process had been described, forty years since. They had endeavoured to alloy copper with it, but had failed; in fact, they could not even adulterate any metal with it. With regard to uranium, there appeared to be no application of it in a metallic state; it was obtained from pitch blende, the greatest deposits of which were at Johan Georgenstadt, on the frontiers of Bohemia and Saxony; they were not becoming scarce; it was highly prized for giving the canary colour to glass. A good account of platinum would be found in Gmelin's 'Handbook of Chemistry,' and a series of useful observations had been made on it by Dr. Woolaston; two parts of silver and one of palladium were found to make a good alloy for balancing weights. Those rare metals, osmium and iridium, were used for making the tips of gold pens; they did not spoil the paper, and were almost indestructible. The upper part of the pens was made of an alloy of zinc and gold, commonly called zinc gold. The grains of osmium and iridium required to be of a peculiar size; the large grains were sold at 8*l.* per ounce, while the smaller could be purchased at 15*s.* per ounce.

He would next speak of aluminium; this was four times lighter than silver, and was now selling in Paris at the rate of 12*l.* per kilogramme; this had been obtained from cryolite, heated with salt and sodium. Some alloys of copper and aluminium were then shown, which had the appearance of gold; the analysis of two were—No. 1, 95 parts copper, and 5 parts aluminium; No. 2, 90 parts copper and 5 parts zinc, and 5 parts aluminium; wherever it was mixed with gold and silver it appeared to spoil it. Some specimens of aluminium were shown, as well as the various alloys. Dr. Percy alluded to the labours of Mr. Deville, and stated that he believed in a few years a more extended application would be given to the use of this metal. They had heard of silicon; the properties of this were as yet but imperfectly known. A short time since some projectors wished to form a company for the purpose of making this, and had shown to an eminent manufacturer in Birmingham specimens of some substance, which did not contain one ounce of it.

* Abstract of a Lecture delivered at the Government School of Mines.

BRACING SHIPS EXTERNALLY WITH IRON.

There is now upon the stocks at the Navy Yard, Brooklyn, the frame of a war frigate, intended by her builder, Mr. Steers, to be the strongest and the fleetest of her size and class afloat. The *New York Herald* says: "This is to be called the *Niagara*, and will be launched sometime during the present year: she is sharp at the bows, something like the fast-sailing yachts which generally take the prizes at the match races, and Mr. Steers expects that she will sail seventeen miles an hour, under an ordinary press of canvas. Her extreme length is 345 feet, breadth 56 feet, and 31 feet depth of hold from the floor to the under side of spar deck. She is intended to carry twelve 11-inch swivel guns. In the strength of this vessel, little, if any, improvement can be made: her frame is of the best live oak, every piece being carefully selected before allowed to go into her hull. She is diagonally braced on the outside of her timbers, instead of the inside, with iron, which Mr. Steers says will add 50 per cent. to her strength. This way of bracing is entirely new, and the idea original with the builder. The custom has always been to place the iron bracing on the inside; but Mr. Steers says, that inasmuch as a barrel iron-hooped inside is not so strong as one hooped upon the outside, it occurred to him that a vessel upon the principle acting in the case of a barrel must be much stronger braced upon the outside of her timbers. This is the first opportunity he has had of testing the truth of his belief as to the mode of iron bracing, and feels confident that the *Niagara* will sustain him in her extraordinary strength. These iron braces are 5 inches wide, and seven-eighths of an inch thick, running diagonally at an angle of 45° each way, from the port sill over the hull down to within 5 feet of the keel, with all the crossings bolted through and through with lrrge iron bolts. All the clamps, ceilings, and bilge-streaks are coned and bolted edgewise between every timber of the frame. The vessel was recently examined by Mr. E. K. Collins, who pronounced the frame to be, in quality of timber and workmanship, superior to anything which he had ever witnessed in the way of shipbuilding in America or in Europe."

VELOCITY OF WATER IN PIPES AND CANALS.

TABLE *for finding Mean Velocities per Second, in feet and decimals of feet, suited for Canals, Pipes, or Culverts, for any Depth and Slope per Mile.*

By R. UNIACKE COXEN, Assistant Superintendent of Repairs, Bombay; late Assistant Executive Engineer, Baree Doab Canal, Punjaub.

⁂ To find the velocity of any canal, pipe, &c., multiply the hydraulic mean depth (in a pipe it is one-fourth the diameter) by the fall per mile, then look for the feet in the top horizontal column, and for the hundredths in the left side vertical column, and at the intersection of the two will be found the mean velocity in feet and decimals of feet per second.

Hundredths of feet.	0 foot.	1 foot.	2 feet.	3 feet.	4 feet.	5 feet.	6 feet.	7 feet.	8 feet.	9 feet.	10 feet.
·00	—	1·29	1·83	2·24	2·59	2·89	3·17	3·42	3·66	3·88	4·09
1	—	1·30	1·83	2·24	2·59	2·90	3·17	3·43	3·66	3·89	4·10
2	—	1·30	1·84	2·25	2·59	2·90	3·17	3·43	3·67	3·89	4·10
3	—	1·31	1·84	2·25	2·60	2·90	3·18	3·43	3·67	3·89	4·10
4	—	1·32	1·84	2·25	2·60	2·90	3·18	3·43	3·67	3·89	4·10
5	—	1·32	1·85	2·26	2·60	2·91	3·18	3·44	3·67	3·89	4·10
6	—	1·33	1·85	2·26	2·61	2·91	3·19	3·44	3·67	3·90	4·11
7	—	1·34	1·86	2·27	2·61	2·91	3·19	3·44	3·68	3·90	4·11
8	—	1·34	1·86	2·27	2·61	2·92	3·19	3·44	3·68	3·90	4·11
9	—	1·35	1·87	2·27	2·62	2·92	3·19	3·45	3·68	3·90	4·11
·10	—	1·35	1·87	2·28	2·62	2·92	3·19	3·45	3·68	3·90	4·11
1	—	1·36	1·88	2·28	2·62	2·92	3·20	3·45	3·69	3·91	4·12
2	—	1·37	1·88	2·28	2·63	2·93	3·20	3·45	3·69	3·91	4·12
3	—	1·37	1·89	2·29	2·63	2·93	3·20	3·46	3·69	3·91	4·12
4	—	1·38	1·89	2·29	2·63	2·93	3·20	3·46	3·69	3·91	4·12
5	—	1·38	1·90	2·29	2·64	2·94	3·21	3·46	3·69	3·91	4·12
6	—	1·39	1·90	2·30	2·64	2·94	3·21	3·46	3·70	3·92	4·13
7	—	1·40	1·90	2·30	2·64	2·94	3·21	3·47	3·70	3·92	4·13
8	—	1·40	1·91	2·30	2·64	2·94	3·21	3·47	3·70	3·92	4·13
9	—	1·41	1·91	2·31	2·65	2·95	3·22	3·47	3·70	3·92	4·13
·20	—	1·42	1·92	2·31	2·65	2·95	3·22	3·47	3·71	3·93	4·13
1	—	1·42	1·92	2·32	2·65	2·95	3·22	3·48	3·71	3·93	4·14
2	—	1·43	1·93	2·32	2·66	2·96	3·22	3·48	3·71	3·93	4·14
3	—	1·43	1·93	2·32	2·66	2·96	3·23	3·48	3·71	3·93	4·14
4	—	1·44	1·93	2·33	2·66	2·96	3·23	3·48	3·71	3·93	4·14
5	—	1·44	1·94	2·33	2·67	2·96	3·23	3·49	3·72	3·94	4·14
6	—	1·45	1·94	2·33	2·67	2·97	3·23	3·49	3·72	3·94	4·15
7	—	1·46	1·95	2·34	2·67	2·97	3·24	3·49	3·72	3·94	4·15
8	—	1·46	1·95	2·34	2·68	2·97	3·24	3·49	3·72	3·94	4·15
9	—	1·47	1·96	2·34	2·68	2·98	3·24	3·49	3·73	3·94	4·15
·30	—	1·47	1·96	2·35	2·68	2·98	3·24	3·50	3·73	3·95	4·16
1	—	1·48	1·96	2·35	2·69	2·98	3·25	3·50	3·73	3·95	4·16
2	—	1·48	1·97	2·36	2·69	2·98	3·25	3·50	3·73	3·95	4·16
3	—	1·49	1·97	2·36	2·69	2·99	3·25	3·50	3·73	3·95	4·16
4	—	1·50	1·97	2·36	2·70	2·99	3·25	3·51	3·74	3·96	4·16
5	—	1·50	1·98	2·37	2·70	2·99	3·26	3·51	3·74	3·96	4·17
6	—	1·51	1·98	2·37	2·70	3·00	3·26	3·51	3·74	3·96	4·17
7	—	1·51	1·98	2·37	2·70	3·00	3·26	3·51	3·74	3·96	4·17
8	—	1·52	1·99	2·38	2·71	3·00	3·26	3·52	3·75	3·96	4·17
9	—	1·52	1·99	2·38	2·71	3·00	3·27	3·52	3·75	3·97	4·17
·40	—	1·53	2·00	2·39	2·71	3·01	3·27	3·52	3·75	3·97	4·18
1	—	1·53	2·01	2·39	2·72	3·01	3·27	3·52	3·75	3·97	4·18
2	—	1·54	2·01	2·39	2·72	3·01	3·27	3·53	3·76	3·97	4·18
3	—	1·54	2·02	2·40	2·72	3·02	3·28	3·53	3·76	3·97	4·18
4	—	1·55	2·02	2·40	2·73	3·02	3·28	3·53	3·76	3·98	4·18
5	—	1·55	2·02	2·40	2·73	3·02	3·28	3·53	3·76	3·98	4·19
6	—	1·56	2·03	2·41	2·73	3·02	3·28	3·54	3·77	3·98	4·19
7	—	1·56	2·03	2·41	2·74	3·03	3·29	3·54	3·77	3·98	4·19
8	—	1·57	2·04	2·41	2·74	3·03	3·29	3·54	3·77	3·99	4·19
9	—	1·57	2·04	2·42	2·74	3·03	3·29	3·54	3·77	3·99	4·19
·50	0·91	1·58	2·04	2·42	2·74	3·04	3·29	3·55	3·77	3·99	4·20
1	0·92	1·59	2·05	2·42	2·75	3·04	3·30	3·55	3·78	3·99	4·20
2	0·93	1·59	2·05	2·43	2·75	3·04	3·30	3·55	3·78	3·99	4·20
3	0·94	1·60	2·06	2·43	2·75	3·04	3·30	3·55	3·78	4·00	4·20
4	0·95	1·60	2·06	2·43	2·76	3·05	3·30	3·55	3·78	4·00	4·20
5	0·96	1·61	2·06	2·44	2·76	3·05	3·31	3·56	3·78	4·00	4·20
6	0·97	1·61	2·07	2·44	2·76	3·05	3·31	3·56	3·79	4·00	4·21
7	0·97	1·62	2·07	2·44	2·77	3·05	3·31	3·56	3·79	4·00	4·21
8	0·98	1·62	2·08	2·45	2·77	3·06	3·31	3·56	3·79	4·01	4·21
9	0·99	1·63	2·08	2·45	2·77	3·06	3·32	3·57	3·79	4·01	4·21
·60	1·00	1·63	2·09	2·45	2·78	3·06	3·32	3·57	3·80	4·01	4·21
1	1·01	1·64	2·09	2·46	2·78	3·07	3·32	3·57	3·80	4·01	4·22
2	1·02	1·64	2·09	2·46	2·78	3·07	3·33	3·57	3·80	4·01	4·22
3	1·02	1·65	2·10	2·46	2·78	3·07	3·33	3·57	3·80	4·02	4·22
4	1·03	1·65	2·10	2·47	2·79	3·07	3·33	3·58	3·80	4·02	4·22
5	1·04	1·66	2·11	2·47	2·79	3·08	3·33	3·58	3·81	4·02	4·22
6	1·05	1·67	2·11	2·47	2·79	3·08	3·34	3·58	3·81	4·02	4·23
7	1·06	1·67	2·11	2·48	2·79	3·08	3·34	3·58	3·81	4·02	4·23
8	1·06	1·68	2·12	2·48	2·80	3·08	3·34	3·59	3·81	4·03	4·23
9	1·07	1·68	2·12	2·48	2·80	3·09	3·34	3·59	3·82	4·03	4·23

Hundredths of feet.	0 foot.	1 foot.	2 feet.	3 feet.	4 feet.	5 feet.	6 feet.	7 feet.	8 feet.	9 feet.	10 feet.
·70	1·08	1·69	2·13	2·49	2·80	3·09	3·35	3·59	3·82	4·03	4·23
1	1·09	1·69	2·13	2·49	2·81	3·09	3·35	3·59	3·82	4·03	4·24
2	1·10	1·69	2·13	2·49	2·81	3·09	3·35	3·60	3·82	4·04	4·24
3	1·10	1·70	2·14	2·50	2·81	3·10	3·35	3·60	3·82	4·04	4·24
4	1·11	1·70	2·14	2·50	2·82	3·10	3·36	3·60	3·83	4·04	4·24
5	1·12	1·71	2·14	2·50	2·82	3·10	3·36	3·60	3·83	4·04	4·24
6	1·12	1·71	2·15	2·51	2·82	3·10	3·36	3·61	3·83	4·04	4·25
7	1·13	1·72	2·15	2·51	2·83	3·11	3·36	3·61	3·83	4·05	4·25
8	1·14	1·72	2·15	2·51	2·83	3·11	3·37	3·61	3·83	4·05	4·25
9	1·14	1·73	2·16	2·52	2·83	3·11	3·37	3·61	3·84	4·05	4·25
·80	1·15	1·73	2·16	2·52	2·83	3·12	3·37	3·61	3·84	4·05	4·25
1	1·16	1·74	2·17	2·52	2·84	3·12	3·38	3·62	3·84	4·05	4·26
2	1·17	1·74	2·17	2·53	2·84	3·12	3·38	3·62	3·84	4·06	4·26
3	1·17	1·75	2·17	2·53	2·84	3·12	3·38	3·62	3·85	4·06	4·26
4	1·18	1·75	2·18	2·53	2·85	3·13	3·38	3·62	3·85	4·06	4·26
5	1·19	1·76	2·18	2·54	2·85	3·13	3·39	3·63	3·85	4·06	4·26
6	1·19	1·76	2·18	2·54	2·85	3·13	3·39	3·63	3·85	4·06	4·27
7	1·20	1·77	2·19	2·54	2·86	3·14	3·39	3·63	3·85	4·07	4·27
8	1·21	1·77	2·19	2·55	2·86	3·14	3·39	3·63	3·86	4·07	4·27
9	1·22	1·78	2·20	2·55	2·86	3·14	3·40	3·63	3·86	4·07	4·27
·90	1·22	1·78	2·20	2·55	2·86	3·14	3·40	3·64	3·86	4·07	4·27
1	1·23	1·79	2·21	2·56	2·87	3·15	3·40	3·64	3·86	4·08	4·28
2	1·24	1·79	2·21	2·56	2·87	3·15	3·40	3·64	3·87	4·08	4·28
3	1·24	1·79	2·21	2·56	2·87	3·15	3·41	3·64	3·87	4·08	4·28
4	1·25	1·80	2·22	2·57	2·88	3·15	3·41	3·64	3·87	4·08	4·28
5	1·26	1·80	2·22	2·57	2·88	3·16	3·41	3·65	3·87	4·08	4·28
6	1·26	1·81	2·22	2·57	2·88	3·16	3·41	3·65	3·87	4·09	4·29
7	1·27	1·81	2·23	2·58	2·88	3·16	3·42	3·65	3·88	4·09	4·29
8	1·28	1·82	2·23	2·58	2·89	3·17	3·42	3·66	3·88	4·09	4·29
9	1·28	1·82	2·23	2·58	2·89	3·17	3·42	3·66	3·88	4·09	4·29

The above Table has been calculated from the formula used in Dwyer's 'Hydraulic Engineering,' and is as follows:—

When side slope is 1 to 1,

$$V = \cdot 9166\sqrt{2f\frac{(B+h)\,h}{h\sqrt{8}+B}}$$

Where B = bottom breadth, h = the depth, f the fall per mile, V = the mean velocity, and a = area; all dimensions being in feet and decimals of feet.

The sectional area of any river or canal, is the number of square feet in that vertical section which is at right angles to the course of the stream.

The border of a river, &c., is the sum of the two sides and bottom, or the perimeter in actual contact with the water.

The hydraulic mean depth of a river, &c., is the area of the section, divided by the border.

Ex. 1—Required the mean velocity and discharge of a canal per second, the area of the section being 125 square feet, border 34·14 feet, hydraulic mean depth 3·66 feet, with a slope of 2·2 feet per mile,

$3·66 \times 2·2 = 8·052$. Under 8 feet, and in a line with ·05 will be found the velocity = 3·67 feet per second, which multiplied into the area of section = the discharge = $3·67 \times 125 = 458·75$ cubic feet per second.

Ex. 2.—Retaining the same dimensions, but altering the slope to 5 feet per mile, required the mean velocity and discharge per second.

$$3·66 \times 5 = 18·3. \qquad V = 1·75.$$
$$1·75 \times 125 = 218·75 \text{ cubic feet per second.}$$

Ex. 3.—Required the mean velocity and discharge per second of the pipe at the Poydownee Reservoir, the diameter being ·5 feet, and slope per mile 12·1 feet.

$$\frac{·5}{4} \times 12·1 = ·125 \times 12·1 = 1·51$$
$$V = 1·59; \quad a = ·7854 \times ·5^2 = ·7854 \times ·25 = ·1963$$
$$·1963 \times 1·59 = ·312 \text{ cubic feet per second.}$$

As the velocities in the Table only range as far as 4·29 feet, therefore when greater are required, proceed as follows:—Divide the product of the hydraulic mean depth into the fall per mile, by any square number, then look in the Table as above described for the velocity, which velocity, multiplied by the square root of the square divisor, will be the required velocity per second.

Ex. 4.—Taking the same dimensions as in *Ex.* 2, but altering the slope to 5 feet per mile, what is the velocity?

$$3·66 \times 5 = 18·3$$
$$\frac{18·3}{16} = 1·143 \text{ velocity, corresponding to } 1·38$$
$$1·38 \times \sqrt{16} = 1·38 \times 4 = 5·52 \text{ feet per second.}$$

Ex. 5.—Required the mean velocity per second through the pipe at Chinch Bunder, whose diameter is 1·5 feet, and fall per mile 88 feet.

$$\frac{1·5}{4} \times 88 = ·375 \times 88 = 33; \qquad \frac{33}{16} = 2·06;$$
$$V = 1·85 \times \sqrt{16} = 1·85 \times 4 = 7·40 \text{ feet per second.}$$

BOMBAY, BARODA, AND CENTRAL INDIA RAILWAY.

Abstract of the Report of **Lieut.-Col. J. P. Kennedy,** ***June*** **1856.**

The first examination of the country was necessarily of a most extensive nature. It would have been unpardonable to recommend a commencement, however small, until it had been clearly ascertained that such commencement would suit for every advisable extension. Hence the necessity of examining, by our engineers, a total distance of about 4000 miles. That survey has well sustained the grounds upon which attention was invited to this particular project. It has shown that the leading features in the territories through which the line ranges are precisely what constitute the first essentials to ultimate success in all railway operations: first, the level character of the country, so indispensable to the economical working of a line; second, its large population, numerous towns, and rich cotton produce; third, its starting-point being the great mercantile capital of India on the coast nearest to Europe; fourth, that from the starting-point at Bombay to its furthest limits, every portion of its course would be through territory of which the local capabilities are calculated to furnish an adequate proportion to the support of the line, whilst its general direction combines the most numerous and the broadest requirements, commercial, political, or military, of a trunk-line of intercourse from which branches could most conveniently diverge.

As to the right mercantile direction of our line, there could be no doubt from the first; but there were two essential points to be investigated by our survey: first, the practicability of bridging the principal rivers between Bombay and Baroach, which our borings and observations on the floods have most satisfactorily established; second, the mode of passing the Vindiah range, to reach the table-land of Malwah and the states of Central India. For this object the direction of the range, lying parallel to the course of our proper line, is the most favourable that could be desired, and we are thus enabled to obtain a gradual rise on a long line, from either Baroach or Baroda, to our summit at Tyrilla Ghat, without purposely lengthening it. A range of heights running perpendicular to the direction of one's line of progress being the worst possible disposition of ground, so that which is adjacent and parallel to the direction, as in our case, is the best, when the range must necessarily be traversed.

On the 10th of August, 1853, we were authorised by the honourable court to execute our survey. On the 20th September, 1853, our first surveying party left England for Bombay; about the 1st of November our surveyors commenced their field operations there. On the 9th of January 1854, I followed the surveying party to India, with full delegated powers to act for the company. On the 28th of April, 1854, only six months after our first engineers had landed in India, the report and trial sections were laid before the government of Bombay and the governor-general.

From that date, our staff engineers in India remained inoperative awaiting the decision of the authorities, until January, 1855, when the directors, having learned that the decision of the governor of Bombay was favourable to the execution of our project between Bombay and Ahmedabad, orders were sent to India to prepare rapidly, during what remained of the cold season, the working plans and sections of as much of the line, commencing at Bombay, as would ensure the profitable employment of our engineers in the ensuing hot season, in the inspection of working parties constructing earthworks—a class of summer-work eligible for Europeans, during the morning and evening hours; although to remain out during the day, as required by surveying operations, would be ineligible and dangerous to health.

On the 16th of April, 1855, we received the official communication from the honourable court, adopting our company for the execution of the line between Bombay and Ahmedabad, but requiring us to commence at Surat, 180 miles distant from Bombay, and thereby rendering futile the providence of our arrangements to secure profitable work for our engineers during the ensuing summer. On the 5th day of June, 1855, our engineers proceeded from Bombay to Surat, but necessarily arrived too late to make preparation of working plans and sections for the summer's construction of earthworks there.

The result of all this has been, that out of thirty months that our establishment of engineers has been located and paid in India, they have been but fourteen months profitably employed, and sixteen months doing nothing,—a waste of time and money which our directors sought by every possible means to avert.

At the termination of our first six months' surveying operations, on the 28th of April, 1854, although we had sufficient data collected, by the survey of about three thousand miles, to justify a confident report as to the advantageous nature of our project, and to justify the government in authorising the execution of a certain portion of it, there still remained to be made the further examination of alternative lines of considerable extent, which the commencement of the hot season necessarily suspended. Accordingly, before I left India, in the execution of the authority vested in me by our directors, certain of our engineers were detached, during the summer, to distant positions of the country favourable for their resuming those surveys at the commencement of the ensuing cold season. Mr. Carey was placed at Delhi, and Mr. Galway at Mount Aboo, preparatory to the examination of the Western line of 350 miles, skirting the Aravalla range of mountains between Deessa and Delhi. Those two gentlemen executed that arduous duty with much zeal and ability, in the cold season of 1854.

Mr. McMahon's attention was directed to districts of the Vindiah range and its table-land, which had been the principal site of his previous labours. He was directed to attend to the suggestions of Sir Robert Hamilton, the resident of Indore and agent of the governor-general in the large and important districts of Central India. Sir Robert's assistance, local knowledge, and sound judgment, in directing the energies of Mr. McMahon in 1854 and 1855, could only be equalled by his previous assistance to myself, in the winter of 1853-4; and fortunately it was not wasted upon Mr. McMahon, whose indefatigable labours during every season, summer as well as winter, enabled him to furnish an incredible amount of valuable data for this company's guidance. It is much to be regretted that the company have since sustained a serious loss, by Mr. McMahon's resignation of their service to occupy himself with a more remunerative employment elsewhere.

Mr. Jacob, and subsequently Mr. Hardy, assisted Mr. McMahon in the latter part of his labours, of which the principal joint result was a survey from Baroda, by the Tyrilla Ghat, Indore, Bhilsa, and Jhansi, to Agra, which has been brought by Sir R. Hamilton under the consideration of the governor-general of India for approval, as an extension line from Baroda, to connect our communication with the East India line, going to the north-west from Calcutta. The important data thus brought forward had a narrow escape of being sacrificed, by a misunderstanding which had nearly produced the recall of the officers before completing their work. The representation of Sir R. Hamilton to the governor-general alone averted this, which would have been a serious disaster, considering the long distances, and difficulty of surmounting them in India, and the great deficiency of close comparative data essential to a right selection of railway projects as regards the interests of different districts, and as regards the various modes by which a given result may be best accomplished.

The recall of the officers, without having completed their investigations, would have made little difference as regards the absolute cost, compared with the expense of completing the important inquiries they had been employed upon. We have to thank Sir R. Hamilton that the hard labours and exposure of those officers and their surveying parties, and the expenditure incurred by the company in seeking to gain indispensable information, referring to several hundred miles of Central India, have been crowned with complete success, which would have been absolutely defeated by a recall of the officers before bringing their labours to a conclusion.

In considering the subject of construction the first item, fences, should entail a very limited cost if judiciously executed. The flat nature of the country requires that the rails shall generally be laid upon a slight embankment, to keep the level well above the effects of inundation. These embankments will be made from side-cuttings, which by proper attention, contribute the chief requirements of a fence or ditch, with stops to prevent their becoming rivulets, on each side of our line. In addition to their use as fences, they will furnish excellent reservoirs for water, free from those elements most injurious to the locomotive boiler, and will be of much benefit in the supply of our stations, as well as of the population in the districts through which we pass. A large portion of the water used in India is derived from tanks artificially made; and there is no reason why the excavations, from which our embankments are formed, should not be made with reference to that great public object. The completion of the side ditches into railway fences will be effected by planting the prickly pear, &c., on the inner crest of the ditch or tanks, at the foot of the embankment slope: the most formidable fences in the world are formed in India by these natural and inexpensive means.

The execution of earthworks in India has generally cost a much higher rate, as compared with our home works of a like kind, than the comparative rates of day-labour in the two countries would justify. The most usual wages of a day-labourer in India may be taken at 3*d.*; that of a labourer in England, 2*s.*—although navvies would receive more. This ratio of 3*d.* to 24*d.*, or one to eight, will suffice for reasoning, without urging the difference of wages to its utmost verge. If the appliances and capabilities of the Hindoo labourer were equal to those of the Englishman, the number of cubic yards excavated and deposited in an embankment by each, under precisely similar circumstances, should be equal.

Without admitting the great inferiority of Indian labourers, *when properly organised*, it may satisfy those who hold a contrary opinion to assume that the day's work of an English labourer is equivalent to that of two Hindoos, their appliances or mechanical facilities being equal. On this assumption, earthworks in India ought to be executed at one-fourth of the cost of precisely similar works in England; we find however that in practice, instead of costing only one-fourth of English rates, they are generally quite equivalent too, if not above, the English rates. The cause for this important difference, so prejudicial to Indian operations, can be easily accounted for. It is traceable to the difference of mechanical appliances respectively employed in the two countries, to facilitate the labourer's exertions. In England, every labourer is practised in the use of the wheelbarrow, the substitute for which in India is a very small basket, carried on the head. It would require very many such baskets of earth to fill a wheelbarrow, which latter it is difficult to train the Hindoo labourer to use, as it requires much practice, and their habits as labourers induce them to remain but a short time in the same employment. When they have earned a small sum of money, they generally go away till it is expended.

In England, we may calculate the average work per man per day, in earthworks, at from six to twelve, or even fifteen cubic yards, including the excavation, filling the barrows, and wheeling from sixty to one hundred feet,—the greater or less quantities depending on the quality or stiffness of the soil. We shall calculate on the minimum quantity of six cubic yards, reduced as above proposed, to three for the Hindoo; and this, at the rate of 1½d. per cubic yard, would enable the labourer to earn 4½d. per day, or fifty per cent. above his ordinary wages.

The large railway contracts for earthworks may vary from four to eight times that rate per cubic yard. In order to secure the most economical results in this branch of the work, we have sent to India a supply of small portable rails, 12 lb. to the yard, and iron for band-trucks, to contain about a ton of earth each. These trucks, when filled, will be moved by three men each to the point for depositing the earth. The men will require no training for their use, and they will do the work more economically than wheelbarrows. The first supply of materials for this purpose has been despatched from Liverpool to Bombay.

The Surat bazaar price for earthwork is 4½d. per cubic yard. The course we propose will give the labourers better wages, at a cost to the company of only 1½d. per cubic yard. Our earthworks over 335 miles should thus cost only 65,000*l*., instead of 195,000*l*. at the bazaar rate, or probably 325,000*l*. at large contractors' rates, producing a saving on this single item of 130,000*l*. as compared with the bazaar rate, and of probably 260,000*l*. as compared with the tender that a large contractor would make, judging from the large contract rates of other railways. Our principle however would not be opposed to contracts; it would merely limit their extent within the means of small native capitalists. It is most gratifying to find conclusive evidence of the success of this principle in the 'Selections from the Records of the Madras Government, No. 18, Railway Department, 1854.' It appears from the reports there given, first, that the Madras Railway have executed earthworks at rates considerably under 1½d. per cubic yard; second, that although executing their works with this enormous saving to their company, and without the intervention of large contractors, their rate of progress in opening their line for traffic is more rapid than that of any other company in India where the large contract system has been adopted; and thirdly, that whilst so executing their works their strength in engineers was very much below what it ought to have been, according to the clear showing of their chief engineer in India.

The construction of earthworks commenced near Surat in May. This would admit of but one month's work previous to the monsoon. We have therefore a right only to debit our chief engineer in India with commencing as in September next. It is unfortunate that we were not permitted to break ground at Surat last November, without waiting for the completion of working-plans and sections to Baroach.

When the East Indian Railway Company were similarly circumstanced at Calcutta, the district being flat like Guzerat, I did not hesitate, as consulting engineer to the supreme government, to receive two miles at a time of the working-plans and sections, and to recommend that the works should be permitted to commence as rapidly as arrangements could be made for obtaining possession of the land on those small portions of the line, having first well ascertained that the working-plans and sections of those small portions were in accordance with the general requirements of the line and with the previous preliminary investigations. A similar facility afforded to us would have enabled us to apply the whole of the last working season to construction of earthworks, which by this time might probably have been completed from Surat to Baroda, and our embankments over that distance would now be ready to benefit by the seasoning of the approaching monsoon. The points for crossing the Taptee and Nerbudda were necessarily fixed as a first preliminary, and there was no gaut or mountain-range in the way, offering a variety of alternatives, to make an engineer pause in affording every facility to rapid progress. Mr. Forde's energy may possibly still get the fourteen miles of earthworks from Surat to the Keem river completed before the monsoon. This is all we can hope; and it will be important, by enabling him to lay down the permanent way over that distance, to use the ballasting engines, and to carry up the materials for constructing our first bridge across the Keem during the next winter.

In treating the subject of viaducts and bridges, the practicability can be explained of executing the works over 335 miles of line in the short period suggested of two years, as compared with the slower rate of past English construction. This is owing to the recent improvements in iron structures, which it is proposed to employ largely in our operations.

The tedious processes of driving extensive tunnels and of erecting piers of masonry for bridges and viaducts have heretofore necessarily regulated the time of constructing a line of railway. We shall have no necessity for tunnels; and iron-pile supports with the advantages afforded by Mitchell's patent, and other modern improvements in iron piers and superstructures for viaducts, have given vast facilities, both in respect to time and cost, in the execution of bridges and other structures.

Numerous works have of late years been rapidly and economically completed by the aid of iron for lighthouses, harbour piers, railway viaducts, bridges, &c., in situations where masonry would either have been inapplicable or attended with a ruinous expenditure; and its adaptation to the bridging of our Indian rivers and inundated lands will remove the *only difficulty* which in our project, without its aid, could have opposed our rapid progress. A specimen of this class of work has already been erected at Kaira, in India, over one of the rivers which we shall have to deal with between Baroda and Ahmedabad.

It is repeated that the only subject of the slightest difficulty on our line is that of bridges,—a difficulty which must be encountered in every part of India; and even including them, the average cost, as appears from the estimate, will be under 6000*l*. per mile. District No. 2 of the work, taken separately, presenting the smallest amount for bridges, although there there will be one of considerable magnitude, gives but an average cost of 4639*l*. per mile.

Our most formidable rivers, the Taptee, Nerbudda, and Mhye, present themselves in the districts between Surat and Ahmedabad, which we have been directed to execute in the first instance.

The Bassein Creek, between Bombay and Surat, although requiring a longer viaduct than either the Taptee or Nerbudda rivers, would, from the less velocity of the floods, be more easily dealt with than either of the other rivers named. The width of the creek where we cross at Bassein is many times the united widths of its tributaries, and its course is level, whilst theirs have a considerable fall; hence the velocity of its current in floods is proportionally diminished compared with theirs.

The first bridge we shall have to construct will be that across the Keem river, about 12 miles north from the Taptee river. The design for this bridge has five spans of 60 feet each. It will illustrate the general principle which it is proposed to adopt throughout. The superstructure is that of Warren's patent, the piers iron piles. This bridge, it is hoped, will be erected during the next winter. Every bridge-girder will be bolted together in England, and accurately tested by the company's engineer with sufficient weights before being taken off the hands of the manufacturer.

The second bridge will be that across the Nerbudda, upon the same principle; it will have similar openings to those of the Keem. It is hoped that it will also be completed next winter.

The third large bridge will be that across the Mhye river, constructed on the same principles and with similar openings to those of Keem and Nerbudda. Its construction may be completed during the winter after next.

The erection of our bridges must depend upon our power of carrying up the materials, either by water or on our own railway, to their respective sites. This latter power again will depend upon the construction of the embankments and the seasoning of the same by the monsoon rains previously to the final laying down of the permanent way.

We may hope to have constructed our earthworks as far as the Keem river before the rains set in, which will enable us to carry up the iron materials from Surat for the Keem bridge during the next winter; and we may likewise calculate on completing the whole of our earthworks between Surat and Ahmedabad before the monsoon sets in next year, June 1857. In that case, after the monsoon has seasoned our works, we shall be able to proceed with the ballasting and laying of permanent way, and with the progressive construction of viaducts, &c., without further impediment, and as rapidly as the supply of materials and other means will admit.

Had we got permission to go on with the construction of embankments at the commencement of the last cold season, there would have been no doubt that by the 1st of May, 1858, the entire distance from Surat to Ahmedabad, 153 miles, would be completed; but as the whole question in this class of construction must be regulated with reference to the alternating rainy and working seasons, we may now possibly be delayed in opening our first section for traffic until May 1859. It would however be equally within our power to open at the same date the entire distance of 335 miles into Bombay, if the government would only sanction our doing so.

As the first security for high dividends and low fares consists in obtaining the best possible level and the lowest ruling gradient for the road, and the second the best class of engine adapted to the traffic, so the third in importance depends upon the best selection of the class of permanent way to be employed. This selection calls for a close comparative investigation of all the known methods in use, and of the modern projects which experience may have suggested for their further improvement, having reference, first, to their mechanical qualities; second, to their cost in annual maintenance and renewal; third, to their first cost respectively. Having made such an investigation with all the caution that its importance demanded, I felt justified in coming to the conclusion put forth in my report addressed to the board of directors on the 6th day of December last, recommending that tenders for rails on the suspended girder principle, sufficient to lay down fifty miles of line, should be invited.

The principle of substituting iron for wood as the medium for supporting the rails, well proved as it has been, and essential as it may be deemed in England, is infinitely more important in India, where the ravages of white ants, and the destructive effects of intense heat, alternating with tropical moisture, render wood, from its perishable nature, peculiarly unfitted to support a *permanent way*.

My recommendation having been unanimously approved by our directors, was on the 30th of January forwarded for the sanction of the supervising authority. On the 15th of February a reply was received from the honourable court, deciding, without giving reasons for such decision, that the rails to be provided should not be those recommended after careful comparative tests, and after the unanimous approval of our board, but that a different class of permanent way should be adopted. The natural course for the supervising authority to have pursued in this important case would have been to appoint a committee of three engineers, one selected by themselves, one by our directors, and an umpire by those thus selected. This committee should have been charged to make accurate tests and calculations, and to report fully upon the case. Such an investigation would have been of vast general practical benefit, far beyond its mere bearings on the interests of our single company. As the matter now stands we are constrained to adopt what, we have distinct proofs, is a most defective and costly principle, at the commencement of a new railway enterprise, when the opportunity occurred of rejecting all that was known to be bad, and adopting only what can be shown to be good.

I am bound in self-defence to repudiate every portion of responsibility in this particular case, and in every other where a similar arbitrary power may be exerted. In inviting tenders for the permanent way referred to, I have used no discretion in the specifications, but have adopted those pointed to by the *ex officio* director, on the part of the honourable court, having gone patiently through all those calculations and tests which proved indisputably the injurious nature and wasteful cost of what we are constrained, by the force of authority, to adopt.

At the Royal Scottish Society of Arts, Dr. Sanders exhibited an apparatus constructed to show the Mechanism of the Circulation of the Blood. It consists of a series of glass tubes representing the arteries, lymphatics, and veins—the heart being an india-rubber hollow ball, having valves attached to the tubes above and below it, and which, when compressed by the hand, propelled the liquid representing the blood into the arteries, and so on, till it returned by the veins to the reservoir, from whence it was propelled, as before.

IRON SUSPENSION AND TRUSSED BRIDGE, HARPER'S FERRY, UNITED STATES.

(With an Engraving, Plate XIV.)

This bridge was erected in 1852, from the designs of Wendel Bollman, C.E., Inspector of Repairs, Baltimore and Ohio Railway. The span is 124 feet between abutments. The length of cast-iron in stretcher, 128 feet. The weight of cast-iron in the R.R. truss, 65,137 lb.; of wrought-iron, 33,527 lb.; making a total weight of cast and wrought iron, 98,664 lb.

The wrought-iron requires little workmanship, the rods from the centre to abutments having but an eye at one and a screw at the other end, with a weld or two between according to length. The long counter-rods have two knuckles and one swivel for adjustment of strain and convenience in welding, as well as in raising the whole.

The cast-iron stretcher is octagonal without, circular within, and averages one inch of metal. It is cast in lengths according to the length of panel, and jointed in the simplest manner;—at one end of each length is a tenon, at the other a socket. The latter is bored out, and the tenon and its shoulder turned off in a lathe to fit the socket; thus, when thoroughly joined, to form one continuous pipe between abutments. The ends of the sections of cylinders, inserted to those contiguous, are slightly rounded, to allow a small angular movement without risk of joint fracture.

A cast-iron plate or washer sets on a bracket cast with each abutment end of stretcher, and at right angles to the centre acting rods. The tension bars are passed through this washer to receive a screw-nut for the erection and adjustment of the system.

The stretcher or straining beam, the vertical posts, and suspension bars compose the essential features of the bridge; each post being hung by two bars from both ends of the stretcher independently of all the others; and each post and pair of tension bars forming with the stretcher a separate truss.

This system, perfect in itself, is additionally connected by diagonal rods in each panel; also by light hollow castings, acting as struts. The diagonal side rods might be safely dispensed with, for the peculiar merit of the truss is its perfect independence of such provision. They are therefore used as a safeguard only in case of the fracture of any of the principal suspension rods.

By this combination of cast and wrought iron, the former is in a state of compression, the latter in that of tension,—the proper condition of the two metals. It unites the principles of the suspension and of the truss bridges. *Each* bar performs its own part in supporting the load in proportion to its distance from the abutment; so that the entire series of suspending rods transmits the same tension to the points of support as would be equally transmitted from thence to the centre of bridge.

The tensile resistance of the best American bar-iron tables at 80,000 lb. per square inch. Its practical value is generally rated at about one-fourth the nominal value. In this diagram the highest given value of iron is 16,000, being reduced below any probable rate of fibral separation in any previous data.

Now to proceed for proportion of one rib; that is,

One-Half Weight of Bridge and Load.

Iron	...	24,000 lb.
Timber	...	15,000 lb.
Load	...	184,000 lb.
Momentum		25,000 lb.
		248,000 lb. = weight to be sustained by one rib.

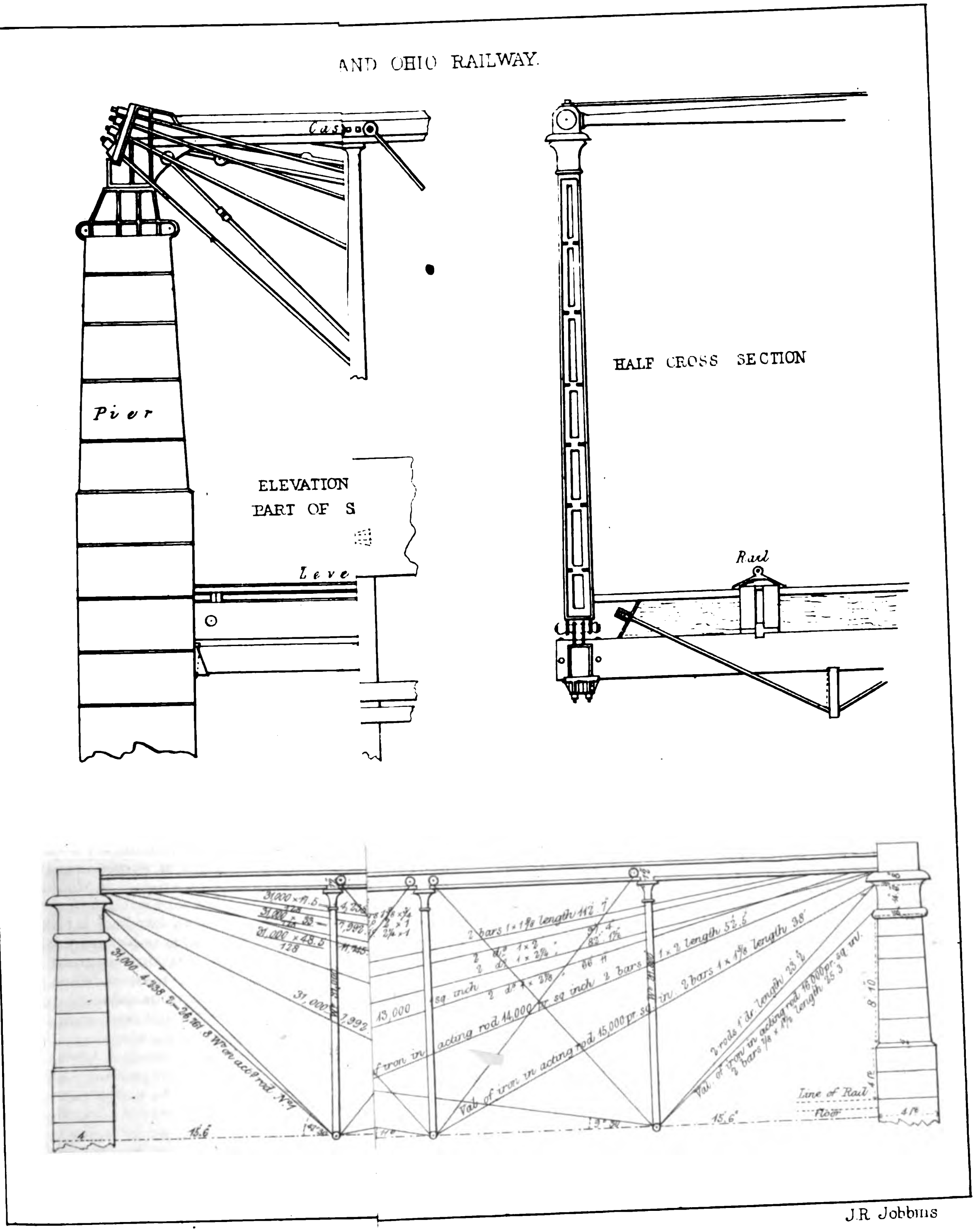
This, when distributed, is carried at eight different points; at the centre by two equal, and on either side by two unequal forces.

Therefore, $\frac{248,000}{8} = 31,000$ lb. on each post; or, in other words, there is a concentration of 31,000 lb. on each floor beam at the points of suspension.

The distance from centre of abutment to centre of bridge $= 64$ feet; so that $\frac{31,000 \times 64}{128} = 15,500$ lb. weight on acting rods at the centre, the forces being equal.

The distance from centre of abutment, or the point of support, to the centre of post, or internal line of first or abutment panel $= 17\cdot5$; therefore, applying the principles of the lever, as before mentioned, we have transferred to the farthest point of support

Pl. 14.



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can be done without trestling up any part of the bridge.

In case of fire, the floor may be entirely consumed without any injury to the side truss.

The permanent principle in bridge building, sustained throughout this mode of structure, and in which there is such gain in

our, was never lower than 4·4 lb., nor higher than 5·9 lb. on any of the experiments, the better and lowest results being obtained when a single boiler was employed, four being the whole number. The figure 4·4 lb. might be taken as the fair expenditure per indicated horse-power per hour of the engines in question, at their fullest work, with clean Welsh coal, urged to a rate of combustion of about 18 lb. per square foot of grate per hour.

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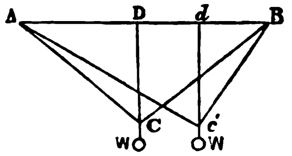
the arteries, lymphatics, and veins—the heart being [illegible] rubber hollow ball, having valves attached to the tubes above and below it, and which, when compressed by the hand, propelled the liquid representing the [illegible] into the arteries, and so on, till it returned by the vei[illegible] [illegible]oir, from whence it was propelled, as before.

rods at the centre, the forces being equal.

The distance from centre of abutment, or the point of support, to the centre of post, or internal line of first or abutment panel = 17·5; therefore, applying the principles of the lever, as before mentioned, we have transferred to the farthest point of support

$\frac{31,000 \times 17{\cdot}5}{128} = 4238$ lb. as the weight; which deducted from 31,000 lb., leaves 26,761·8 lb. as the weight transferred to the nearest point of support.

To use further plainness in application of first principles, let us take the following diagram:



$$AD = \tfrac{1}{2} AB = 6$$
$$Ad = \tfrac{3}{4} AB = 9$$
$$Bd = \tfrac{1}{4} AB = 3$$
$$W = 144$$

In the triangle ABC, AC = CB. Then the weight being between the fulcrum and power, AB : AD or DB :: W : AC or BC. 12 : 6 :: 144 : 72 lb., or $\frac{144 \times 6}{12} = 72$lb. weight on AC or BC, the forces being equal.

$Bd = 3$; then AB : Bd :: W : Ac', or 12 : 3 :: 144 : 36 lb., or $\frac{144 \times 3}{12} = 36 - 144 = 108$ lb. on Bc', or by proportion AB : Ad :: W : Ac', or 12 : 9 :: 144 : 108 lb. on Bc', the forces being unequal.

The sum of resistances of the extended fibres should equal the sum of resistances of the compressed fibres.

This bridge, it will be seen, is composed of seven independent trusses, which transfer the weight concentrated on each floor-beam directly to the abutments, without aid from any other connection; and not from panel to panel, as in general use.

The strain on cast and wrought iron is wholly in direct line; and the result, the least quantity of metal is required to carry a given weight. The weight of bridge and load has a vertical pressure on the piers, towers, &c., the only horizontal thrust being from the expansion of iron, which is accommodated by rollers, sliding of abutment bracket over its pedestal, or by other means: the necessary dimensions of masonry may therefore be most moderate.

It is evident, from an inspection of the drawing, that no chord is requisite at the bottom of the truss to resist tension; the only advantage of that employed is to regulate the movement produced by expansion, in the performance of which agency the resistance is one to compression.

Although the abutment bracket casting and its pedestal were so constructed as to admit of accommodation to expansion, by rollers, yet such contrivance was omitted with the view of fully testing the effect of greatest expansion throughout the system. From the closest inspection it is found that the extreme expansion measures, as near as possible, $\frac{5}{16}$-inch on each tower, or $\frac{3}{8}$-inch in the entire length, 128 feet of stretcher; and without the slightest perceptible derangement of masonry; the dimensions of which are 4 feet square of base, 12 feet high, and 2 ft. 9 in. at top.

While on the subject of expansion, it may be well to notice the effect from difference in expansion of the rods. At the first point of suspension, or where the longest and shortest rods meet, the counter rod is about four and a-half times longer than the acting rod; and the expansion of the counter is four and a-half times that of the acting rod. But there is also a proportionate difference in the lengths of stretcher from the point directly over the centre of connection to the extremities of these rods. This has been practically proved in this bridge.

The suspender-bolt, when the expansion is extreme or $\frac{3}{8}$-inch in the length of stretcher, exhibits a motive difference of three-sixteenths towards the short or acting rod; which difference is provided for, as seen by slot dotted in the elevation, where the vertical suspender-bolt moves to accommodate any such difference, and to give that proportion of weight to each rod according to the angle.

It affords easy access for repairs; for instance, should a new floor beam be required, it is but needed to slacken the horizonal rod and the keys in longitudinal strut, remove the washer under point of suspension, and let down the beam to be replaced; which can be done without trestling up any part of the bridge.

In case of fire, the floor may be entirely consumed without any injury to the side truss.

The permanent principle in bridge building, sustained throughout this mode of structure, and in which there is such gain in competition with every other, viz., the direct transfer of weight to the abutments, renders the calculation simple, the expense certain, and facilitates the erection of secure, economical, and durable structures.

In an experiment undertaken to prove the rigidity of this structure, three first-class tonnage engines, with three tenders, were first carefully weighed, and then run upon the bridge, at the same time nearly covering its whole length, and weighing in the aggregate 273,550 lb., or $136\frac{1550}{2000}$ tons nett, being over a ton for each foot in length of the bridge.

From this test it was found, according to gauges properly set and reliable in their action, that the load did not cover the entire length of bridge by about 13 feet, yet the excess of weight in the middle, and at a speed of about eight miles per hour, produced no greater deflection than $1\frac{3}{8}$ inch at the centre post, and $\frac{9}{16}$-inch at the first post from abutment.

INSTITUTION OF CIVIL ENGINEERS.

March 17, 24, and 31.—The discussion on Mr. Armstrong's Paper "*On High-speed Steam Navigation, and on the Relative Efficiency of the Screw-Propeller and Paddle-Wheel,*" occupied three evenings.

In opening the discussion, it was remarked, that the author of the Paper had used the terms "power," "force," and "resistance," incorrectly. Power was the force developed in a given time, and consisted of two elements,—force, and the space moved over. All naval constructors agreed, that the resistance and the moving forces varied as the square of the velocity; and in calculating the resistance, or force necessary to propel the vessel, they had always taken the area of the largest, or main section, as the principal element. Now, if the resistance was as the square of the velocity, then the horse-power expended, multiplied into any number of square feet of main section, must, as a mere mathematical rule, be as the cube.

It was contended, that the tabular statements which the author had brought forward, in support of what he termed "the square theory," rather showed a more perfect accordance with the ordinary, or "cube rule." It was argued, that the shape and lines of a ship could not be disregarded, as had been imagined, and that the speed did not depend alone on the quantity of horse-power put into a vessel. Four timber ships of the same dimensions, the same displacement, the same horse-power, and engines, all made by one firm, were instanced. In these cases the four vessels had different lines, being constructed by different builders. The result was, upon a run of 16 miles, that their several speeds were 12½—12—under 11—and something between 10 and 11 miles per hour.

A steam vessel, constructed to go both ways, but built with one fine end, and the other less fine, as an experiment, went fully a knot faster one way than the other, although the midship section and the horse-power were necessarily identical at all times. This showed that there was something more than engineering in the construction of a steam-vessel. For upwards of twenty years a few experiments had been wanted to determine how much force it took to drag a vessel of a given shape and a given size through the water at a given speed. It was suggested, that the government should institute a series of experiments for this purpose, and that the *Duke of Wellington* should be towed by several steamers with a rope, at speeds of 2½, 5, 7½, and 10 knots per hour, and the drag upon the rope be ascertained by means of a dynamometer. A similar series of experiments with such a vessel as her Majesty's yacht, would give results from two totally different classes of ships, and such experiments would do much more for the science of naval architecture than the mere construction of empirical formulæ.

It was remarked, that a series of trials made in 1852, on board H.M.S. *Desperate*, of 1037 tons burthen, and 400 nominal horse-power, confirmed in a remarkable degree the usually received theory, that the velocity of the ship varied as the cube root of the power, and not as the square root. The results of these trials, expressed in a tabular form, were as follows:

	Indicated H.P.	Speed in knots.
No. 1, with 4 boilers and 4 cylinders ...	805·89	9·15
No. 2, with 3 boilers and 4 cylinders expansively	572·32	8·25
No. 3, with 2 boilers and 4 cylinders expansively	363·87	7·35
No. 4, with 1 boiler and 2 cylinders expansively	169·32	5·98

In these trials with the *Desperate*, the expenditure of hand-picked Welsh coal, per indicated horse-power per hour, was never lower than 4·4 lb., nor higher than 5·9 lb. on any of the experiments, the better and lowest results being obtained when a single boiler was employed, four being the whole number. The figure 4·4 lb. might be taken as the fair expenditure per indicated horse-power per hour of the engines in question, at their fullest work, with clean Welsh coal, urged to a rate of combustion of about 18 lb. per square foot of grate per hour.

To show the importance of the lines of a ship as regarded speed, it was stated, that H.M.S. *Rifleman*, which with 348 indicated horse-power only attained a speed of 8·09 knots per hour, when her stern lines were altered maintained a speed of 9¼ knots, with 367 indicated horse-power, and when this was reduced to 188 indicated horse-power, the speed was 8·01 knots. Again, H.M.S. *Teazer* originally required 176 indicated horse-power to attain the speed of 6·31 knots; but with reduced engines, working to 128 indicated horse-power, after the stern lines had been made finer, the increased speed of 7·68 knots was attained. H.M.S. *Bann* and *Brune*, fitted with a rudder at each end, were found to have a greater speed when going ahead, than when going astern, at full power, the indicated horse-power being the same in both cases. Experimental trials with H.M.S. *Dwarf* showed, that the speed could be reduced to less than one half, by filling up, or doubling upon her stern lines; and the original speed could be again restored by removing the doubling—the indicated horse-power being in both cases the same.

It was argued, that frictional resistance was increased in proportion to the increased immersed surface of hull. Estimating the dynamic duty of vessels by the generally received law,—$\frac{V^3 D^{\frac{2}{3}}}{\text{Ind. H.P.}}$,—it was believed, that there was a limit to the advantageous increase of the length in proportion to the beam. Vessels which had produced the highest index number of dynamic duty by the above law, had been found invariably to have curved sides.

With regard to the proportion between the power and the speed, it was stated that H.M.S. *Minx*, when propelled by 31·6 indicated horse-power, attained the speed of 4·51 knots per hour, but to propel the vessel at 9·14 knots required 234 indicated horse-power, or nearly as the cube of the speed. The same rule had been found to obtain with H.M.S. *Banshee*, which had been adapted for different services, requiring a variation of speed from 12 knots to 16 knots. The speed of vessels which had been long on a foreign station, was frequently reduced as much as 20 per cent. during the period of commission, chiefly in consequence of the foulness of the bottom.

With reference to the relative efficiency of the Screw Propeller and the Paddle-Wheel, it was stated, that the highest index number of dynamic duty, and the highest ratio of effective to indicated power, were produced by the screw propeller.

It was shown, that resistance by friction between the water and the sides of the vessel in such a ship as the *Rattler*, would amount to about 170 horse-power at a speed of 10 knots per hour.

Trials with the *Retribution* paddle-wheel steamer, of 1800 tons burthen, in July 1850, showed that with four boilers, and 1092 indicated horse-power, a speed of 10·4 knots per hour was attained, whilst with one boiler worked at the highest grade of expansion, and 226 indicated horse-power, the speed was 6·22 knots. With a totally different class of vessel, one of the paddle-wheel mail boats between Dover and Calais, with two boilers, worked to full power, and 533 indicated horse-power, a speed of 13·16 knots per hour was realised, whilst with one boiler and 158 horse-power the speed was 8·6 knots. With H.M.S. *Desperate*, a screw-steamer, before referred to, with two boilers, a speed of 10·76 knots was attained with 891 indicated horse-power, whilst with one boiler the speed was 8·78 knots, with 391 indicated horse-power.

With regard to measuring the power by the quantity of coals burnt, the trials with the *Retribution* were referred to, and two indicator diagrams were shown, by which it appeared that the quantity of steam per indicated horse-power was 6·5 cubic feet in one case, where expansion was adopted, and 11 cubic feet in the other, where as much steam was put into the engines as was possible. The boiler surface in the former case was 7 superficial feet per indicated horse-power, and 6 superficial feet in the latter—but the former burnt 50 per cent. more coal. With the *Desperate* 5 lb. of coal were burnt per indicated horse-power when four boilers and four engines were worked, and 8 lb. when two boilers were worked expansively. It was asserted that nine-tenths of the advantage of working steam expansively resulted from the reduced expenditure of power, with of course a diminished speed.

With a view of showing the influence of form on the speed, it was stated that the *Dart*, a London and Margate steamboat, originally constructed like a sailing ship, had a new bow added, by which her speed was improved 10 per cent. In the *Magnet* the original bow was at an angle of 42°; this was altered to 23°, when the speed was increased from 10·02 knots to 11·75 knots per hour, or nearly 30 per cent. A recent instance was that of the *Flying Fish*, one of the larger class of government despatch boats. This vessel, with 1166 indicated horse-power, only attained a speed of 11·73 knots. When, however, an elongated bow, 18 feet in length, was added so as to divide the water more freely the speed was increased to 12·53 knots per hour, and making allowance for the propelling power being increased 100 indicated horse-power, the performance was better in the ratio of 7 to 6. By lessening the resistance the screw became a better propeller.

In the tables brought forward by the author, it was assumed that the same co-efficient applied to all forms and kinds of vessels. Now, it was well known that for every vessel a different co-efficient was necessary. Thus for H.M. Yacht *Fairy*, the co-efficient was 700, whilst for the *Himalaya* it was 1200, and yet these two had been treated by the author as identical. Experience had shown, in all cases, that the resistance was nearly as the cube of the velocity, and that when a proper co-efficient was adopted the speed might readily be calculated to within a quarter of a knot.

A comparison of the actual speed of two ships belonging to the Peninsular and Oriental Company, the *Candia* and the *Pera*, with the speeds calculated by two of the rules given in the course of the discussion, showed the following results:—

	CANDIA.				PERA.			
			ERROR.				ERROR.	
	Knots.	Statute miles.	Knots.	Statute miles.	Knots.	Statute miles.	Knots.	Statute miles.
Speed, actual	11·98	13·7	..	..	12·55	14·4	..	..
By $\frac{\sqrt{\text{H.P.} \times c}}{D^{\frac{2}{3}}}$	11·33	13·1	·55	·6	11·22	12·93	1·33	1·5
By $V^3 = \frac{\frac{2}{3}\text{I.H.P.} \times 100}{\text{Mid. Sect.}}$	11·28	13·	·65	·7	11·28	13·	1·27	1·4

It had been determined by mathematicians of the highest standing, that the resistance was as the square, and the power as the cube; and it was, therefore, contended that it was useless to discuss, whether the actual friction was as the square of the velocity, and whether the resistance to a body moving in water was also as the square. The theory of rivers, and the movement of water in pipes, both showed that allowance must be made for the resistance due to friction. It was calculated that the *Himalaya* had an immersed surface of 18,000 square feet, and that this, at a velocity of from 13 knots to 15 knots per hour, would absorb 800 indicated horse-power supposing that the bottom was perfectly clean and free from barnacles, &c. It was easy to contrive a formula which should give results nearly agreeing with the actual facts at some one point over a long range of figures; and the error was less apparent when the actual and calculated velocities were compared, than when the power was taken into account, as a variation of only 7 or 8 per cent. in the former case would cause a difference in the latter of 25 or 30 per cent.

It was argued, that nothing required greater care, knowledge, and skill, than the conduct of experiments on the friction of bodies moving in water. A large series of experiments of this kind, which had gained for their author admission into the Royal Society, had been found to be incapable of analysis. The size of the vessel, and particularly its length, were undoubtedly of great importance for ocean navigation, as the vessel then acquired sufficient momentum to overcome the irregularities and undulations of the surface of the sea, which it must encounter.

It was remarked, that in experiments to ascertain the resistance of bodies passing through fluids, and the amount of steam power necessary to overcome that resistance, it was proper to separate the different parts of the experiment, and to confine one experiment to the variations of one element alone. It was believed, that, up to the present time, there had not been a sufficient number of experiments to determine the relation of the resistance to the velocity; and that any authoritative series of experiments on this point could not fail to be of great value to science.

With regard to the screw propeller, it was remarked that there were several causes tending to inefficiency. One of these was the 'slip,' the screw not holding its place as if the water were a solid medium. The 'slip' varied according to the pitch of the screw, or the angle at which the blades were fixed with respect to the axis; it being greatest where the water was carried round by the screw. It was suggested, that two extreme cases might be taken, the one where the planes of the fans, or blades, all passed through the axis, producing rotary 'slip,' and the other where there was no rotation, but a disc surface was moved in the direction of the spindle, causing longitudinal slip. A combination of these two might then be made, so as to give the minimum amount of slip. Another cause of inefficiency was friction, which, considering the speed at which the screw was made to revolve, must be considerable.

It was urged, that the trials with the *Flying Fish* showed, that the form of the ship ought to be made suitable to the power intended to be applied. When tried on the 3rd July, the following results were obtained:—

	Revolutions per minute.	Indicated H.P.	Speed in knots.
With full power	74½	1106·06	11·603
„ ¾ „	68¼	877·	11·201
„ ½ „	59	576·	9·923

Thus, when the power was doubled, there was only an increase of speed of 1·68 knot. She was then fitted with a temporary bow, to give a finer entrance, and again tried on the 16th September, with the following results:

	Revolutions per minute.	Indicated H.P.	Speed in knots.
With full power	77	1309·	12·572
„ $\frac{3}{4}$ „	68	918·72	11·150
„ $\frac{1}{2}$ „	60	660·18	10·120

Thus doubling the power, with the false bow, gave an increase of speed of 2·452 knots, or just what was due to the cube of the extra power exerted. With the temporary bow, no increase of speed was obtained at half and three-quarter power, whilst at full power nearly 1 knot extra was obtained. In these trials it was proved, that there was considerably more resistance offered by the water to the blades of a screw when set at an inclination towards the ship, than when at right angles with the screw shaft. The screw of the *Flying Fish* had two sets of blades, one set being at right angles with the shaft in the ordinary way, and the other at an angle of about 18° to the ship. In the first case the pitch was 20 ft. 6 in., the number of revolutions $75\frac{1}{4}$ per minute, and the indicated horse-power 1281·8; whilst in the latter the pitch was only 16 feet, the number of revolutions 77·3 per minute, and the indicated horse-power 1265·, giving a result slightly in favour of straight blades. It was stated that the steam-ship *Dane*, of 40 horse power and 500 tons measurement, had originally a screw of 10 ft. 6 in. diameter, and 18 feet pitch, with three blades, each 3 ft. 4 in. wide at the point, and 1 ft. 10 in. at the root, when the speed obtained was 8·5 knots per hour. When a screw with two blades was applied, of the same diameter and pitch, but the points only 9 inches wide, and 3 feet at the root, the speed was 8·675 knots, all the circumstances being alike, excepting that the two-bladed screw made six revolutions per minute more,—partly due to the diminished friction and to the increased speed of the vessel. The screw of the steam-ship *Augusta*, of 60 horse-power, was 5 ft. 6 in. diameter, and was originally 11 ft. 3 in. pitch, when the number of revolutions was 110, and the speed was 6·385 knots. When the pitch was altered to 10 ft. 3 in., the speed was increased to 7·9 knots, the number of revolutions, and all the other circumstances, being the same.

A series of observations, made during the running of the vessels belonging to the Chester and Holyhead Railway Company, between Holyhead and Kingstown, was referred to; and it was stated, that these vessels,—the *Anglia*, *Cambria*, *Scotia*, and *Hibernia*,—were built expressly for speed, which was to remain constant, the variations of wind and tide being met by increased power. The distance between the two ports was about 63 miles, and this it was proposed to traverse in three hours. As an instance of the want of uniformity in the practice of different ship-builders and engineers, it was mentioned that "the vessels proposed (to fulfil these requirements) differed in displacement from about 1550 to above 3000; in nominal horse-power from 550 to 1600; in ratio of breadth to length, from 9·37 to 11·6 per cent.; in draught of water to breadth, from 30 to 40 per cent.; in maximum speed to be attained in smooth water, from 22 to 25 miles an hour." The analysis of the performances of these vessels showed very remarkable results, and it was stated that in consequence of a deviation from the lines of the hips of one of them, the vessel would not answer the helm when any speed was attained. It was remarked, that a careful record and analysis of the performances of the steam-ships belonging to the Cunard and Collins lines, between Liverpool and New York, would afford very valuable results, and would enable the work done and the amount of fuel consumed to be accurately obtained.

It was stated, that the usual formula of Colonel Beaufoy, $R = a\,w\frac{v^2}{2g}$ only gave the resistance to a boat with a square head; but what was wanted was the reduction upon this for a certain amount of sharpness of bow, for different sizes, shapes, and proportions of vessels. With a semicircular head, it had been found that the resistance was only two-thirds of the amount derived from the above formula; and with an elliptical head it was still less, and it had been gradually brought down to one-fifth, one-sixth, and one-seventh, as the result of a long course of experiments. A comparison was instituted between two vessels, in which everything was alike, but form and length. Each was 15 feet wide; one was 144 feet, and the other 100 feet in length; one had 42 square feet of midship section, the other had 43 square feet; the engines of each had cylinders 30 inches diameter, and 2 ft. 6 in. stroke. The one which travelled fastest made 36 revolutions per minute, the other making 38 revolutions; the speed of one was 10·08 knots, and the other was 8·88 knots. In two other vessels, whose lengths were as nearly alike as 190 feet and 186 feet, their breadths being the same; the engines had cylinders 48 inches diameter and 4 ft. 6 in. stroke, and the number of strokes was in the one case 39, and the other from 38 to 40. The one made 15·3 knots per hour, and the other 11·32 knots. The difference was due entirely to the shape, as the one had 124 square feet of midship section, and the other 71 square feet; the draught of water being respectively 6 ft. 8 in. and 2 ft. 10 in. In experiments made with a vessel 1500 tons burthen, towed through the water at 10 knots, the head resistance was reduced to 50 lb. per square foot, and with engine power, when not towed, the resistance was only 65 lb. per square foot.

The following formulæ were submitted as the results of the experiments instituted by Mr. Hawksley, and of present experience on the subject:

$$H = V^3 \left\{ \frac{a}{174}\left(\sin^2\frac{\theta}{2} + \sin^2\frac{\theta'}{2}\right) + \frac{s}{25125} \right\} \quad - \; - \quad \text{No. 1}$$

$$V = 29 \left(\frac{H}{144\,a\left(\sin^2\frac{\theta}{2} + \sin^2\frac{\theta'}{2}\right) + s} \right)^{\frac{1}{3}} \quad - \; - \quad \text{No. 2}$$

in which (H) was the effective horse-power (= about $\frac{5}{8}$ths of the indicated horse-power), (a) the area of the midship section in square feet, (θ) the angle of the bow lines, (θ') the angle of the stern lines, and (s) the immersed, or wetted surface of the vessel, in square feet. The value of the co-efficient of (s) had been ascertained from numerous experiments made to determine the friction of water passing through pipes, and from the consistency of the results, might be regarded as practically correct, for surfaces of iron. At a velocity of 15 feet per second the resistance of water amounted to 25 ounces per foot superficial.

The precise value of the co-efficient of (a) was somewhat less certain, inasmuch as the theoretical and experimental results were not altogether coincident, or in perfect agreement amongst themselves, and it was, therefore, proposed to institute a further course of experiments, which would, in due time, be laid before the Institution. In their present form, however, the equations would give a near approximation to actual experience;—for instance when applied to the *Atrato*, a large steamer having upwards of 3000 indicated horse-power on board, the formula gave a speed of 15 miles per hour, while upon the measured mile, the actual speed appeared to be 16 miles per hour.

It was quite useless to attempt equations for curved forms, nor was it necessary to do so, as by dividing the immersed solid into four parts, by five equidistant planes, taken parallel to the load water-line, and calculating each part by three or more angles, formed by the intersection of tangents to the respective curves of the bow and the stern lines, any required degree of exactitude might be obtained. In general, with regard to sharp vessels, a single calculation would be sufficient for ordinary practical purposes, and especially after a little experience had been gained, in estimating the angles at the head and stern, capable of approximating to the results of curves.

In the course of the discussion it had been stated, that the economy of working marine engines expansively resulted from the development of reduced power; and that in the trials of the *Desperate*, whilst the amount of steam used when working expansively was only $6\frac{1}{2}$ cubic feet, and 11 cubic feet when using full power, yet the consumption of coals was 8 lb. per indicated horse-power per hour in the former case, and 5 lb. per hour in the latter. From this it might be inferred, that working steam expansively was an expensive process, which was opposed to all experience.

In reply, it was explained, that the conditions in a marine engine were not the same as in land engines, whether stationary or locomotive; and that however startling the assertions might appear, they were nevertheless true. A record of the performances for three or four years of H.M. paddle-wheel steamer *Fury*, of 515 horse-power, showed, that when working full power, 50 tons of coal were consumed per day of 24 hours, or 4·27lb. per horse-power per hour, the distance run being 264 statute miles per day, and then she could travel, with the coal she was able to carry, 2112 miles. When working at the first grade of expansion, 40 tons of coal were consumed per day, or 4·65 lb. per horse-power per hour, the speed attained being 240 statute miles per day, and then she could travel 2400 miles. At the seventh grade of expansion, 15 tons of coal were consumed per day, or 12·3 lb. per horse-power per hour, the distance run was 110 statute miles per day, and then she could travel 2890 miles. In the case of H.M.S. *Terrible*, which had large engines of 1640 horse-power, worked moderately, the quantity of coals consumed per day was 76 tons, or 4·33 lb. per horse-power per hour, and the speed attained was 12·8 knots; whilst at the sixth grade of expansion, when the power exerted was 650 horse-power, the coals consumed were $44\frac{3}{4}$ tons, or 6·42 lb. per horse-power per hour, and the speed attained was 9·8 knots. An opposite case to this, that of small engines, worked hard, was the *Llewellyn* of 350 nominal horse power, but worked up to 1890 indicated horse-power, when the consumption of coals was only $3\frac{1}{4}$ lb. per horse-power per hour, in place of 4·3 lb. as in the *Terrible*. The *Rosamond*, of 280 nominal horse-power when exerting her greatest effort of 492 indicated horse-power, consumed $4\frac{3}{4}$ lb. per indicated horse-power per hour; but when working only to 168 indicated horse-power she consumed 7·9 lb. per horse-power per hour.

In marine engines, the attempts hitherto made to comply with the conditions necessary for realising the benefits to be derived from working expansively, had not been attended with adequate success. The loss, when working expansively, was believed to arise, to a great extent, from the condensation from the extended surfaces through which the steam passed, as only indifferent means were adopted for keeping up the temperature, and thus there must necessarily be a loss of mechanical effect.

Allusion was made to the experiments "On the Resistance of

Fluids to bodies passing through them," instituted by Mr. James Walker, and published in the Phil. Trans. for 1828. They were made with boats of 20 feet and 28 feet long, in the East India Docks, and by such application of power as could be correctly estimated and collated with the speed attained. All the results confirmed the accepted rule of the resistance being as the square, and the power as the cube of the velocity. This first series of experiments was not, however, so valuable as the second series, which it was hoped would be given to the Institution.

It was stated that Mr. Andrew Henderson had been labouring for ten years to obtain returns of the performances of vessels, for depositing in the archives of the Institution. Lately, the Peninsular and Oriental Steam Navigation Company had caused to be prepared a tabulated return of the trial trips of a great many of their vessels, and this would enable the approximation to truth of different formulæ to be accurately ascertained.

In the reply to the remarks, attention was directed to the immediate object of the paper under discussion, "An examination of the circumstances that appeared to limit the maintenance of higher speeds in deep sea navigation." It was implied from the proposition of that subject that the necessary requirements were not generally understood.

In the explanation of these circumstances it was pointed out, that for the advancement of naval architecture, and the progress of steam transport economy, it was necessary to obtain the power to discriminate between good and bad vessels, to tell whether the engine was doing its assigned duty, and whether the vessel was fulfilling the requirements for which it was designed, and to reduce the necessary requirements, for any velocity, to a simple mathematical calculation. As a proof that the necessary requirements were not understood, the vessels belonging to the West India Mail Company were adduced; and it was asserted that the power of elimination was concentrated in the proposed formula $V^2 = \frac{\sqrt[3]{\text{I.H.P.}} \times 100}{\text{Mid. Sec.}}$. But whether the formula was theoretically correct or not, it might be conceded as a standard of comparison for recording the progress of naval architecture, on the same principle that the power of the steam-engine was calculated. Without using comparisons, by means of that formula the well-known list of screw vessels in H.M. Navy had been tabulated, and by those examples it was attempted to be demonstrated that by that formula the proposed subject was answered.

It was inferred, that as the vessels with the highest velocities were all on the positive side of the speed deduced by the formula, it might be safely calculated, that the expenditure of power above the square would not negative the speed deduced, up to 18 miles per hour; this fact was adduced in proof that "the power only increased as the square of the velocity." In proof of the author's first assumption, that the form was not necessary in calculations of velocity, it was pointed out that the speeds of the *Vulcan*, *Minx* (diminished), *Encounter*, *Sharpshooter*, *Himalaya*, and *Ajax*, were deduced by the formula to within one-fifth of a mile, and the speeds of the *Archer*, *Arrogant*, *Rattler*, *Rifleman*, *Niger* (diminished), *Alma*, *Candia*, *Ava*, *Aden*, *Dauntless*, *Phœnix*, *Conflict*, and *Amphion*, were deduced within one mile. This variation was believed to be entirely owing to the various degrees of efficiency of the propellers; the vessels being tabulated in the following order:

	Ratio of Speeds.	Pitch to Diameter.	Number of Revolutions.
Plumper	1·21	·62	100
Reynard	1·21	·91	108
Archer	1·13	·86	108
Arrogant	1·12	·96	55
Rattler	1·12	1·10	104
Rifleman (diminished)	1·08	1·12	110
Niger	1·08	1·36	68
Alma	1·06	1·32	57

This table was asserted to be in exact accordance with experiments upon the *Ajax*, *Dauntless*, *Minx*, *Phœnix*, *Plumper*, *Rifleman*, (diminished), and *Sharpshooter;* and therefore proved that the form of vessel, on the propelling power increasing as the cube of the velocity, was not the cause of the variation from the speed deduced by the formula.

It was argued that the element "frictional resistance" was completely ignored by the power required in the *Himalaya*, being 400 indicated horse-power less than the proportionate power to the midship section of the *Fairy*, although the *Himalaya* was three times as long, twice as broad, and had three times the draft of water, whilst the immersed surface was as 20 to 1; and by the fact, that the longest and largest vessels were all on the positive side of the speed deduced by the formula, and the smallest on the negative side.

In the cube theory, the combination of space with velocity was asserted to be unphilosophical, and against the opinion of writers on dynamics and hydrodynamics. It was pointed out, that the *Minx* was the only example that favoured this theory. In a comparison of the *Minx* (diminished), *Teazer*, and *Fairy*, the facts were in favour of the square theory; and from experiments on the same vessels, the *Dauntless*, *Desperate*, *Termagant*, and *Charlemagne*, the deduced power by the square theory was under the actual power in every case. In a comparison of the *Himalaya*, *Amphion*, *Minx*, and *Termagant*, the facts were decidedly in favour of the power increasing as the square of the velocity.

It was argued that the increase of speed, by lengthening the bows of steam-vessels, must be attributed to the effect of that increased length decreasing the normal immersion of the after-end of the vessel at high velocities, and not from any decreased resistance on the bow of the vessel. In corroboration of this, it was stated, that in the *Flying Fish* there was no increase of velocity up to 10 knots by the lengthening of her bows at half power. As a further illustration, a vessel was assumed of the same displacement as the *Himalaya*, but with 70 square feet less midship section; it might then be asked whether the advantages of the sharp water-lines of the *Himalaya* were equivalent to the rounder water-line (assumed) vessel, having 160,000 tons less water to displace, in sailing one hour. The formula, when applied to the four experiments with the *Desperate*, alluded to in the early part of the discussion, enabled the most effective and economical power to be ascertained. In the first experiment, the effective horse-power was 68 per cent. under the indicated horse-power; in the second, with three boilers and four cylinders, the effective horse-power was 45 per cent. under the indicated horse-power; in the third, with two boilers and four cylinders, the effective horse-power was only 17 per cent. under the indicated horse-power; and in the last, with one boiler and two cylinders, the indicated horse-power was 18 per cent. under the effective horse-power. The inference deduced from these facts was, that small boilers and large engines would be the most conomical and effective, and induced doubts as to the accuracy of the rule for calculating indicated horse-power. In the

	I.H.P.		MID. SEC.			
Plumper	148	propelled	204	at the rate of	8·47	miles per hour.
Reynard	165	„	184	„	9·43	„
Archer	345	„	372	„	8·93	„
Ajax	846	„	807	„	8·16	„
Phœnix	382	„	347	„	8·11	„
Amphion	592	„	546	„	7·71	„

It was therefore believed to be impossible for 169 indicated horse-power to propel 440 square feet of midship section in the *Desperate* 7 miles per hour.

In closing the proceedings, it was observed, that the paper had been, and with justice, severely criticised for promulgating doctrines so decidedly at variance with the actual state of scientific knowledge; and as in the reply to the observations of various speakers, the author did not appear to perceive the errors into which he had fallen, the employment of other arguments with a gentleman who contended that the power was not as the cube, whilst he admitted that the resistance was as the square, would be as useless as to attempt to hold a conversation with him in a language which he did not understand. Still the discussion would be useful in having elicited many facts which, if properly treated, would assist in throwing light upon the practical treatment of the question of the resistance to bodies passing through fluids.

Even Bossut and other eminent experimenters had neglected essential elements of resistance, and thus had permitted the existence of the anomalies which had obscured the subject. For instance, whilst the effect of the angle of the bow had been carefully investigated, that of the angle of the stern, which was almost of as great importance, had been entirely neglected. The question of that important element, friction, also had not been duly considered, and although, when mentioned, it had been argued that the friction of fluids in the interior periphery of a pipe differed from that on the exterior surface, such a proposition could not be admitted. It was incumbent on the Institution to prosecute the inquiry, and not to allow the subject to rest until many apparent anomalies had been reconciled.

The question also of the asserted increase of expenditure of fuel when working steam expansively in marine engines, must be thoroughly investigated, as though the effect of condensation might be considerable in large engines working slowly, it was not sufficient to account for the augmentation of fuel expended in producing a less effect. There were members present, from whom, on all parts of these questions, valuable papers might be obtained, and it was expected they would devote their time and knowledge for the benefit of the profession, and from the partial promises already received, there was reason to hope for these papers before the expiration of the present session.

April 7.—G. P. Bidder, Vice-President, in the Chair.

The Paper read was "*On the Laying of the Permanent Way of the Bordeaux and Bayonne Railway.*" By F. R. Conder, Assoc. Inst. C. E.

The Paper commenced with a description of the extensive and barren district lying between the important cities of Bordeaux and Bayonne, and known as the Grandes Landes. The soil of the department of the Landes was stated to consist of fine dry sand, chiefly covered with heath, furze, and rushes, and partly clothed with pine, whilst in winter it was generally wet and swampy. In the commencement of 1854, Messrs.

Conder and Goode entered into a contract for the laying of the permanent way of the Great Southern Railway of France through this desert.

A detailed description was given of the construction of the permanent way, as well as of the series of operations that was necessary for its completion. It appeared that although called "Voie Brunel," the principle adopted was in no way identical with that of the Great Western and other broad-gauge English railways; the only resemblance being the use of a bridge rail, and the longitudinal position of the short pieces of timber that supported the rails, which were little more than half the dimensions of those used on English railways.

On the Great Western lines the stability of the way was effected by the housing of the transoms into the longitudinals, and by tie-bolts which were passed through the latter, and were firmly secured to the former; and the continuity of the longitudinal timbers was secured by a sort of dowel, called a "joint plate," which had been found in practice to unite the ends of the timbers with a degree of solidity that could hardly have been expected, but which was an essential condition in the system. On this Bourdeaux and Bayonne line, unfortunately, all these precautions, which a long experience in England had proved to be necessary, were omitted. The short longitudinal timbers were merely laid end to end on the transoms, the rails where laid on and riveted to the joint-plates, and the only tie between the outer and the inner rail was effected by the bolts, which passed vertically through the rail, the longitudinal timber, and the transom. The result was, that the riveting of the rails, an operation which had been tried and abandoned in this country, was almost the sole thing on which the gauge of the way depended. The details were then given of the mode of construction, and it was stated, that the head of the works was frequently three miles in advance of the finished work. As an instance of the effects of expansion and contraction it was mentioned, than above one thousand yards of riveted rail had been known to become suddenly elongated, so as to form a series of vertical and lateral curves, which were quite impracticable until night-fall lowered the temperature, and thus reduced the additional length.

The barren nature of the country traversed was such, that the workmen had to be accomodated either in tents, which were supplied for the purpose by the imperial government, or in a sort of travelling village, which was built on trucks and moved along the railway, from one to two miles a-head daily. During the month of August, in which a speed of nearly one mile and a quarter per diem was maintained, a considerable number of workmen were obliged to bivouac. Food of all descriptions, and even potable water for the men to drink, had to be sent a distance of forty to fifty miles, so that the cares of a commissariat were added to the other difficulties of the operation. All the rails and iron work used had also to be sent from Bordeaux over the single line in course of construction, and the delivery of the materials was thus a matter of as much difficulty as their arrangement in place.

The object of this extreme pressure was the preparation of the line for the passage of their Imperial Majesties on their visit to Biarritz. It appeared that the contractors completed a longer length of line, and that in a shorter time, than the stipulations of their contract required, but that owing to the non-completion of a smaller portion of the line which was in the hands of the company, the Emperor was unable to travel by it on a stated day, although their Majesties both passed over the line on their retunm to Paris.

The Paper concluded with a brief indication of the methods suggested by the author, from his personal observation of the district, for improving the condition of the Landes; and for thus adding the bloodless conquest of a great province to the claims of the Emperor Napoleon the Third on the gratitude of France.

In opening the discussion it was remarked, that in a country like the Grandes Landes, where timber was scarce, the longitudinal system of permanent way should not have been adopted, for one essential of its success was the use of long pieces of timber. That kind of road had been adopted in many instances in this country, and it was believed almost every variety of the system had been tried. On the old Bolton line, the ordinary contractors' rail was fastened to the longitudinal timbers, which again were let into cross timber transoms. The next variety was the use of a plank underneath the longitudinal timber, instead of the transom, and the adoption of a bridge rail, with a joint plate let into the timber. The making an accurate bed for the joint plate was the chief thing to be aimed at, no difficulty having been experienced in the riveting of the rails to the plates. Subsequently the bridge-rail was abandoned, in favour of a contractors' rail 4 inches in depth, 6 inches in width at the foot, and weighing 78 lb. to the yard. This rail was simply laid on the longitudinal timbers, which were tenoned into cross transoms, the gauge being further maintained by tie-bolts ¾-inch diameter. A steel plate ⅜-inch in thickness, bent up at the edges, was placed on the longitudinal timber, at each joint; and bolts were passed through the rail, the steel plate, and the timber. The contractors' form of rail possessed several advantages over the bridge rail. The metal was better disposed for carrying weight, and such a rail was much stiffer for the same weight of iron. It was easily laid, no chairs were required, and "fishes" could be used. It was difficult to roll, of the dimensions above given, and on this account great care had to be taken in its manufacture, and the best metal only could be employed. The longitudinal system was asserted to be a little safer than the transverse sleeper road. It required, however, better ballast, and there was not the same facility for putting in points and crossings, on which account it was not quite so well suited for a mineral district.

In Prussia the contractors' rail, 5¼ inches in depth, and weighing 62lb. to the yard, had been generally preferred. It was fastened by "dogs" to cross sleepers, each 10 or 12 inches wide, and placed 3 feet apart. The joints were 'fished,' and great care was taken in the laying, in this respect comparing favourably with the practice in England, for after all the trouble and expense incurred in constructing railways in this country, the permanent way was generally laid too hurriedly.

It was stated, that in Egypt, with Greaves' cast-iron sleeper, three miles, of permanent way had been laid and made good in a week. This sleeper had also been used in India with most favourable results. In the Brazils, with the Barlow rail, not more than one mile and-a-half had hitherto been completed in a week.

It was observed, that the rail adopted on the Colchester line, in 1839, was perhaps the deepest and the thinnest that had ever been used. The chairs were very small, and the intermediate as well as the joint sleepers were all laid five feet apart. This road had remained in a satisfactory condition up to the present time, but a few years back, it was deemed advisable to introduce additional intermediate sleepers. It was remarked that too much stress had hitherto been laid on the supposed influence of lateral strain.

In closing the discussion it was observed, that from the remarks which had been made, it might be gathered, that with good materials, it would be difficult not to lay a safe road. The kind of system to be adopted must always depend, in a great degree, upon purely local considerations, on the superior facilities for obtaining timber, or iron, and on the comparative cost of the two, as well as on the climate and on other conditions. The greatest difficulties would be encountered in countries liable to extreme variations of temperature, as in Canada and Norway, where at times they were subject to almost tropical heat, and at others the temperature was 40° below zero. In Norway the frost penetrated to a depth of from 4 to 5 feet, and this mass of earth was sometimes lifted three inches or four inches, so that, on one occasion, seven miles of fencing had been thrown down in a very short time. On a railway in that country, longitudinal timbers laid on cross sleepers had been adopted, and every precaution taken to make the road sufficiently rigid to hold together, so as to be passable during the whole of the winter. Hitherto success had been complete, for no interruptions had been caused to the regular passage of the trains by the climate. At first the joint plates were simply laid on the longitudinal timbers, and allowed gradually to make a bed for themselves. In the succeeding summer, the plates were heated in position, and allowed to burn themselves into the timber. The system practised in Denmark, with so much success, had been followed in Canada, but for some unaccountable reason, it had suffered "official" condemnation.

April 21.—G. P. Bidder, V.P., in the Chair.

The Paper read, was "*On the application of Electro-Magnetism as a Motive Power.*" By Robert Hunt, F.R.S.

The author commenced by giving the progress of the investigations by which Oersted first proved the connection between electricity and magnetism, and which led Sturgeon to construct the electro-magnet. The powers of this form of electric force, as developed temporarily in soft-iron, naturally induced the idea of employing it for the purpose of exerting mechanical motion,—*doing work*. The principles of the electro-magnetic machines of Dal Negro,—of Botta,—of Jacobi,—of Armstrong,—of Page, and others, were next described. It was shown, that all engines acting by a direct pull, were inefficient, from the circumstance that the repeated blows received by the iron so altered its character, that it eventually assumed the quality of steel, and had a tendency to retain a certain amount of permanent magnetism. This induced Jacobi, after a large expenditure of money, to abandon arrangements of this kind, and to employ such as would at once produce a rotatory motion. The engine, thus arranged, was stated to have been tried upon a tolerably large scale on the Neva, and by it a boat containing ten, or twelve people was propelled at the rate of three miles an hour. Page's engine, and that of Hjorth, which in 1851-52 excited much attention, was described as being in principle an electro-magnetic piston drawn within, or repelled from, an electro-magnetic cylinder. By this motion, it was thought that a much greater length of stroke could be secured than by the revolving wheels or discs. After having generally described the forms under which electro-magnetic engines had been constructed, the author proceeded to give, as the result of his experiments, confirmed by those of others, the difficulties which still stood in the way of the application of electricity as a motive power.

In the first place, it was pointed out, that the loss of power through space was very great, and that the lifting power of any magnet was not to be regarded as the power it was capable of exerting at a distance from its poles, howsoever short that distance might be.

In the second place, it was shewn that,—supposing the reduced force exerted by two magnets, a few lines apart, was considered available for driving machinery,—the moment the magnets began to move in front of one another, there was again a great additional loss of power. As the speed of the engine increased, there was curiously a corresponding diminution of available mechanical power, a falling off in the *duty* of the engine as the rotations became more rapid.

In the third place, the conditions of the voltaic battery were considered,—the generation of electricity was dwelt on,—the mode by which it passed from one plate in a series to another,—and the loss of power consequent upon the resistances, in passing from a solid to a fluid, and again from a fluid to a solid, was explained. It was insisted, that under any circumstances, with the present forms of the voltaic battery, it was useless to attempt to utilise, in this direction, the chemical electricity generated. All study should be directed to the development of electricity by chemical action, so as to secure, if possible, the whole of the electricity developed by every change of form in matter. More emphatically the author endeavoured to enforce the law, that all mechanical force, of whatever kind, whether horse, or man-power,—steam-power,—or electrical power,—involved a change of the forms of matter, to produce that force. That to produce motion, it was essential to use matter, and that virtually, in all cases, it must be destroyed as a useful agent. Thus—that a man or horse moving a weight consumed muscle equivalent to that weight, and the space through which it moved. That a steam-engine drawing a train, pumping water, or impelling any machinery, consumed, in the production of steam, a quantity of fuel exactly representing the work done. That in producing motion by electricity, the element changing its form to produce that motion, was one of the solid agents employed in the battery, and the exciting fluid element used.

An equivalent of matter, in changing its form, would produce an equivalent of force, which might be rendered available;—but as there was a constant relation between the chemical combining proportion of any element, and its capability to produce mechanical power, the question of the application of electricity, as a motive force, was narrowed to the enquiry into the quantity of power produced relatively by fuel in the furnace; and by zinc, or iron in the battery. It had been proved by experiment, that 6 grains of carbon in the fuel produced a motive power equal to 32 grains of zinc in the battery, and that, under the best possible conditions, an equal result would be secured, by the combustion of 6 pounds of anthracite coal,—the most carbonaceous fuel,—as by the conversion in the battery of 32 pounds of zinc into oxide. Another and a parallel form of putting the case was, that the 32 pounds of zinc burnt in the furnace would develope precisely the same quantity of heat as that which would be obtained from burning 6 pounds of charcoal in the same furnace. That whether producing heat during combustion, or electricity during chemical change, the mechanical force obtained would be precisely the same. Hence the commercial question of cost was greatly in favour of steam, and adverse to the use of electricity as a motive power.

ROYAL SCOTTISH SOCIETY OF ARTS.

A Description of the Ganges Canal. By THOMAS LOGIN, Esq., C.E., Executive Engineer in Pegu.

The author exhibited large and well-executed diagrams illustrative of his communication. He stated that as canals in India are chiefly introduced for irrigation, though also navigable, they are greatest at their source, and diminish in volume as they approach their lower extremities, having to give off branches for irrigation all along their course. They are, therefore, like arteries, which convey nourishment to the animal system; while rivers, like veins, convey it away, and increase in volume as they approach the sea. The Ganges Canal, therefore, though 150 feet wide at its head, is only twenty feet broad at its termini on the Ganges and Jumna rivers. In the first twenty miles of the Ganges Canal, where it crosses the drainage of the Sewalik or lower Himalayan range, were the chief difficulties to be overcome. This drainage was disposed of as follows :—First, by allowing the minor torrents to flow into the Canal; second, by passing two rivers over the Canal; third, by making the Ratmoo river to flow through the Canal; and lastly, by conveying the Canal over the Solani Valley, and causing the river to flow under it. "After passing the Solani Valley, the Canal reaches the high level between the Jumna and Ganges, which is called the *Doab*," so that from this point it flows along the backbone of the country, giving off branch lines above the heads of those rivers which drain the Doab. These irrigation branches, as well as the main canal, therefore flow parallel to the natural drainage of the country. By this means the water can be drawn off to almost every field for irrigation; at the same time, where requisite, the Canal is made to drain the country as well as irrigate it, and thus, it is hoped, improve the climate. To assist in illustrating the paper, a few diagrams were shown, without which no very clear idea of such a work as the Ganges Canal can be arrived at. However, to give some conception of the magnitude of this Canal (it might be called a river, as it discharges as much water as the Tay, the Clyde, and the Forth all put together), second to few public works in the world, it may be all summed up in the words of Colonel B. Smith, the present Director :—"The Ganges Canal with its branches, is navigable throughout for a distance of 890 miles, along which are distributed 17 dams or escapes, with waterways from 800 to 18 feet; 202 bridges, from 200 to 20 feet waterways; 297 inlets for minor drainage; 16 falls for regulating the slope of the Canal bed; 31 locks and navigable channels; 282 rajbaha heads for irrigation channels; an aggregate length of not less than ten miles of bathing ghats, for the use of the community; 49 first-class and 122 second-class chokies, or houses, for the shelter of the establishments; six workshops; two super passages for passing torrents over the Canal, of 200 and 300 feet waterway; and lastly, the great aqueduct over the Solani river."

As to the size of some of these works, it should be added, that were all the bricks used in the construction of the Puttri and Ratmoo works placed end to end, they would have extended to a distance of four thousand miles, and those used on the Solani aqueduct would have more than encircled the globe! The excavation of the Canal alone, if formed into one cube, would have had each of its sides not less than 1365⅔ feet in length; but if *all* the earth dug had been spread over Edinburgh, which is about two and a-half square miles in area, the whole city would have been buried fifty feet below the soil! The cost of this work up to April 8, 1854, the day on which it was officially opened, was 1,400,000*l.*; and probably 600,000*l.* more will be expended before it is in full operation; yet, large as this amount may appear, the same quantity of work could not be executed in this country for less than seven million pounds sterling, even with a free grant of the land. On the first twenty miles alone there were nearly 30,000 native workmen employed; and any one of them, by giving fifteen days' warning, could demand his pay up to the day of his leaving. About two-thirds of these workmen came from Oude; and had that province been annexed a few years earlier, neither would the works have been completed in the time they were, nor would the rates have been so moderate.

The discharge of the Ganges Canal is calculated at 6750 cubic feet per second. This will furnish abundant irrigation for 4,500,000 acres; and if this water was applied to driving machinery, little short of 50,000 horse-power might be made available. As a financial measure, this great work is expected to give a direct return of 7 per cent. when it is in full operation, and double that amount in indirect revenue, by bringing portions of the country under cultivation which is now all jungle; and it also provides against such famines as that of 1836-7, when Government had to remit one million sterling of revenue, and thousands of inhabitants perished from starvation. As a political measure it is of no less importance, as it shows to the native of India a wish on the part of the English Government to add to their comforts; but the Ganges Canal will also have a powerful effect on Hindooism, in proving to the Hindoo that his sacred river can be controlled like any other stream. India is indebted to Colonel Sir P. T. Cautley for being the first to conceive the idea of turning a mighty river from its course to fertilise a country—and not only did he design every work, but saw almost all carried out to completion; to Mr. Thomason, the late Lieutenant-Governor, for aiding the project by every means in his power; and to Lord Dalhousie, who, during the Punjaub war, ordered this work to be proceeded with, as if there was no unusual drain on the Government, though every other work might stop for a time.

On the Cause of Railway Locomotives and Carriages running off the line, and the Means of Preventing it. By J. STEWART HEPBURN, Esq., of Colquhalzie.

In this paper the position assumed as the cause of this casualty is the action of the centrifugal force upon railway carriages in passing, at high speed, along a curve, coincident with what is termed a "jump" of the outer wheel of the carriage, from its encountering a dislocated joint, or other obstruction, on the rail. On a perfectly straight line of rails the direction of the momentum of the carriages is parallel to the rail, and the wheel, on the occurrence of a "jump," alights again in its place; but, on the smallest deviation from the straight line, the centrifugal force comes into action; the direction of the momentum becomes oblique to the rail—the flange of the outer-wheel is pressed against it, that of the inner-wheel opposing no counteracting power; and, if a jump then occur, the flange of the outer-wheel alights, not in its place *within* the rail, but *upon* it, and, the centrifugal force still acting, the carriage runs off the line, tearing up the rail, and dragging the succeeding carriage after it. The remedy proposed is to furnish the wheels with a double flange, by which, when a "jump" of one wheel occurs, the flange of the other wheel retains its hold of the rail, and preserves the carriage on the line. The author stated that he knew nothing to prevent the use of double-flange wheels, except the arrangement of the switches; but that, in his opinion, these could be so altered as to present no insuperable objection.

New Tent for Military and other Purposes. By FRANCIS LIGHTBODY.

As compared with the common military bell tent, the pole of the proposed tent is materially shortened, thereby increasing its stability, by presenting much less obstruction to the force of the wind. It is provided at its top with four arms, composed of wood and galvanised iron, which extend at right angles and opposite to each other, and on which the canvas covering rests. When the tent is *struck*, these arms fold into grooves, formed in the pole to receive them, and the canvas, which is permanently secured to the arms, is folded round the upper half of the pole. By means of the arms, a much larger amount of head room is obtained, and facility for complete ventilation. From partly using galvanised iron in the construction of the arms and top of pole, greater strength and durability are said to be attained. The picket-ropes are shorter, and the picket-pins less numerous in the improved tent than in the common bell tent. By the particular arrangements of the new tent as described above, additional space is said to be obtained, and greater accommodation afforded, to a larger number of troops than in the ordinary bell tent, without a proportionate increase in weight and bulk, and a smaller area of camping ground is said to be required for the tents necessary for the accommodation of a given number of men. The author stated that the practical advantages of his new tent may be estimated from the circumstance, that 1000 infantry soldiers can be accommodated in forty-eight tents of the kind proposed, while sixty-seven of the ordinary bell tents are required for the same purpose; and that the weight of the sixty-seven ordinary bell tents is 1 ton 19 cwt., while that of the forty-eight proposed tents is only 1 ton 11 cwt. 13 qrs. 15 lb.

Electro Magnetism as a Motive Power. By James Elliot.

The author considered that it would be very useful if electro-magnetic machines of every description in the possession of members of the Society, or within their reach, could be brought together and their peculiar claims discussed. With that view he exhibited two or three machines, not as new, but such as might be interesting to those who had not seen them before, briefly alluding to their distinctive principles. He showed that the expensiveness of electricity, compared with steam, as a motive power, would be compensated in some cases by its convenience; that the total amount of mechanical force obtained from a given battery power might be increased by a better mode of forming the coils, and that there was some reason to hope, although great difficulty was involved in the attempt, that the rapid diminution of power with increase of distance might be evaded. He showed different ways in which it seemed possible that that result might be attained. The author also suggested a new form of battery, applicable only to electro-magnetic engines, in which the positive metal, in the form of a disc or cylinder, should revolve, having one part out of the liquid and the other part immersed. It would thus be constantly freed from the adhering portions of hydrogen, which so much deaden its energy, and, if of copper, might be cleaned as it revolved. This would give a constant renewal of the greater power which is well known to be developed on the first completion of the circuit, but disappearing immediately afterwards.

Marine Hydraulic Propeller, applicable to Steam Navigation.
Patented by Messrs. Ruthven, Edinburgh.

The patentees stated that the object of this invention is to attain an improved method of propelling sea-going vessels of every size, and for every purpose; suitable also for every description of inland navigation; free from all the defects attributable to paddle-wheels or screw; and as these objects have been obtained, and practically tested, for a period of more than eight months, theoretical speculation as to the extent of the power, and the means of obtaining it, is now unnecessary. That the uniform advantages obtained by the hydraulic propeller are—increased speed over other vessels similar in size, of the same horse-power, and consuming the same amount of fuel; the entire command of the vessel in the hands of the officers on deck; and from the greatest speed to standing still or going backwards is accomplished without any communication with the engineer, or changing the motion of the engines, or in the slightest degree creating any strain thereon. That there being no reaction on the engines, the hydraulic propeller is free from the danger thus caused to screw and paddle propellers. An unprecedented power of backing and stopping the vessel in a space little more than her own length—an independence of the rudder, as the vessel may be made to rotate on its own centre, by the propelling medium alone. As there is no water-slip, the hydraulic propeller was stated to be eminently adapted for tug-vessels; and that how rough soever the sea may be, this propeller never loses any of its power. That the contrary is true both of screw and paddle-wheels, and of the latter in particular; when the sea runs high, one or both paddle-wheels are frequently thrown so much out of the water, and the steam-power in consequence so much lost, that the steam-tug, as well as the vessel being towed, become almost unmanageable, and liable to be shipwrecked. Lastly, that the hydraulic propeller can be adapted to vessels not exceeding *one foot* draught of water, and capable therefore of being applied to the navigation of shallow rivers, where the screw and paddle-wheels would be wholly useless.

THE EMBANKMENT AND IMPROVEMENT OF THE RIVER THAMES.

A special meeting of the Metropolitan Board of Works was held on the 21st ult., to consider the report from the Committee of Works and Improvements on the subject of a communication from Mr. Lionel Gisborne, C.E., respecting a design for the embankment and improvement of the Thames, of which he is promoter, and on a memorial from Messrs. Loder, Jackson, and Bird, the promoters of an undertaking for the "Formation of an Embankment on the North Side of the Thames, between Southwark and Westminster-bridges, and for the construction of a Railway and other Works." The following is the report of the committee:—

"Before examining the main features of the two measures which have especially engaged their attention, your committee deem it important to define certain leading objects, to which they consider that every measure of Thames embankment should be mainly directed.

They are of opinion that the embankment of the Thames should be carried out with reference to the following objects:—

1. To improve the Thames as a navigable river, having due regard to the safety of existing bridges.
2. To increase the wharfage accommodation, and improve the means for the shipment and delivery of goods.
3. To improve the Thames in a sanitary point of view.
4. To remedy the present unsightly condition of the banks of the Thames, and afford facilities by means of architectural embellishment, for improving their appearance.
5. To open up a new thoroughfare between the eastern and western parts of London.
6. To facilitate the construction of a low-level intercepting sewer.

It is proposed by the plan of Mr. Gisborne to build quay walks on both sides of the Thames, the effect of which will be to confine the waterway of the river to a width of 700 feet, the width sanctioned by the Board of Admiralty for the new bridge at Westminster. For the accommodation of the present wharves, floating basins will be constructed of a minimum width of 100 feet to be provided with entrances to admit of the ingress and egress of barges and other craft, and to remain open at least three hours each tide.

On the ground obtained by filling in, to a height of 4 feet above high-water mark, between the river wall and the floating-basins, certain works are intended to be constructed on either side of the river.

The quay wall on the Middlesex side is to extend from Westminster-bridge to London-bridge, and will be 21 feet above Trinity high-water mark, to avoid the necessity of drawbridges over the entrances to the tidal basins. At that level, and as far as St. Paul's-wharf, it is intended to have a covered esplanade for foot-passengers. The esplanade will be next the river, and 20 feet in width, along which the ground for 50 feet back will be let for building, except at particular points, where buildings would be objectionable, such as Whitehall, the Temple-gardens, &c. It appears by the drawings and report that the buildings are intended to be 70 feet above the esplanade, and 91 feet above Trinity high-water mark. Parallel with the esplanade, and extending from Hungerford-bridge to London-bridge, it is proposed to construct a railway.

Next the railway there is to be a street, varying from 90 to 40 feet in width, commencing at Westminster and terminating near St. Paul's, which street is designed to pass under each of the present bridges and have approaches to the main thoroughfares.

The remainder of the embankment having an average width of about 65 feet, will be let for building ground, suitable for large stores, &c. Capacious cellars are proposed to be formed under the esplanade, railway, and road, which will connect the river with the stores next the floating-basins, and are intended to afford facilities for unloading barges.

Opposite Whitehall, the Temple-gardens, &c., and in other parts, the quay wall is to be built only 4 feet above Trinity high-water mark, and the esplanade, railway, &c., are to be carried on columns 25 feet apart, so as not to exclude the view of the river, or interfere with existing wharves, between a point near St. Paul's and London-bridge, and for this distance an additional width of about 40 feet will be added to the present wharves.

On the Surrey side the quay wall is to extend from Lambeth Palace to London-bridge, for the greater part of which distance it will be about 21 feet in height above Trinity high-water mark. Next the river a road 70 feet wide will be formed, along which the ground is to be appropriated to the erection of large stores, shops, &c.

At each of the bridges it is proposed to divide the road into two; one half forming an approach to the bridge, the other accommodating the through traffic and passing underneath.

Cellars, similar to those on the Middlesex side, and appropriated to like purposes, are to be constructed under the road on this side of the river.

The promoters of the plan state that it will afford peculiar advantages for the construction of a portion of the low level sewer, forming part of the scheme of main intercepting drainage on the north side of the river.

It is stated that the works can be executed for less than 2,000,000*l*., and it is calculated that the annual ground-rents of shops, warehouses, wharves, &c., with the receipts from the railway, will amount to 103,000*l*.

The promoters offer to apply to Parliament for a private bill, enabling them to carry out their objects, if this Board will guarantee them 4 per cent. upon a capital of 2,000,000*l*. secured on the metropolitan rates; the guarantee to take effect only on the completion of the works, and to be limited to making up a net revenue equal to 4 per cent. upon 2,000,000*l*., in case the revenue derivable from the ground-rents and railway should prove insufficient; the enjoyment of the ground-rents by the company to be limited to 60 years, and half the surplus profit beyond 5 per cent. to be handed over to this board in furtherance of public improvements.

The objects of the Thames Embankment and Railway, as appears by the statement signed on behalf the promoters and by the explanations of Mr. Bird, are to construct an embankment and other works, comprising floating and tidal docks on the north side of the Thames, between Southwark and Westminster bridges, and to form a public road and footways to be carried on a viaduct along that part of the embankment between Whitehall-place and Charing-cross, and Chatham-place, Blackfriars, having communications with some of the streets leading out of the Strand; It has also for its object the laying down of a railway. at a low level, within the line of embankment from Queenhithe, near Southwark-bridge, to Manchester-buildings, near Westminster-bridge, and aqueducts are to be carried over the railway, to allow of the ingress of craft from the river. The plan originally included an extension to the Greycoat Hospital, near the new Victoria-street, to join the Westminster Terminus Railway; but in consequence of the abandonment of a large portion of the latter scheme by its promoters, it is understood that this part of the undertaking is relinquished or suspended.

It is urged by the promoters that an intercepting sewer might be advantageously erected in connexion with the works of the embankment at a greatly reduced cost, as the dams which must necessarily be used for the construction of the embankment would, for a considerable portion of the distance, be available for the construction of the sewer.

The estimate for the contemplated works is 583,770*l*, and the promoters look to the railway as the source from which their profits are to be derived.

With regard to the first of the conditions above suggested—namely, the improvement of the Thames as a navigable river, having regard to the safety of existing bridges,—your committee have to observe that neither of the schemes referred to them exactly coincides with the line of embankment laid down by Mr. James Walker, and which it is understood was approved by competent authority; but they are of opinion that, provided the width of waterway be not diminished below that now existing at the narrowest part of the river, a little above London-bridge —viz., 700 feet—the variations in the designs before them are not such as injuriously to affect the navigation.

It may also be stated that by the line laid down by Mr. Page, and approved, after long examination, by a committee of the House of Commons, it was intended to narrow the waterway of the river to a greater extent than is proposed by either of the schemes which have been referred to your committee.

As regards the criterion set up by the second of the above conditions—namely, increased wharfage accommodation, improved means for the shipment and delivery of goods, and the means of access for barges—they consider Mr. Gisborne's plan superior to that of Messrs. Bird, Loder, and Jackson.

The basin or docks shown on the latter plan are deeper than the aqueducts which lead to them, a feature which the committee regard as objectionable; but as each of the schemes before the board contemplate the covering of the mud-banks, they would, in this respect, both be beneficial in a sanitary point of view.

With reference to the fourth condition, that is to say, the improvement of the appearance of the river-banks, it is to be observed that, as by Mr. Gisborne's plan it is proposed to erect buildings in some instances 91 feet above high-water and 70 feet above the esplanade, your committee consider that this would involve an obstruction to light and air, and form an objection to Mr. Gisborne's plan which does not apply to the plan of Messrs. Bird, Loder, and Jackson.

Both schemes, in proportion to their extent, satisfy the fifth condition—namely, the opening up of a new thoroughfare between the eastern and western portions of the metropolis.

And both schemes present equal facilities for the accomplishment of the sixth object—namely, that of facilitating the construction of a low-level intercepting sewer.

Your committee think it necessary to add, that, in their opinion, the promoters of each of the designs under discussion have prejudiced the efficiency and value of those designs as works of public utility by seeking to render them commercially remunerative; and they consider that the public advantage should be the primary object in a work of such magnitude and of so peculiar a character as the embankment of the Thames."

NOTES OF THE MONTH.

The shop, No. 114, Piccadilly, well known as Mr. Truefitt's, is now being converted into a private residence for Theodosius Uzielli, Esq. The front is being cased entirely with stone, and the whole of the very ornamental design of the former shop has been re-modelled and re-carved where retained the new carving and general design being made to accord with that kept. In the old front, which notwithstanding was striking, and arrested attention, the features were taken from almost every known style of ornament, and the whole effect was too "showy" for a private residence. In the new ground-floor front, which is all that will be seen by passers-by, ornament has by no means been stinted, and red serpentine marble is used—for the first time, it is believed, externally—for the columns in the windows, and for inlaying a part of the window-heads. Brocadilla is used for the pilasters. The whole is from the designs of Mr. James Edmeston, jun; the carving is by Mr. Seale; the Architectural Pottery Company, of Poole, are supplying the paving to ground-floor passages; and Messrs. Hart and Son have the contract for iron-work, some of which will be very ornamental. The convolvolus and passion-flower are taken as original types for the ornamentation throughout.

A new Independent chapel was recently opened at Batley. It is built of Yorkshire stone, in the early Decorated style of Gothic architecture, and measures 68 feet by 36 feet, and 30 feet in height within (the roof not being open to the apex). It consists of the chapel, vestry, with organ gallery over, gallery at the west end, and tower and spire 100 feet in height placed at the south-west angle, outside the external walls. The whole has been executed from designs by and under the superintendence of Mr. Michael Sheard, jun., architect, Batley, at a cost of about 1700*l*., exclusive of the land.

In our notice of the Government barracks competition (*ante* p. 126) we stated that the third prize had been awarded to Mr. Jones, of Sleaford. It should have been, the third prize of 50*l*. was awarded to Mr. J. P. Jones, of Seaforth, near Liverpool, and Cambridge-street, London.

More than ten years since the restoration of the cathedral church of Llandaff began with that of the ladye chapel at the eastern end. The presbytery, the choir, and the unfallen portion of the nave, have regained their original character by the reconstruction of the clerestory, the removal of the Italian cornice, and the restoration of the roof to its primitive form. The beautiful Norman arch between the nave and the eastern chapel has been disclosed to view, while a suitable reredos has replaced that of Bishop Marshall, which was too dilapidated to be permitted to remain. The nave has been laid with encaustic tiles, and appropriate seats have been provided for a congregation. The pulpit and sedilia, of a rich design, are still in progress; but the whole work was so far advanced that the cathedral was reopened for public worship on the 16th ult. 9000*l*. have already been expended on the restoration. The work has been carried on under the direction of Mr. Wyatt and Messrs. Prichard and Siddon, the diocesan architects, and the result has elicited great approbation. A proposal has recently been made for the entire restoration of that part of the fabric which is still a ruin. To accomplish this 10,000*l.* more will be required; a considerable portion of which has been already either subscribed or promised; and there is reason to hope, therefore, that this beautiful cathedral will speedily be completely restored.

Among the attainments of modern science we feel pleasure in noticing that a desideratum appears to have been attained for remedying one of the cardinal miseries of domestic life,—a simple and inexpensive cure for a smoky chimney. Mr. John Billing, F.R.I.B.A., of Westminster, has so far mastered the subject that he has remedied the chimneys upon a considerable portion of Somerset House,—about 150 flues,—which were entrusted to him for that purpose by the Office of Works three months since; and we are glad to hear that no complaints have since arisen of inefficiency or defect of any kind. The appearance of the edifice architecturally is much improved by the alteration, which, as far as we can judge, will be altogether free from derangement, whether from the effects of weather, ordinary use, or sweeping. The method has been applied to numerous buildings of all classes with the same success; and we cannot but hope that it will prove to be what it appears,—a real panacea for all smoky houses.

A return has been published recently of all gasworks established by Act of Parliament in England and Wales, with various particulars, such as the charge per foot, the average quantity of gas evolved from a ton of coal, the illuminating power, and the cost. The London Gaslight and Coke Company charges from 4*s.* to 4*s.* 6*d.* per 1000 cubic feet (Newcastle coals), and 6*s.* for cannel gas. The average quantity evolved is 9000 cubic feet from Newcastle, and 10,000 feet from cannel coals. Five feet of Newcastle gas is equal to 12 candles, and five feet of cannel gas equal to 26 candles. The Imperial Gaslight and Company charges 4*s.* 6*d.* per 1000 feet, and produces 9518 feet of gas from one ton of coal. The quantity of gas evolved in London varies from 8500 to 10,000 feet from one ton of coal, and the illuminating power from 12 to 14·2 candles. The Phœnix Company uses Newcastle and cannel coals mixed.

The first section of the Santander and Alar Railway, Spain, which is being constructed by Mr. Mould, for a Spanish company, has been recently opened. The entire line is rather more than 80 miles in length, and will connect the rich provinces of Castile, and ultimately the capital of Madrid, with Santander, and the great northern seaport of Spain. The southern section, upwards of 30 miles long, between Alar-del-Rey (the terminus of the Canal of Castile) and Reynosa, is now in active operation. The inauguration pageant took place on the 28th of March last, the interest of the spectacle being greatly enhanced by its extreme novelty, for the completion of a railway and the working of locomotives in that lofty and romantic region (3500 feet above the level of the sea, and, consequently, of the northern terminus of the line), has been regarded as a perfect marvel, even by some who are aquainted with such arduous works in our own country as those of the Lancaster and Carlisle line, with which Mr. Mould's name is associated. On the 1st ult. the business working of this section of the railway was commenced, the departure of the first train, conveying about 150 tons flour, iron, and other goods, being witnessed by an immense concourse of curious spectators, to whom the mule and bullock carts of the country had hitherto presented the only means of conveyance. The traffic of the line will chiefly consist of flour, grain, cattle, and the other superabundant agricultural produce of the Castiles; and the railway, when completed throughout, will offer to passengers the most convenient and direct route from England to Madrid.

M. Verrier, engineer, who is engaged in clearing away the Rose Rock, which obstructs the entrance of a part of the harbour of Brest, called the Penfield, made an experiment recently which was perfectly successful. A man, covered with a diving-dress, descended to the rock at half-tide, and deposited a box full of gunpowder, to which were fitted two gutta-percha tubes, also similarly filled. As soon as the man had come up a light was applied to the tubes, and shortly after a loud cracking noise was heard, and a large column of water, with fragments of stone and a quantity of sand and mud were thrown up to the height of 20 feet.

COMPETITIONS.

The Corporation of the Borough of Hertford wish to receive Plans, Specifications, and Estimates for reconstructing and raising the roof of the Corn Exchange, for ventilating the building generally, and making improvements in the interior. Premium, 10 guineas, unless employed to superintend the works. Particulars may be had at the Town Clerk's Office, Castle-street, Hertford, to whom plans are to be sent by the 11th instant.

A Design is required for a new public room, and other buildings, to be erected at Strick landgate, Kendal. Particulars, with a plan of the site, may be obtained on application to Mr. C. Webster, Borough Surveyor, Kendal. 20*l.* is offered for the best design. Designs to be sent in by the 18th inst.

The Corporation of Chichester are desirous of receiving Plans, Designs, Specifications, and Estimates for laying out and enclosing the burial-ground, and for the erection of two chapels, lodge, entrance, and boundary fence. A premium of 20*l.* will be given for the best design. Should the architect carry out the design, a commission of 5*l.* per cent. will be paid. The sum to be expended not to exceed 2000*l.* The area to be enclosed is about six acres. A plan of the ground, and any other information may be obtained on application to the Town Clerk of Chichester. Designs to be sent in by the 20th instant.

Plans and Designs are wanted for laying out the Bellfield-park estate, near Weymouth, comprising 120 acres, for building purposes. Designs to be sent to Mr. R. Damon, Weymouth, by the 20th instant.

Plans and estimates are required for the rebuilding the Parish Church of Bowden, near Altrincham, Cheshire. The ancient type to be preserved, and restored, as far as possible. The church consists of a nave, with clerestory, western tower, north and south aisles, south porch and north door, chancel with north and south chapels. The monuments to be preserved and reinstated. The roof to be raised, and the seats rearranged, so as to increase the accommodation as much as possible. Estimates are required, allowing for the use of such old materials as may be suitable. The drawings to be prepared without colour or tinting of any kind, to the scale of 8 feet to an inch, and to be sent in addressed to the Vicar and Churchwardens of Boden, near Altrincham, Cheshire, on or before the 21st instant. Sixty guineas will be awarded to the most approved design, and 30 guineas to that considered next in merit. Further particulars may be obtained of John Mort, Churchwarden, Altrincham.

Designs are invited from artists of all countries for a Monument to be erected in St. Paul's Cathedral, to the memory of the late Duke of Wellington. The cost, with all expenses, not to exceed 20,000*l.* Premiums of 700*l.*, 500*l.*, 300*l.*, 200*l.*, and five of 100*l.* A ground-plan of the cathedral, and the site of the proposed monument, &c., will be forwarded, on application to Mr. Alfred Austin, Office of Works, Whitehall. Designs from artists residing in the United Kingdom to June 1st, 1857; from artists residing abroad to the 25th of the same month.

The Council of the Borough of Brighton are desirous of obtaining Designs and Plans for appropriating the northern buildings comprised in the Pavilion Estate. 200*l.* will be paid for the best, and 50*l.* for the second-best designs. Designs to be sent in by the 10th July next, to Mr. Charles Sharood, Town Clerk, Brighton.

Plans and estimates are wanted for alterations and additions required to the County Gaol, Kilmainham, Ireland, in order to carry out the separate system. Premiums, 25*l.*, 15*l.* and 10*l.*

The premium of 20*l.* for the best Design for laying out the new cemetery at Cardiff, erecting the chapels, &c., has been awarded to Mr. R. G. Thomas, architect, Newport, Monmouthshire, who will also superintend the proposed works.

The Directors of the West Riding Union Banking Company have selected the Designs of Mr. Michael Sheard, jun., architect, Batley, for their new bank and manager's house, to be erected at Dewsbury. The probable cost will be from 3000*l.* to 4000*l.*

The Warwick Burial Board have selected the Designs of Mr. E. Holmes, of Birmingham, consisting of two chapels united by a covered archway surmounted by a bell-turret. The Episcopal Chapel is on the right, and the Dissenters' on the left. They are different in design, the former being of the Early Decorated, and the latter of the Early English period.

The Committee have selected three designs for the new Lichfield Museum, those prepared by Mr. Cranston, of Birmingham, Mr. Veale, of Wolverhampton, and Messrs. Bidlake and Lovatt, of Wolverhampton; and have requested those gentlemen to re-arrange their plans to suit another and more convenient site.

The Metropolitan Board of Works have given notice that they wish to receive designs from Architects, Engineers, and others, showing the best mode of laying out the surface and subsoil of an intended new street in Southwark, as an example of a first-class street, and of an intended new street between Cranbourn Street, Leicester Square, and King Street, Covent Garden, as an example of a second-class street, and showing any improved means of facilitating the traffic and the better disposition of the private vaults, sewers, drains, gas and water pipes, telegraph wires, &c., with such underground or surface arrangements as may be adapted to those and other useful purposes.—Premiums for first-class street, 100, 50, and 10 Guineas; for second-class street, 50, 25, and 5 Guineas.—The width of the first-class street will be 70 feet from front to front of the houses, and the level of the invert of the sewer at the junction of Stamford Street and Blackfriars Road, will be 1·40 above Ordnance datum; the invert at Wellington Street, London Bridge, 0·75 above Ordnance datum, and the area of the sewer 14 superficial feet.—The lowest level of the crown of the road is to be 12·55 above Ordnance datum; length of street, 1130 yards. The width of the second-class street, will be 50 feet from front to the front of the houses, and the level of the invert of the sewer, in St. Martin's Lane, 50·69 above Ordnance datum; the invert of the sewer in King Street, 57·32, above Ordnance datum, and the area of the sewer, 8 superficial feet. The lowest level of the crown of the road is to be 67·9 above ordnance datum; length of street, 135 yards. It is an essential condition of a first-class street, that it should contain facilities for the supply of gas, water, telegraph, and sewer communications to the houses on each side of the street, and also leading mains for an entire surrounding district. A second-class street must contain facilities for the supply of gas, water, telegraph, and sewer communications to the houses on each side of the street, without provisions for the surrounding district.—The designs to be on double elephant drawing paper, drawn to a scale of half an inch to a foot, and must comprise a plan, a longitudinal section of a portion of the street taken down the centre, longitudinal section near the line of the houses, and also a transverse section, with such descriptive details as can be shown on one sheet of double elephant paper; the drawings to be in line, and shaded (if and where necessary) in Indian ink, or sepia only. The plans must embrace service connections, of gas and water pipes, &c., and surface paving for foot and road ways; provision must also be made for surface drainage, comprising gullies, channels, &c. Every design must be accompanied by an estimate of the cost per lineal yard for each class of street. It is proposed that the designs shall be publicly exhibited after the decision.—Robert Stephenson, M.P.F.R.S.; Thomas Hawksley, C.E.; Thomas H. Wyatt, F.R.I.B.A., A.C.E.; and George Lowe, F.R.S., C.E. will be associated with a committee consisting of John Thwaites, Chairman of the Metropolitan Board of Works, and Alderman Cubitt, M.P., and Alexander Wright, members of the Board, assisted by the Engineer and Superintending Architect of the Board, for the purpose of deciding upon the merits of the designs. Further information may be obtained on application to the Superintending Architect, at the Office of the Metropolitan Board of Works, Greek Street, Soho Square. The Designs to be sent in by the 1st day of July next, to E. H. Woolrych, Clerk of the Board.

NEW PATENTS.

PROVISIONAL PROTECTIONS GRANTED UNDER THE PATENT LAWS AMENDMENT ACT.

Dated December 12, 1856.

2954. H. Wimball, Aldermaston, Berks—Improvements in machinery or apparatus for the manufacture of bricks, tiles, pipes, and other articles of a similar nature

Dated December 20.

3017. E. Loos, Leicester-square—Improvements in the manufacture of cement, mortar, concrete, and artificial stone

Dated December 22.

3031. T. Roberts and J. Dale, Manchester, and J. D. Pritchard, Warrington—Improvments in the manufacture of oxalate of soda, which improvements are also applicable to the manufacture of oxalic acid

Dated January 6.

38. H. A. Jowett, Sawley, Derby—Improvements in steam engines

Dated January 17.

189. C. F. Vasserot, Essex-street, Strand—Improved paint. (Communication from L. Kaercher and F. Perrin, Marseilles, France)

Dated January 20.

163. A. V. Newton, Chancery-lane—Improvement in the manufacture of hosiery. (Communication)

Dated January 27.

234. C. T. Hook, Snodland, Kent—Improvements in the manufacture of paper. (Communication)

Dated January 31.

288. D. Morrison, Bordesley Works, Birmingham—New or improved manufacture of ordnance

Dated February 18.

477. T. W. Davenport, Ormond-street, Birmingham, and S. Cole, Wilton-street, Aston Manor, Warwick—New or improved method of manufacturing and ornamenting articles in papier maché and charcoal

Dated February 19.

482. L. Wilks, Bedford Row—An apparatus for signalling between the guards and engine drivers on railway trains, which is also applicable to other similar purposes
486. J. Abernethy, Westminster—An improved mode of constructing breakwaters in deep water
487. J. Crook, Winckworth Place, Hoxton—Improvements in looms for weaving elastic and other fabrics
488. T. Clayton, Manchester,—Improvements in machinery or apparatus for ornamenting and embossing wood, leather, paper, and other similar articles
489. W. Clark, Chancery Lane—Improvements in the manufacture of sheet glass.—(communication)
490. J. Lord, Brierly Street, Rochdale, and W. Soothill, Stock Road, Rochdale—Improvements in steam boilers for the more effectual consumption of smoke, whereby a great saving of coal will be effected
491. H. Y. D. Scott, Brompton Barracks, near Chatham, Kent—An improved manufacture of cement
492. P. Cato and J. Betterley, Liverpool—Improvements in the masts, yards, and spars for ships or sailing vessels

Dated February 20.

493. W. Oakes, Stockton-on-Tees, Durham—Improvements in the manufacture of iron
494. H. T. Helyer, Ryde, Isle of Wight—Improvements in the construction of bridges and arched structures
495. E. Edwards, Abenbury Forge, Wrexham, Flint—Improvements in the manufacture of chains for cables and other purposes
496. J. Grist, Islington—Improvements in mash tuns and in apparatus to be employed therewith, which apparatus is also applicable to the heating and keeping up of a continuous circulation of liquids in any vessel to which it may be connected
497. R. A. Brooman, Fleet Street—Improvements in steam digging apparatus suitable for draining and excavating purposes, parts of which are applicable to reaping. (Communication)
498. J. R. Crook, Birmingham—Improved material for, and an improvement in, the manufacture of hat-tips, which material is also applicable to the manufacture of hat and other boxes or cases
499. J. Combe, Leeds—Improvements in the construction and driving of power looms in the formation of shuttles, and in the winding and arrangement of weft, parts of which improvements are applicable to other purposes
500. F. C. Jeune, Gresham Street—Improved manufacture of artificial leather
501. J. Glover, and J. Bold, Liverpool—Improvements consisting of extended uses of photography as applied to dials, tablets, and pictures
502. W. Zipser and J. P. Klein, Biala, Galicia, Austria—Improved machinery or apparatus to be used in the manufacture of woollen cloth
503. I. Aldebert, Long-acre—Improved shackle for the springs of carriages

Dated February 24.

536. C. S. Latruffe, South-street, Finsbury—Improvements in heating apparatus.
537. R. A. Brooman, Fleet-street—Improvements in under-skirts or petticoats. (Communication)
538. S. W. Hawks, Gateshead-upon Tyne—Improvements in railway-chairs.
539. J. Betteley, Liverpool—Improvements in machinery for lifting and working anchors, cables, and other weights on shipboard.
540. J. Robinson, Glasgow-terrace, Thames-bank, Pimlico—Improvements in the stages used in green-houses and hot-houses
541. A. Parkes, Birmingham—Improvements in separating tin from tin-plate scrap, and tin or zinc from other surfaces of iron.
542. J. Pullar and L. Pullar, Perth—Improvement in the manufacture of umbrellas and parasols
543. J. H. Johnson, Lincoln's-inn-fields—Improvements in fastenings for dress and other purposes. (Communication from H. Marie, Paris)
544. G. M'Callan, Johnstone, Renfrew—Improvements in air and water discharge apparatus for steam-pipes
545. A. Mitchell, Peterhead, Aberdeen—Improvement in harpoon-guns
546. J. Thornton, Belfast—Improvements in the manufacture of bricks, tiles, and tubes of earthenware

Dated February 27.

578. E. Mucklow, Bury, Lancaster—Improvement in the manufacture of "alizarine"
579. W. H. Thornthwaite, Newgate-street—Improvements in barometers

Dated February 28.

594. P. A. le Comte de Fontainemoreau, South-street, Finsbury—Improvements in finger and other rings. (Communication)

Dated March 3.

617. G. Sileoni, Genoa—Obtaining starch from a plant called arum maculatum and arum Italicum, and from all other roots and plants of the arum genus
618. J. Broad, Drury-lane—The application of artificial boards, or papier maché, or patent composition boards (or partly so) of any vegetable fibre, and the like, either in its raw state or worked up from old substances, to friction washers of every description of wheeled carriage and cart axles, also for covering wing and dash irons, and forming heel boards for Hansom cabs

Dated March 4.

630. R. Bodmer, Thavies-inn, Holborn—Improvements in apparatus for steering ships. (Communication from J. D. Gherel, Genoa)
632. T. Brown, Fenchurch-street—Improvements in capstans
634. T. W. G. Treeby, Westbourne-terrace-villa, Paddington—Improvements in sewers and gulleys, and outfall to sewers and gulleys, and of sewage
636. W. E. Newton, Chancery-lane—Improvements in machines for cutting standing crops. (Communication)
638. J. Stephens, Northampton-road, Clerkenwell—Improvements in paint brushes and in similar kinds of brushes

Dated March 5.

640. W. F. T. Bradshaw, Thomas-street, Sheffield—Improvements in making palette and other like knives
642. J. L. F. Bardin, Paris—A new mode of ornamentation
644. W. Holland, Birmingham—New or improved manufacture of runner notches and top notches for umbrellas and parasols
646. A. Ansens, Paris—Improvements in moulds or forms for loaves of sugar
648. J. Woodley and H. Swinford, Limehouse, Middlesex—Improvements in sawing machines
652. W. E. Newton, Chancery-lane—Improved manufacture of tracing cloth. (Communication)
654. G. T. Bousfield, Sussex-place, Loughborough-road, Brixton—Improvements in machinery for compressing clay and other materials applicable to the manufacture of bricks and other articles. (Communication)

Dated March 6.

658. W. Findlater and W. Keetley, Birmingham—Improvement or improvements in carriages
660. G. Danré, P. F. Mouillard, and P. A. Mercier, Paris—Improvements in carbonising or distilling wood, peat, oil-cake, coal, and other substances for the production of gas for lighting, in carburetting or increasing the illuminating effect of and in compressing gas, also in the apparatus employed for such purposes
662. R. A. Brooman, Fleet-street—Improvements in furnaces and fire-places. (Communication from A. E. Dussard, Marseilles)

Dated March 7.

666. G. Hawksley, Bromley, Middlesex—Improvement in constructing apparatus for heating and cooling air, steam, and other fluids
668. W. Urquhart, New Oxford-street—New mode of ornamenting household furniture
670. R. J. Maryon, Hooper-street, Westminster-road—Improvements in the construction of steam locomotive engines
671. P. McGrade, Upper Liffy-street, Dublin—Improved machinery or apparatus for propelling ships or boats
672. R. A. Brooman, Fleet-street—Improved method of, and apparatus for, maintaining the water levels in boilers. (Communication)

Dated March 9.

676. J. D. Lee, Shipley, Bradford, and J. Crabtree, Windhill, Calverley, York—Improvements in power looms
677. F. S. Hemming, Westminster—Improvements in the manufacture of railway chairs and sleepers
678. W. Tytherleigh, Birmingham—Improvements in the manufacture of bullets and shot
682. E. Cook and J. Stokes, Birmingham—Improvements in certain parts of metallic bedsteads
684. F. Simpson, Redhill, Reigate—Improved mode of forming a screw in the necks of bottles, jars, and other similar vessels
686. C. H. J. W. Liebmann, Fartown, Huddersfield—Improvements in the purification of water, and the preparation of materials requisite for the process. (Communication)
688. W. E. Newton, Chancery-lane—Improvements in steering apparatus for ships and other vessels. (Communication)
690. J. G. Marshall, Leeds—Improvements in machinery for preparing flax, hemp, China grass, and other fibrous substances
692. W. H. Barlow, Derby, and J. Samuel, Great George-street, Westminster—Improvements in cast-iron sleepers for railways
694. F. A. Fitton, Ardwick, Manchester—Improvements in certain machines for preparing, spinning, and doubling cotton and other fibrous substances

Dated March 10.

698. W. C. Day, the Strand—Improvements in portmanteaus
700. J. Hamilton, Rochdale—Improvements in coating iron and other metals with metallic substances
702. R. L. Jones, Chester—Improvements in regulating clocks by electricity

Dated March 11.

703. G. Mountford, Caledonian-terrace, Leeds—Improvements in machinery or apparatus for cutting or chopping loaf sugar, roots, and other substances
704. W. Makin, Hollingworth, Chester—Improvements in furnaces and apparatus for generating steam
705. C. E. Giajola, Birmingham—Improvements in moderator lamps
706. S. Denham, Strafford-square, Wakefield—A self-acting machine for the delivery of postage and receipt stamps
707. W. Boden, Blackwall—Improved apparatus for flushing water-closets and urinals
708. J. R. R. Humfrys, Salford—Improvements in apparatus for burning gas
709. W. Hale, Swan-walk, Chelsea—Improvement in rolling iron and steel
710. J. D. Cooper, Great James-street, Bedford-row—Improvements in producing engraved surfaces for surface printing

Dated March 12.

711. J. J. Derriey, Paris—Improvements in machines for manufacturing losenges, wafers, or pastilles of pasty materials
712. A. Viscount de Waresquiel and J. D'Hello, Paris—Improvements in railway carriages
713. J. Avery, Essex-street, Strand—Improved method of purifying schistous or bituminous oils. (Communication from C. Camus, and J. Missilier, Paris)
714. J. Avery, Essex-street, Strand—An improved method of preserving butter. (Communication from J. Girard, Ml Commet, France)
715. G. Travis, Mercaston, Derby—Improvements in apparatus used in the manufacture of cheese
716. J. Shaw and W. Mainwaring, Britannia Works, Banbury—Improvements in machinery or apparatus for cutting or reducing turnips or other vegetable substances
717. W. E. Newton, Chancery-lane—Improved machinery for drawing and preparing silk, cotton, wool, flax, hemp, and other fibrous substances. (Communication from A. L. Warnery, Lyons, France)
718. W. E. Newton, Chancery-lane—Improvements in the process of, and apparatus for tanning. (Communication from C. C. Knoderer, Strasbourg, France

Dated March 13.

719. T. Horne, jun., Birmingham—New or improved method of ornamenting metallic bedsteads and wash-hand stands
720. E. Berger and E. Matile, Paris—Improvements in machinery for beating and brushing carpets
721. S. L. Taylor, Cotton End, Bedford, and T. Rolfe, Northhill—Improvements in boilers for generating steam, heating water, and for other heating or boiling purposes

722. W. R. Nevins and J. J. Yeats, New York, U. S.—Improvements in preparing and baking bread and biscuits, and in machinery employed therein
723. W. W. Squires, Liverpool—Improvements in the means of letting on and drawing off water and other fluids
724. A. W. Heaketh, Accrington, Lancaster—Improvements in looms
725. E. J. N. Juvin, Paris—Improvements in producing printing surfaces

Dated March 14.

726. C. Cowper, Southampton-buildings, Chancery-lane—Improvements in the manufacture of artificial leather, or a substitute for leather. (Communication from A. Micoud, Paris)
727. J. Wheatman and J. Smith, Sheffield—Improvements in the mode of grinding circular saws
728. R. Macdonald, Glasgow—Improvements in sewing or embroidering textile fabrics (Partly a communication)
729. H. Bridges, Bridgewater—Improvements in buffing, bearing, and draw springs, and buffer cases for railway purposes
730. J. P. Oates, Edrington, Warwick—Improvements in machinery for the manufacture of bricks, tiles, pipes, and other articles made of plastic materials
731. M. Nunn, Hampstead—Improvements in machinery or apparatus for washing or cleansing cloths, piece-goods, and other articles
732. H. Bradley and E. Wray—Improvements in beaters used in thrashing-machines
733. T. Bowden, Pendleton, Lancaster—Improvements in apparatus for discharging the water resulting from the condensing of steam used in apparatus heated by steam

Dated March 16.

734. G. Marshall, Morpeth, Northumberland—Improved saw-setting apparatus
736. J. Thomson, Black Ruthven—Improvements in mowing and reaping machines. (Communication from W. Thomson, Canton, Illinois)
737. H. Glaysher, Isle of Wight—Improvements in steam-engine boiler and other furnaces
738. H. Martin, County Lunatic Asylum, Hanwell—Improvements in apparatus for the supply of water to steam-boilers
739. G. J. Hall, Archer-street St. James'—Improvement in finishing fabrics made wholly or partly of silk
740. J. Moss, Rue de l'Exchiquier, Paris—Improvements in warming and ventilating
741. R. A. Brooman, Fleet-street—Improvements in zincing or coating getals with zinc, and in cleaning metals. (Communication)
742. R. A. Brooman, Fleet-street—Improvements in apparatuses for splitting leather, in order to manufacture tubes, sheaths, and other articles. (Communication)

Dated March 17.

743. N. J. Amies, Manchester—Improvements in machinery or apparatus for polishing and finishing yarns or threads
745. H. B. Palmer, Bermondsey—Improved fire lighter
746. G. F. Remfry, Riches-court, Lime-street—A portable apparatus for working punkas and whisks
748. T. Dean, Whittle-lane, near Burnley—Improvements in looms
749. W. E. Newton, Chancery-lane—Improvements in folding window blinds and shutters. (Communication)
750. W. E. Newton, Chancery-lane—Certain Improvements in artificial legs. (Communication)
751. M. Anquetin, Paris—Improved traveller's watch
752. J. Withnall, Manchester—Improvements in the manufacture of rollers or cylinders to be employed for printing calico and other surfaces
753. W. MacNaught, Rochdale—Improvements in engines worked by steam or other motive power, and in their gearing for connecting them with machinery, and in the means of lubricating such engines
754. W. McCulloch, and T. Kennedy, Kilmarnock—Improvements in stop-cocks or valves
755. G Forsyth, Stakeford Foundry, Maxwelltown, Kirkcudbright—Improvements in steam cooking apparatus
756. J. Fox, Preston, Lancaster—Improved music scale

Dated March 18.

757. J. Millar, Edinburgh—Improvements in stoppers or closing apparatus for decanters, bottles, and other receptacles
758. T. Yarrow, Arbroath, Forfar—Improvements in locomotive steam engines
759. J. Green, Philadelphia, United States—Improvements in gas consuming furnaces, and in the automatic action of the controlling valves or dampers of the said furnaces
760. F. B. Loubatières, France—Improvements in the manufacture of paper, cardboard, and pasteboard
761. J. Murdoch, Staple-inn—Improved process for imitating the skins of animals upon fulled cloth. (Communication from J. Picque and C. Piot. Paris)
762. R. Talbot, Moxley, near Bilston—Improvements in furnaces and in the manufacture of iron
763. J. Wilkes, T. Wilkes, and G. Wilkes, Birmingham—A new or improved manufacture of rollers or cylinders for printing fabrics
764. L. Hope, Bishopsgate Churchyard—Improvements in the manufacture of paper. (Communication from H. Smith, Canada)
765. Sir J. C. Anderson, Fermoy, Cork—Improvements in locomotive and other carriages
766. J. Taylor, New York—Improvements in buckets and valve seats for bilge and other pumps
767. R. Johnson, Manchester—Improvements in cleaning iron and other metals, after the manner known as "pickling"
768. J. Lewis, Salford—Improvements in machinery or apparatus for reaping and mowing

Dated March 19.

769. J. Williams, Mold, Flint—Improvements in cocks or taps
770. H. Armistead, Colne, Lancaster—Improved 'picker' to be used in power looms for weaving
771. S. Campbell, Newington, Surrey—Improvements in preserving vegetable substances
772. R. A. Brooman, Fleet Street—Improved projectile. (Communication)
773. W. Reid, Shettleston—Improvements in safety apparatus for guarding the mouths of pits, excavations, and other openings
774. M. A. C. Mellier, Frews Weir Mills, Exeter—Improvements in desiccating or drying paper and other goods in process of manufacture
775. W. G. Merrett, Leadenhall-street—An improvement in coats and waistcoats

Dated March 20.

776. T. S. Adshead, and A. Holden, North end Mills, Stalybridge—Improvements in machinery for carding cotton and other fibrous materials
777. J. Ninck, Brewer-street, Golden-square—Improvements in placing sets, or partial sets, of teeth, gums, and palates on plates
782. C. Weiss, and H. Lister, and J. Mitchell, Sheepridge, near Huddersfield—Improvements in finishing woollen and other textile fabrics, and in the machinery or apparatus employed for that purpose
784. N. J. Greenwood, Morley, near Leeds—Improvements in spinning mules and slubbing machines
786. J. Chedgy, Grove, Southwark—Improvements in machinery for mangling, calendering, or pressing goods
787. G. W. Sayer, Cognac, France—Improved machinery for stopping or retarding railway carriages
788. I. Atkin, and M. Miller, Nottingham—Improvements in dividing lace
789. W. Johnson, Lincoln's-inn-fields—Improvements in steam boilers and furnaces, and in apparatus connected therewith. (Communication)

Dated March 21

790. W. Seaton, Chester-place, Regent's-park—Improvements in the construction of the permanent way of railways, and in the machinery or apparatus employed therein
791. W. Moxon, and J. Clayton, Bluepits, Lancaster, and S. Fearnly, Halifax—Improvements in looms for weaving, which said improvements are applicable to looms for weaving carpets and other looped or piled fabrics
792. T. Lawrence, Salford—Improvements in steam engines
793. W. Banks and J. Banks, Bolton, Lancaster—Improvements in machinery, or apparatus to be employed for washing, scouring, or bleaching cotton, linen, and other textile fabrics
794. H. Lafone, Liverpool—Improvements in tanning
795. G. Parrott, Cork—Improvements in horse gearing
796. S. Hemming, Bow, Middlesex—A new or improved material for roofing or other building purposes
797. R. A. Brooman, Fleet-street—Improved method of driving the spindles of spinning frames. (Communication)
798. G. J. Gunther, John-street, City of London—Improvements in preparing blocks and stones for building purposes
799. J. E. Cole, New York, U.S.—Improvements in the rig and working the sails of square sail vessels
800. M. A. Crooker, New York, U. S.—Improvements in paddle wheels
801. R. Mushet, Coleford, Gloucester—Improvements in the manufacture of cast steel
802. R. Mushet, Coleford, Gloucester—Improvements in the manufacture of cast steel
803. F. S. Hemming, Westminster—Improvements in the mode of treating peat, mixed or not mixed with other vegetable or animal fibrous substances, and in the application of the same to various purposes
805. T. H. Head and J. Wright, Teesdale Iron Works, Stockton-on-Tees—Improvements in casting railway chairs, and in the manufacture of other castings
806. E. Hyde, Kinston-upon-Thames, Surrey—Improvements for the manufacture of fabrics from products of the husks of cocoa nuts
807. H. Dolby and E. T. Dolby, Regent-street, Quadrant—Improvements in machinery used when printing several colours in succession on the same surface

Dated March 23.

808. L. A. Normandy, jun., Judd-street, Brunswick-square—Improved process for manufacturing iron. (Communication from d'Aubréville, Rue de l'Echiquier, Paris)
809. W. Heap, Ashton-under-Lyne—Improvements in self-acting slide lathes
810. T. Nuttall, Farnworth, near Manchester—Improvement or improvements in machinery for preparing cotton, flax, wool, or other fibrous material
811. J. Sherar, Aberdeen—Improvements in oil and spirit lamps for the formation of burners obviating shadow
812. E. Rowland, Manchester—Improvements in steam-engines
813. W. Mills, Lower Craven-place, Kentish-town—Improvements in the action of upright pianofortes
814. J. Smith, Albion-square, South Side, Dalston—Improvement in applying steam or other aeriform fluids expansively in steam-engines
815. T. M. Smith, Hammersmith, and C. Burke, Earl-street, Kennington—Improvements in the preparation of materials applicable to the manufacture of candles
816. J. J. Baranowski, Paris—Improved method of, and apparatus for, signalling upon railways
817. F. J. Jones, Aldermanbury—An improved buckle or fastening
818. M. Chastaguon, Essex-street, Strand—Improvements in tuyeres for blast-furnaces

Dated March 24.

819. R. H. Collyer, Park-road, Regent's-park—Improved machine for cleaning and purifying wheat and other grain
820. J. Tangye and J. Tangye, Birmingham—New or improved lifting-jack
821. J. A. Zibelin, Paris—Improvements in the fabrication of artificial wines, brandy, and vinegar.
822. T. Y. Hall, Newcastle-upon-Tyne—Improvements in steam-guages and water-indicators
823, A. V. Newon, Chancery-lane—Improvements in carding engines.. (Communication)
824. S. Fox, Deepcar, Sheffield—Improvements in hardening and tempering steel-wire and in straightening wire
825. T. Lawes, Chancery-lane—An improved construction of agricultural implement to be used in tilling the land

Dated March 25.

826. C. F. L. Oudry, Auteuil, near Paris—Improvements in the preservation of articles of cast, wrought, rolled, and forged iron, zinc and other metals or alloys of metals against oxidation from humidity and other destructive effects of air and water
827. W. H. Collins, Birmingham—Improvements in attaching knobs to spindles
828. T. Lawes, Chancery-lane—Machine or apparatus to be used in cleansing, purifying, and drying animal and vegetable substances
829. J. Mickle, Newcastle-upon-Tyne—Improvements in machinery or apparatus for reaping and mowing
831. J. Hewett, Sheffield—Improvements in sewing machines. (Communication)
832. P. Hill, Hampstead—Improvements in machinery for stamping, marking, or printing and arranging papers, letters, and other articles
833. A. V. Newton, Chancery-lane—An improved construction of water meter. (Communication)
834. R. Sims, Bedford, near Leigh, Lancaster—Improvements in machinery or apparatus for cutting hay, straw, and other similar substances
835. J. Henderson, Lasswade, Midlothian—Improvements in writing instruments
836. J. Henderson, Lasswade, Midlothian—Improvements in the manufacture or produced on of plain and figured fabrics
837. W. Somervail, Dunlop, Ayr—Improvements in the treatment or preparation of fibrous materials for being spun
838. R. Cassels and T. Morton, Motherwell—Improvements in the manufacture of iron
839. C. Cowper, Southampton-buildings, Chancery-lane—Improvements in the manufacture of shot and shells for rifled ordnance. (Communication from J. M. Sigourney, Watertown, New York)
840. S. M. Allaire, Paris—Improvements in manufacturing hats, caps, and bonnets
841. J. W. Wilson, Banbury, Oxford—Improvements in the cutting tools used for rounding surfaces, or otherwise operating on wood

Dated March 26.

842. J. Radcliffe, J. Fearnehough, and J. Mather—Improvements in index-machines applicable to looms for weaving
843. U. Lane, Regency-square, Brighton—Improvement in the transmission of motive power
844. C. H. Baker, Angel-court, City of London—Railway passengers signal-alarm
845. W. T. Clark, Cottage-place, City-road—Portable metallic spring mattress
846. G. White, Laurence Pountney-lane, Cannon-street—Improvements in glass-furnaces. (Communication)

Dated April 1.

895. C. Iles, Birmingham—Improvements in bolts for doors
897. B. H. Paul, Torrington-street, Torrington-square—Improvements in the preservation of stone, either natural or artificial, also of cements and other similar compositions
899. C. Greves, St. Thomas-street, Southwark—Improvements in breech-loading guns and pistols
901. R. Adam, Paisley—Improvements in preparing and finishing threads or yarns
903. L. Perin, Rue Barbette, Paris—The easy discovery of flaws and escapes in gas pipes
905. J. Sugden, Bradford, York—Improvements in the manufacture of combs for combing wool, silk, cotton, flax, or other fibrous materials
907. A. V. Newton, Chancery-lane—Improvements in fire-arms. (Communication)
909. J. Oliver, Bow-lane, Poplar—Improvements in apparatus for manufacturing and conveying sulphuric acid

Dated April 2.

911. G. Lowry, Salford—Improvements in machinery for heckling flax and other fibrous materials
913. J. F. Wieland, Glasgow—Improvements in portable apparatus and materials for cleaning the teeth
915. H. A. Holden, Bingley Works, Birmingham—Improvements in carriage lamps and general carriage and harness furniture and fittings
917. E. Maw, Doncaster Iron Works, Yorkshire—An improvement in the points of railway crossings
919. R. A. Brooman, Fleet-street—Improvements in treating and bleaching fibrous vegetable substances, and in machinery employed therein. (Communication from H. Bouchet)
921. A. V. Newton, Chancery-lane—Improvements in repeating fire-arms. (Communication)

Dated April 3.

923. W. H. Box, East Looe, Cornwall—An improved fish hook
925. S. Barker, Birmingham—Improvement or improvements in the manufacture of steel
927. R. A. Brooman, Fleet-street—A machine for the manufacture of bolts and rivets. (Communication)
929. D. Joy, Leeds—Improvements in steam engines
931. T. Craddock, Tachbrook-street, Pimlico—Improvements in the steam engine and steam boiler
933. F. M. Baudouin, Paris—Improvements in the wires or conductors of electric telegraphs, and in the machinery for the manufacture thereof

Dated April 4.

935. J. Bourne, Billiter-street—The generation and application of motive power
937. H. Harvey and R. Smith, Surrey-street, Strand—Improvements in raising sunken ships, other vessels, and all other matters and things, from under to the surface of the water, and to prevent their sinking
939. E Adler, New York, and F. B. Howell, Lebanon, Ohio, United States—Improvements in machines for cleaning knives and other similar articles
941. J. Auston, Rue des Martyres, Paris—Improvements for extracting silk and other textile and vegetable substances from the bark and leaves of every description of mulberry trees
943. A. Leclercq, Trith St. Leger, near Valenciennes, France—Improvements in sleepers of railways
945. R. Birkin, jun., and T. I. Birkin, Nottingham—Improvements in the manufacture of figured lace
947. E. Testelin, Ghent, Belgium—A new system for the application of electricity as moving power
949. W. Sumner, Preston—Improvements in machinery or apparatus for preparing, slubbing, and roving fibrous materials
951. J. H. Johnson, Lincoln's-inn-fields—Improvements in preserving food. (Communication from P. Lemetteus, and M. Boniere, Rouen, France)
953. J. Hansor, Barnes, Surrey—Improvements in apparatus for consuming gas
955. J. J. Rippon, Oakenshaw Print Works, near Accrington—A new or improved instrument or apparatus for straining or filtering colours

Dated April 6.

957. T. Melling, Rainhill Iron Works, near Prescott—Improvements in taps or valves, and in apparatus to prevent the overflowing of, and letting off, the water from baths
959. G. T. Bousfield, Loughborough Park, Brixton—Improvements in treating India rubber and gutta-percha, in order to render the same impermeable to illuminating and other gases. (Communication)
961. S. Clarke, Albany-street, Regent's-park—Improvements in the manufacture of candles and night lights
963. A. V. Newton, Chancery-lane—An improvement in the construction of smoothing irons. (Communication)
965. C. Goodyear, Liecester-square—An improved manufacture of waterprof fabric, applicable as a substitute for leather, prunella, embroidered and other ornamental fabrics and stuffs
967. J. H. Taylor, Alma-street, Hoxton—Improvements in regulating the flow of fluids

Dated April 7.

969. W. Neville, Jersey—Improvements in amalgamating certain substances for the production of fuel
279. J. Rothwell, Enfield, Middlesex, and S. D. Cooper, Westminster—Improvements in breech-loading fire-arms
973. J. T. Pitman, Gracechurch-street—Improvements in apparatus called fire-escapes (Communication)
975. H. Dearden, Rochdale—Improvements in power-looms for weaving
977. E. Finch, Bridge Works, Chepstow—Improvement in railway breaks
979. W. S. Gale, New York—Improved means for rendering the joints of engines or other machinery steam or fluid tight
981. F. Piercy and S. Flagg, Belgrave-street, Argyle-square—Portable expanding life and military boat, which is also adapted for other purposes

Dated April 8.

985. B. Hingley and S. Hingley, Cradley, Worcester—Improvements in anchors.
987. J. B. Sparke and A. Sparke, Thorne-lane Foundry, Norwich—Improvements in sawing machinery
989. E. Edwards and E. Beacher, Thorncliffe and Chapeltown Ironworks, near Sheffield —Improvements in machinery or apparatus for washing or cleansing mineral and other substances
991. A. V. Newton, Chancery-lane—Improved machinery for cultivating land (Communication)
993. A. V. Newton, Chancery-lane — Improved machinery for manufacturing coiled springs. (Communication)
995. D. Bethune, Cambridge-terrace, Hyde-park—Improvements in apparatus for preventing or consuming smoke in chimneys and furnaces.

Dated April 9.

997. J. Harland, Shield-street, Newcastle-upon-Tyne—Purifying plastic clay used for the making of all kinds of earthenware, and for the cheaper and more expeditious manufacture of bricks, tiles, draining pipes, and other articles of clay of a similar nature or description
999. J. A. Molineaux, Brighton—Improvements in economising heat in locomotive and other high-pressure steam-engines
1001. A. F. Kynaston, Osborne-place, Plymouth — Securing and disconnecting ships' boats, and towing cables
1003. E. P. Alexander, Lincoln's-inn-fields—Improvements in the manufacture of fulminating powder. (Communication)
1005. J. Purnell, John-street West, Barnsbury—Improvements in apparatus for taking photographic pictures
1007. W. Clark, Chancery-lane—An improved instrument for indicating the pressure of steam. (Communication)
1009. W. Armitage, Farnley Ironworks, and H. Lea, Farnley, near Leeds—Improvements in the manufacture of iron
1011. J. Beech, Shrewsbury, and J. Williams, Wellington, Salop—Improved mode of securing the rails of railways in their chairs
1013. J. C. Haddan, Cannon-row, Westminster—Improvement or improvements in the smelting and refining of iron, (Communication)

Dated April 11.

1015. C. J. Bunker, New York—Improved life preserver, or "life preserving shirt or sack"
1017. J. Marrow, Sheerness—Improvements in machinery or apparatus for manufacturing bolts, rivets, nuts, and other similar forgings
1019. J. Matthews, Hurcott Mill, near Kidderminster—A new or improved vat to be used in the manufacture of paper
1021. S. D. Lheritier, Paris—Improvements in signals
1023. J. England, Beverley—Improvements in machinery for washing and wringing woven fabrics and similar articles
1025. F. D. Lejard, Paris—Improved safety apparatus to be applied to the triggers of fire-arms
1027. T. Wilton, and J. Huggett, Eastbourne, Sussex—An apparatus for regulating the flow or supply of gas
1029. C. S. Johns, Barnard's-inn, Holborn—Improvements in preparing pulp for the manufacture of paper
1031. J. Gimson, Leicester—Improved apparatus for preventing the explosion of steam boilers

Dated April 13.

1033. J. B. Pascal, Lyons, France—Improvements in electric lamps
1035. J. Maurice, Regent-street—Improvements in the fastenings, fixings, and attachments used for supporting or securing artificial teeth in the mouth
1037. J. and E. Ratcliff, St. Paul's-square, Birmingham—An improved mode or modes of adjusting chandeliers
1039. W. E. Newton, Chancery-lane—Improvements in the construction of boats, buoys, floats, or other buoyant vessels. (Communication)
1041. D. Reading, Claverdon, Warwick—An apparatus for ventilating and increasing the draft in fire-places and flues
1043. P. V. Beaumesnil and C. Erhard, Paris—A new and improved system of wheels for railway and other carriages
1045. C. Barlow, Chancery-lane—Consuming the smoke and gases of furnaces, and at the same time furnishing a hot-air blast, being a smoke and gas consuming hot-air blast furnace. (Communication from T. Aldridge. Hudson, Jersey, U.S.)
1047. J. Ramsbottom, Longsight, Manchester—Improvements in wrought-iron railway chairs, and in machinery for manufacturing the same and other articles

Dated April 14.

1049. P. Wicks, and T. G. Ghislin, Cape of Good Hope—Superseding the use of bristles, cocoa fibres, flax, hemp, whalebone, &c., to be styled and called an invention for adapting and applying the fibrous plants of South Africa for the purposes of manufacture
1051. J. Rubery, Birmingham—Improvements in the manufacture of umbrella and parasol ribs
1053. R. A. Brooman, Fleet-street—Improvements in machinery for mixing, solidifying pressing, and moulding. (Communication from M. Evrard)
1055. R. Knowles, Manchester—Improvements in machinery or apparatus for winding yarn
1057. J. H. Johnson, Lincoln's-inn-fields—Improvements in machinery or apparatus for raising and forcing of fluids. (Communication from J. Lasserre)
1059. A. V. Newton, Chancery-lane—Improvements in carding engines
1061. H. Willis, Manchester-street, Gray's-inn-road—Improved machinery for supplying air to organs and free reed instruments

Dated April 15.

1063. J. Coutts, Wellington Lodge, Northumberland—An improved method of uniting together the parts of all kinds of floating bodies composed of metallic substances, as well as vessels for containing fluids, gases, &c.
1065. A. V. Newton, Chancery-lane—Improved apparatus for taking the measurements for coats and other garments. (Communication from L. Derby, New York)
1067. R. F. Brunel, Hampstead-road—Improvements in raising sunken vessels and other submerged structures and articles, and in machinery and apparatus employed therein
1069. T. Richardson, Newcastle-on-Tyne, and M. Prentice, Stowmarket—Improvements in the manufacture of manure
1071. J. B. Leuillet, Paris—Improvements in binding account and other books

Dated April 16.

1073. G. Raggett, Duke-street, St. James'—Improvements in railway breaks and carriages. (Communication)
1075. S. T. Crook, Halifax—Improvements in the mode or method of manufacturing iron retorts, safes, cisterns, ovens, boilers, chests, and other similar articles of iron manufacture
1077. R. Hindle, Sabden, Lancaster—Improvements in that apparatus used in calico and other printing known as the sieve

PATENTS APPLIED FOR WITH COMPLETE SPECIFICATION.

860. G. Gilmour, Massachusetts, U. S.—A new and useful contrivance or mechanism for shackling or attaching another anchor to the chain of an anchor to which a vessel may be riding, his said invention being termed by him a "second anchor shackle."—March 27.
888. A. J. Quinche, Paris—Improvements in apparatus for counting, registering, and indicating the distance travelled by vehicles.—March 31
898. R. E. Lee, Giltspur-street—A portable printing apparatus, adapted alike for moveable type, lithography, and copper-plate.—April 1
962. G. Barrington, Chudleigh, Devon—Making the stop funnel for the prevention of waste of liquids whilst bottling or transferring them from one vessel to another.—April 6
988. J. F. V. Larnaudès, Rue Gabrielle, Montmartre, near Paris—The disinfection and deodorisation of animal and vegetable substances.—April 8
1108. C. Barlow, Chancery-lane—A mechanical apparatus for regenerating the impulsive force of any motive power. (Communication from J. Commandeur, Lyons, France,—April 20

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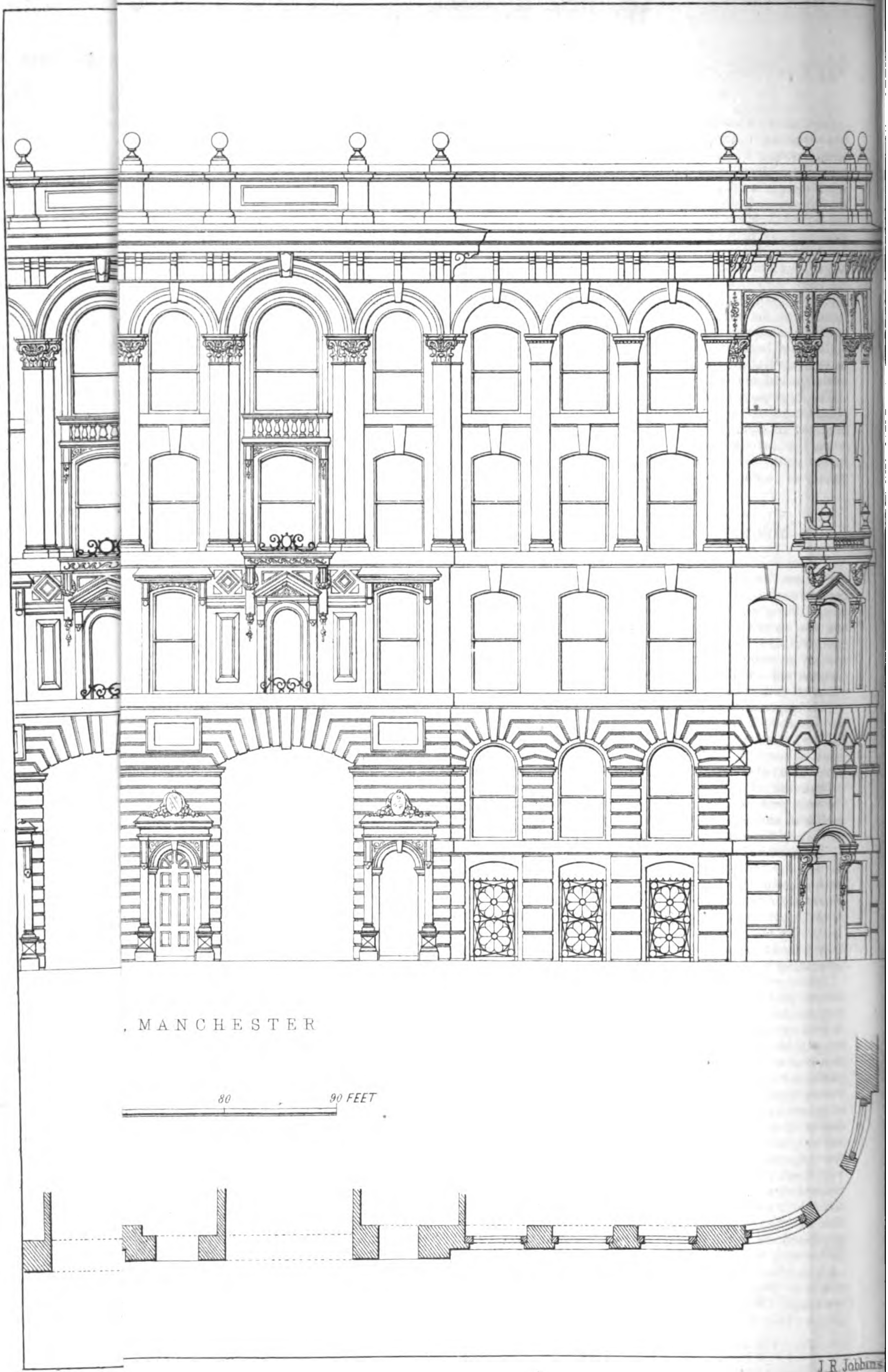


WAREHOUSES, CHORLTON STREET, MANCHESTER.

(*With an Engraving, Plate* XV.)

The view exhibits one half of the principal front of a design for an extensive range of warehouse buildings to be erected in Manchester. The block will consist of several warehouses, each perfectly distinct, and each requiring three entrances, one for customers, one for porters, and one for wagons. The nature of the site requires that all these entrances shall be from the front: and advantage has been taken of this circumstance to form an architectural feature by combining of the three in each warehouse, bringing them forward a little in advance of the general line of the building, and adding some amount of decoration to the piers and openings over them. This treatment will, it is expected, give play of light and shade, and an appearance of richness to the whole facade, while at the same time it will most distinctly indicate the leading divisions of the building.

Care has been taken to arrange the design so that there shall be as little liability as possible to disturbance from the unequal settlement of masonry and brickwork if carried up side by side.

The basement, string-courses, key-stones, caps and bases of pillars, cornices, and other ornamental features are proposed to be executed in Darley Dale stone, the remaining portions in brickwork, the ornamental gratings in front of basement windows in cast iron. The designs have been prepared by Mr. T. Roach Smith, of Adam-street, Adelphi.

THE DESIGNS FOR THE NEW GOVERNMENT OFFICES.

Before the issue of our next number, the judges appointed to decide on the great competition of the day—the future "Government Offices"—will, in all probability, have made their award, and the hopes or fears of the 218 competitors be set at rest. Meanwhile, as part of the sight-seeing public, it behoves us frequently to enter an appearance at Westminster Hall, and also, as professional scrutineers, to contribute our quota to the stock of recorded criticism.

It is impossible to overrate the importance of the subject before us: whether it be viewed as an architectural opportunity not likely soon to occur again, or as a special occasion for the development of talent hitherto concealed, or for ripening and expressing those cherished sentiments towards art which have ordinarily no channel of diffusion; or, once more, if it be regarded as a "*grande certamen*," open to the world, and in which, therefore, each who enter the lists might be expected to strain every nerve, and tax to the utmost his energies and skill.

When we reflect, therefore, on the comparatively limited period allowed for the elaboration of so comprehensive and difficult a scheme, and the fact that other public competitions, occurring almost simultaneously, have divided the attention of many of the contributors, it is truly a marvel to behold what has been accomplished by the various authors, on sheets of illustration ranging from 1 to 42 to each individual, and on drawings in the aggregate amounting to some thousands in number.

Before entering in detail on our task, we cannot withhold a tribute of commendation to the way in which, generally speaking, the drawings have been arranged for examination. Each set is kept as much as possible together, and is plainly marked on every sheet with its own serial figure, according to position, so that it is no difficult matter at once to ascertain to which set any particular drawing may happen to belong. This is the more fortunate, since, as the regulations issued respecting scale, character of drawings, and mode of finishing, were unusually stringent, a degree of similarity in appearance is sometimes necessarily consequent, and this might, therefore, have been otherwise productive of confusion. It must not, however, be concealed that a very large proportion of the competitors have broken through the prescribed conditions, and have tinted in unmistakeable colours, some their plans and sections, and some even their elevations, so that the "light brown India-ink," which, and which alone, was stipulated for in the "Instructions," would seem to be chameleon-like, visible in many a shade and hue; and, in justice to those authors who have conscientiously adhered to the rules laid down, it is to be hoped that the judges will not overlook these transgressions. We make this remark for the sake of fairness, not that we hold in every particular with the judiciousness of those instructions, nor on every point with their capability of being clearly understood.

When, on the opening day of exhibition (May 4th), all London, as it were, sallied forth to Westminster Hall, and ourselves among the number, the first impression generally created by the sight of the drawings was one bordering on disappointment; and, after cursorily glancing round the several screens, it was not uncommon for friends, who recognised each other, to shrug their shoulders, and agree that the whole lot might be weeded down to about a dozen. Successive visits have, however, to a great extent set aside this hasty judgment, since it turns out, as frequently happens, that not a few of the least assuming are the most meritorious; while the bolder and more showy, having arrested a momentary attention, dwindle into their true rank of comparative nothingness.

In the *architectural character* which has been given to the designs, there is almost every conceivable variety, dictated either by the predilections of their authors, or by the supposed harmony or actual incorporation with existing buildings. Acting on these grounds, there are several Gothic designs which more or less agree with the gigantic national work immediately adjoining, and now nearly completed; and also with Westminster Abbey and Hall: others have founded their designs upon Classic models, and conform to the details of Whitehall, the Treasury, or, it may be, the Horse Guards. A third class seeks to compromise matters, by covering that portion of the area which borders most upon Gothic buildings, with a Gothic structure, and *vice versâ*. Without pronouncing on the great question of Gothic or Classic, or on the compromising expedients just referred to, it may be gathered from an examination of the best drawings, or a perusal of the "Reports," that each possesses many an ardent champion; and public opinion, where divested of prejudice, seems pretty equally divided on the subject, so that it is impossible to anticipate the important decision.

In regard to *Block Plan* and *General arrangement*, we conceive that some difficulty must ultimately be discovered, since, somewhat heedlessly as it may be thought, a liberal premium is to be awarded to the best block plan, and others to the best detailed arrangements. Now, on the face of things, the presumption is, that, practically, these doubtless good, but short-sighted, intentions will be frustrated, inasmuch as there can be little hope that the approved *block plan* (that is *per se*) and the approved *general design* will at all coincide, so as to render the blending of the two a feasible matter. This difficulty appears to have been generally felt, for while there are some competitors who have from different causes sent in for the block plan (a matter, moreover, involving much more head-work than actual labour), the majority of competitors whose designs will repay scrutiny, have based their designs for the respective Offices on a "well-considered" block plan.

Another difficulty, with which in all probability, the Commissioners themselves had not the skill to grapple, was Westminster bridge; whether it should be retained or removed, and what means of access should be provided from across the river. Accordingly, at the outset, this becomes a main question, and we may state at once, that as far as our observation goes, though some bring it about 120 yards further north, the majority of schemes show it retained in its present position, but reckon on the widening as commenced by Mr. Page. The committee which sat last session to consider the site of the bridge, advised that the new works should not be proceeded with until the block plans for the entire area were prepared. It was also recommended by them that a new bridge should be erected between Lambeth Palace and the Horseferry. Nearly all the competitors agree in placing a new bridge of ample size at Charing-cross, and this is absolutely requisite to relieve the overcrowded traffic which now at an immense disadvantage is compelled to traverse Westminster bridge. Even if one of the block plans be decided on, it does not follow that it will be immediately carried out. It seems, however, to be but common sense that this should be the first thing determined, and that the new War and Foreign offices should be prepared in conformity with it; after which the remaining works contemplated may be proceeded with at leisure. While on the general subject of arrangement, it may be mentioned, that there are very many plans which occupy a far greater area than that defined by the boundary lines prescribed: in fact, some parties have shamelessly begged, borrowed, or stolen, as suited convenience, thus obtaining an immeasureable advantage over those who rigidly kept within bounds. It is to be hoped that such trespassers will, on the score of justice, meet with their due. The question to be decided on ought, in the first instance, to be, which drawings are truly in conformity with instructions; and next, which of these is on the whole most available. Any deviation from rules laid down should have been shown by supplementary drawings or fly-leaves.

Adequately to describe each of the host of schemes in array before us, would encroach too much on the space at our disposal; we shall therefore examine a portion *seriatim*, as a fair sample of the complexion of the whole, and afterwards select only such as from their merits or peculiarities have a claim to notice.

No. 1, consists of 8 sheets in plain outline. Corridor arrangement well contrived, affording a separate entrance to each room. These corridors are lighted from open areas, and the principal staircase by two glass domes. The elevations are poor, but in some degree assimilate with the present Treasury buildings.

No. 2, is a kind of "Roman" design, but sets at defiance all the rules of composition and precedent.

No. 3, presents three Italian designs, on 16 sheets, all of the simplest and most uncharacteristic style.

No. 4, in plan exhibits two uniform blocks of building, and in elevation an Italian front, somewhat tame, owing to the repetition of certain features. It is sparing in decoration, but enlivened by a few trophies and candelabra, also by occasional niches for appropriate statues.

No. 5, is pains thrown away in every respect; one of the most unpromising designs in the place.

No. 6, partakes of the Lombardic element, but with "Bramante" for its motto. Some portions are decidedly French, and there is the characteristic feature of high and peculiar roofs. The design of the wings is good, and the attics and domes are excellently devised.

No. 7, unites the two departments in one building. The design professes to be an adaptation of Roman architecture, but ignores porticos, which the author says are a useless appendage, excluding light, and admitting rain. To make up for this unusual omission, extra attention has been bestowed on the windows, which are rendered proportionably important. The effect of the whole is, however, feeble. A well written report is appended.

No. 8, is in some respects ambitious. There are 19 drawings to explain but a sorry Italian design, which looks best in flank. The report abounds in bad spelling, is vaguely drawn up, and dwells for the most part on the desirableness of ample "space."

No. 9, *The Ides of March are come*, and No. 13, *Confide recte agens*, are two of those abominable perpetrations often put forth under the name of "Gothic," but with which they have no actual feeling in common.

No. 10, is a careful set of drawings, well delineated, and in outline only. The height of building is divided into three stories, in which the lower has rustications, and the upper ones are columniated. The whole effect is tame and poor, notwithstanding sundry bits of sculpture and other enrichments.

No. 11, *Roma*,—is a good specimen of bad Classic.

No. 12, attracts, as it deserves, considerable attention. It is a foreign design, and is chiefly noticeable for the boldness and symmetry of the block plan. Westminster-bridge is proposed to be removed as far down as Richmond-terrace, and would open a wide street terminating in a handsome square, to be called Place du Gouvernement. On each side of this street three offices are proposed to be erected, the Admiralty and the Home Office facing the river, and the other side of the square would be appropriated to the remaining offices. The new Treasury would form the centre of the west side of the square. Correspondent improvements are suggested on the Surrey side, and also a new bridge between Lambeth and the Horseferry. Nor must the architectural portion of the design be overlooked; for though certainly most unlikely to harmonise with neighbouring buildings, being essentially French, it has great intrinsic merit, and like several other productions of the same school, is most beautifully drawn. Colour is also cleverly and *freely* used.

No. 14, is a fair specimen of "German Gothic," but not at all prepossessing.

No. 15, is a kind of "Classic" design, very whimsically treated. An effect is apparently attempted to be gained by certain inequalities of level in the floors, &c.; this is by no means satisfactory.

No. 16, is a modification of "Classic," scarcely more successful. The plan embraces two nearly equal blocks of building, with a handsome archway between them.

No. 17, outlined in brown ink, is Italian, pretty well grouped, but wanting in striking features. The block plan contains some good suggestions.

No. 18, is a most laborious production, but withal not good. The whole block area is covered with one huge mass of building, which from this very fact becomes inconvenient and unmanageable. The elevation is Italian, and pretentious, but the wings with their double domes outbalance the centre. We observe in this design what is strangely wanting in a great number of the other Classic ones, a long panel of sculpture under the principal entablature.

No. 19, (also Italian) does not call for particular remark.

No. 20, under the motto *Corona*, exhibits designs for the War and the Foreign office, in a series of 21 exquisite drawings. The general block plan bears some resemblance to that of No. 12, except that here the Treasury building would not intercept the view into the park. The principal object of the author has been to concentrate these offices as much as possible, in the disposition of the two blocks laid down. A new street is proposed from the Victoria Tower as far as Victoria-street, clearing away the masses of adjoining houses, and taking down also the south side of Great George-street. The style of architecture adopted is the Roman-Corinthian, and some praiseworthy novelty of treatment is observable in the windows. Although the general effect is excellent, the outline against the sky appears to be too much cut up and frittered.

No. 21, is another of the atrocious classic perpetrations of which the less that is said the better.—eighteen large sheets of wasted paper!

No. 22, a "Renaissance" composition, is overdone, in the attic especially,—which, indeed, would have been better omitted.

No. 23, (20 drawings) is Italian, and has some good points, only that the storied levels are not well managed. There is a continuous arcade (fenestrated) along the first-floor, which has a noble effect.

No. 25, a very complete set, good in parts, but not grand enough for the object. The cornice is weak, and is devoid of relieving sculpture or attics.

No. 26, has novelty in the plans. There is a large open area or quadrangle in the centre of the block of buildings, having staircases at each of the four corners. The elevation is one of the few founded on the castellated type..

No. 27, excepting its plan, which is clever, is perfectly absurd.—"German Gothic."

No. 28, is another instance of trouble thrown away; for however satisfactory in other respects, the elevations of neither of the three designs can for a moment be tolerated—From the plan we learn that the removal of Westminster-bridge is contemplated.

No. 29, is very ordinary Classic. The order is Corinthian, with columns engaged, and running up between the windows to the height of two stories.

No. 31, Italian, in 16 drawings, is a degree better.

No. 32, *Labora et oro*, is indeed laborious. The design is an execrable one, of that stamp familiarly known as "Carpenter's Gothic."

No. 33, may also be passed over.

No. 34, two "Renaissance" designs, are well composed, but deficient in leading architectural features.

No. 35, is decidedly one of the few good Gothic designs; the plans, too, are well arranged. They comprise a noble square block, whose outline is quite unbroken, and the high pitched roofs which cover it, preserve the same severity of form. In the perspective is shown one of the chief features of the scheme: viz., a large staircase, occupying the angle, and whose lines of masonry and openings follow the direction of the steps. The principal merit of the design, however, appears to be the proportioning of its horizontal features and the grouping of its windows; these are sometimes in couples, and sometimes enclosed by a continuous arcade. Sculpture is lavishly introduced, sometimes it would appear, *at random*, especially over the ground-story windows, and the richest ornamentation is disposed near the eye. A very beautiful vignette drawing, showing one bay complete, accompanies this design.

No. 36, is Italian, and well drawn. A main feature consists of a piazza. The plan proposes an alteration in the position of Westminster bridge.

No. 38, is another good specimen of bad Gothic.

No. 39, (Italian), has a most complicated plan and ill-proportioned elevation, crowned with an ill-looking dome.

. No. 40, is very inferior Classic, quite subdued in detail. The plan has been well studied.

No. 41, presents some anomalies in what may be termed the Italian-Villa style. The effect of the decreasing or gradually contracting stages is curious. The skyline is broken by numerous domestic-looking open towers. In the plan is shown a scheme for embanking the river, and constructing a spacious terrace along the side.

No. 42, is, we presume, founded on some of the specimens of Wren's Italian, but the *genius* of the master is wanting. The elevations are a ponderous heap of rustications, and of coarse, would-be ornaments; in fact there is not an atom of sensible plain wall anywhere. It is to be hoped that there is no chance for such a design, notwithstanding the infinite study and labour it must have cost the author.

No. 43, is of four stories, the centre surmounted by an octagonal dome, but the details in the composition of which are positively larger than those in the main building below! The plan is irregular, and awkwardly contrived, but the written report is good.

No. 44, owes much to artistic skill. In the design the public offices on the east side of Parliament-street are intended to be "Gothic," and, on the west, Classic. The position of Westminster bridge is not interferred with, for reasons which are stated.

No. 45, labours under the misfortune of being scarcely appreciable, owing to the feebleness of the drawings, and the great height at which the plan and description are absurdly hung. The perspective, which is a bird's-eye (Renaissance) does not promise much.

No. 48, is quite a burlesque. The drawings altogether are disgraceful.

No. 50, has the eccentric motto, "No corridors," which proves to be the key to the plan. The style of architecture chosen is the Italian, and though in point of composition it manifests considerable skill, yet, for the object intended, it is assuredly inappropriate. The elevation is kept low, and rigorously plain. The block plan looks at first sight doubtful, but turns out to have some recommendatory features, especially the one implied in the motto. Westminster bridge might be either retained or moved; Hungerford bridge would be widened for carriage traffic, and a new bridge be constructed at Horseferry-road.

No. 52, is chiefly noticeable as a plain solid mass of building, but much too insipid for satisfactory effect. It may be classed as "Astylar Italian." Some of the details will bear examination, and there is some novelty in the treatment of the arch-headed windows.

The author of No. 54 has produced the giant work of the collection, in submitting no less than 43 carefully-executed drawings, explanatory of two designs, one being in the Gothic style, and the other (which is infinitely the better) in Renaissance. Though this latter evinces considerable skill in plan and effective arrangement, it is scarcely up to the mark, as a comparison with others in immediate contiguity will show. The Gothic design is borrowed largely from a well known French example, upon which the English features are only grafted; and, as many of these are quite out of place, especially an enormous church-like window,—which constitutes the central feature, and is moreover by no means required by circumstances,—it may be imagined that, as a whole, it is not pleasing.

No. 56, is well planned, especially in the manner of lighting, for which large glazed areas are secured. The drawings throughout are careful, the detailed parts especially; the design itself would have looked better had it been less fussy. We are glad to note a liberal use of sculpture.

No. 58, is a kind of Renaissance, looking much better in the elevation than the perspective,—on the Parliament-street side in particular. This elevation has the wings slightly projecting, and admits of a screen across, connecting the two and completing the regularity of the plan. The Park elevation is also good.

No. 62, like 44, varies the style of the two buildings: that of the War Office, next Whitehall, very much resembling Wyattville's Windsor Castle, and that of the Foreign Office being Palladian, with the roof formed into terraces. The plans are well elaborated. Among the materials proposed to be employed are Oakhampton granite and Cornwall serpentine.

No. 64, "*Well considered*," answers to its motto, but is on far too extensive a scale to be carried out. A large block of building is proposed to be erected on the river-bank, close to Westminster bridge, for the purposes of the Board of Trade, Admiralty, and the Home and Colonial offices. In this design, columns are liberally employed.

In 67, ample provision has been made for lighting the different apartments; of course this is an all-important matter, but one that under the circumstances has proved a difficult problem. The elevation is Italian, well massed.

No. 69, has entailed a vast amount of labour. The perspective shows a kind of mixed design, in which Gothic, Italian, and Renaissance features may be observed. It is beautifully drawn.

No. 71, is a continuation of the Whitehall building.

No. 72, recommends the removal of Westminster bridge to Whitehall; to make a wide entrance into the park; and to erect one block of buildings in the Italian style. The arrangements are confused.

No. 73, carries out the Treasury style on one side, and that of the Houses of Parliament on the other. The Whitehall front has a tower 200 feet high, with a clock and belfry over.

No. 75, is a series of 14 exquisite drawings in pencil, altogether some of the best that are submitted. They are from a foreign source, and may be ranked with No. 12, before noticed. The plan is very good, but especially so are the elevations, which are in the Renaissance style, and most perfectly studied out both in detail and the *ensemble*. In execution the chief thing that strikes us would be wanting, is one or more projecting features, so as to produce greater variety of light and shadow. The front consists of three stories, besides the attic (in a Mansard roof) and the basement (which is rusticated, and wholly above ground). On the ground story the divisional piers are broad and flat, the first floor is engaged-columniated, and on the second are narrow fluted pilasters. The sections are very complete, and show the fittings of library, &c., nicely touched in.

Adjoining this last set is an English one (No. 77), unquestionably one of the very best in the place. The are many ingenious novelties in the plan, which, besides, bears evidence of having been well thought over; we may instance the contrivance of the staircases. A thoroughfare of 75 feet is left between the two blocks of building. The elevations are in the French Renaissance style, of the time of Francis I., and are very good adaptations of the kind.

No. 76, is distinguished by considerable novelty and effectiveness of detail; still, as a whole, the design is not a successful one, being greatly wanting in repose. The area of the ground is divided into three united quadrangles, but without any carriage-way through,—a scheme nearly followed out also in No. 78.

No. 79, proposes a general system of embankment on both sides of the Thames, also a bridge at the Horseferry;—opening St. James' Park to the river by clearing away the houses between Whitehall-place and the Duke of Buccleuch's (except the Banquetting House), and by pulling down Lady Dover's house, with a portion of the Horse Guards, and substituting a screen of columns. There are 19 drawings; the design, generally, poor.

No. 86, is on an extensive scale, and exhibits an outline well calculated for a considerable amount of play and effect.

No. 94, is decidedly one of the best among the Renaissance designs. It is stately and ornamental. There is perhaps a superabundance of enrichment, and it happens to be just of that class which, though telling well in effect, is, on close examination, often unmeaning. The plans are also very well arranged.

Of No. 97, the block plan is chiefly noticeable. The author suggests two bridges, each 60 feet wide, one at Charing-cross, and the other opposite Lambeth Gardens; but that if only one should be determined on, that it be placed intermediately, say, opposite to Dover House.

No. 98, is another capital production in the same style, but more subdued. Owing to the drawings being unfortunately separated in the hanging, the author does not appear fully to explain himself, or to have the credit to which he is certainly entitled. One good feature in his design is the through-corridors.

No. 99, has entailed infinite labour. In the block plan the limits proposed are boldly overstripped, and considerable encroachments shown on the Park. This sacrifice could ill be made, as the present Parade-ground behind the Horse Guards is the only convenient spot we have. Moreover, the scheme, in its entirety, contemplates a fresh laying out of the area between the Horseferry-road and Somerset House. A new bridge is proposed at Lambeth, and an embankment of the river as far as Somerset House. The War Office constitutes an important feature among the public buildings. It is intended to join immediately south of the present Treasury, but set back from the road line, though a screen extends across, and to be crowned with an enormous dome. Behind this is the Foreign Office, while still southward is another range of building, uniform with the Treasury. Although the plans are generally pretty explicit, it is not clear how light is obtained in the lower main corridors; the upper ones are lighted from the roof. The same question arises in No. 101, and indeed in very many of the designs, as before hinted.

No. 103, has a well arranged plan, the buildings forming a quadrangle, in the centre of which is a small octagonal hall, whence corridors radiate to the respective side buildings.

No. 109, is a carrying out of the Banquetting House style of architecture; the groupings would be picturesque. Great pains have been bestowed on the drawings.

No. 112, is one of the impracticable schemes. There is such a reckless disregard of instructions, and of expense, that, though there is much that is praiseworthy in the design, it can be regarded but as a dream.

No. 116, is a most remarkable set of drawings both as to conception and manipulation. It is shown by 30 drawings, including a large block plan; the designs for the War and Foreign offices, also, are shown under two arrangements, The style chosen is a modification of that of Northern Italy, treated in a more uniform and massive way than usual. Great variety is, however, ensured by the statues which occupy niches and pedestals along the various frontages. The author distinguishes his angle staircases externally, as already noticed in No. 35.

An Italian design (No. 124) has on plan, in the centre of the War office, an elliptical court (152 by 120 feet) from which different offices radiate. The fronts are well conceived.

No. 126, is Renaissance, and very good. Immense labour has been bestowed in perfecting every part.

No. 128, has two designs. That which agrees with the model below is unquestionably the preferable of the two, and has some excellent points.

No. 129, may be quoted as a specimen of pure Gothic both in design and general feeling. Still there is nothing in the *tout ensemble* bespeaking its purpose. It appears to be rather a collection of pleasing fragments than a consistent whole, and is certainly innocent of the appearance ordinarily assumed by such buildings as it purports to represent.

No. 130, is of that kind of "Carpenter's Gothic" which we have before had occasion to speak of.

No. 134, is equally nondescript in another way. There are 14 huge drawings.

No. 136, makes a very good group, being bold in parts, and well massed.

No. 137, is one of the extravagant schemes never likely to be realised. A good notion in the plan is the covered street down the centre, and used as a Walhalla.

No. 140 shares with 35, 116, and 129 the Gothic honours of the exhibition. Every part is well worked out. As in 35, a good result is gained by the coupling of the windows in the different stories. There is also considerable play of outline both in plan and elevation. The sky-line is agreeably broken by towers and spirelets, though these look more for ornament than use. Some well-designed lantern-lights in metal are introduced over the staircases. Stables also are suggested, to occupy a distinct building if desirable. The accompaning report is well drawn up.

No. 141, is altogether a debased design. A large square tower rises at one angle, emulating both architecturally and in outline the whimsical one at the "Schools," at Oxford.

No. 144, is probably the most tasteful and elegant of all the Palladian designs. Every part is detailed with the most scrupulous care, and one can scarcely help being allured by it, notwithstanding its anomalies of broken entablatures, &c.

No. 144, is another instance of prodigious expenditure of labour, without an adequate result.

Nos. 152 and 153, consist only of ground plans.

No. 156, is evidently a burlesque.

No. 164, attracts attention. It consists only of a general plan, and a bird's-eye isometrical view.

No. 194, proposes to place a new Westminster bridge about 100 yards from the old one, and to have watergates and landing stairs on the present site. It also contemplates the taking down of St. Margaret's Church, and rebuilding it at the corner of Little George-street.

No. 197, has four large sheets, with nothing to arrest the eye except the magnitude of the scale. The elevations are Italian—very poor.

Nos. 203, 205, 206, 214, 215, 216, 217, consist of block plans only. No. 208, is a block plan of a most *sweeping* character, with a small view in one corner of one of the proposed buildings—a palpable reproduction of the Doge's Palace, Venice.

No. 218, (the last number) is a model, unaccompanied by explanatory drawings.

The award of the judges is expected to be made about the middle of the month, after which time the Hall will be again in requisition for the display of the designs for the Wellington Monument, which are to be sent in to-day.

THE NEW GOVERNMENT OFFICES.—THE JUDGES.

It appears that the appointment of the judges in reference to the designs for the new Government Offices to be built at Whitehall has given great dissatisfaction not only to the profession, but also to the public generally. This is the more to be regretted, when it is so well known that up to the last step in the transaction, her Majesty's chief commissioner of works had conducted the business in the most fearless and admirable style. Unfortunately, at the close of the race he has stumbled, by having been most injudiciously advised. It is a glaring and remarkable fact in the affair, that out of the seven judges appointed, four are Scotchmen! not one of whom is really competent to the duties imposed. The head of the commission is the Duke of Buccleuch, who has at his elbow, Mr. Burn, a Scotch architect, and, by-the-bye, the only solitary professional architect amongst the "seven wise men." It is well known that Mr. Burn has been for many years employed by the Duke of Buccleuch in designing and altering mansions and farm buildings, and, as a matter of course, it would be most ungracious in him to express an opinion contrary to that of his noble employer,—therefore his voice in the matter is nullified.

Again, Lord Stanhope has been erroneously called by several of our contemporaries, the President of the College of Architects. The fact is, there is no such institution in existence; Lord Stanhope is the President of the Antiquarian Society, and every one must know who has studied the science of architecture practically, that it requires somewhat more than the knowledge of antiquities to adjudicate on one of the most comprehensive architectural schemes that has been submitted to public competition during the present century.

In reference to the appointment of Mr. David Roberts, we freely admit, that as a painter of picturesque architecture on canvas, he is probably unequalled; at the same time, we believe he will himself admit that he does not possess sufficient technical and scientific knowledge to qualify him to decide so purely architectural a problem as the one in question.

No one can doubt the engineering qualifications of Mr. Brunel; and as there are some engineering points at issue, that gentleman is, so far, well placed.

As for the other members of the Commission, they are purely amateurs, and consequently unfit for the duties thrust upon them. As regards men who have almost made architecture the sole study of their lives, apart from studying the science professionally, it is with surprise that we find the names of Earl de Grey, the President of the Royal Institution of British Architects, and Mr. Beresford Hope, omitted, gentlemen whose high sense of honour and integrity are beyond all impeachment. There should have been also, at least, two eminent English architects on the Commission who had not competed for the prize.

As the Commission stands, we have as judges, a Scotch duke, and one Scotch architect, unknown to fame in England—a painter—one engineer, and three amateurs, to adjudicate one of the most difficult and important architectural questions that probably ever came before any tribunal, modern or ancient. No doubt some of the "seven wise men" will have the modesty and ingenuousness to throw up their appointments, and leave the decision to more experienced hands.

It is probable that the judges may have given their awards previously to the publication of our next Number, and we trust full justice will be done to those competitors who have *strictly* adhered to the instructions issued by Sir Benjamin Hall, and that the judges will give no undue preference to some designs in the collection, the façades of which are so bedizened with colour, as to produce false effect. As a matter of course, those of the designs which contain only block and ground plans will be at once rejected; and when a careful selection of the remainder is made, about a dozen will be set aside, on which final judgment will be passed.

Let us hope, for the honour of our Government, for the honour of our country, and as a precedent for all future competitions, that no jobbery will be permitted in the matter; but that the author, or authors, of the best design will have the first prize, and be instructed to carry out the works; so that we may have no repetition of the Lille and Liverpool jobs.

THE ROYAL ACADEMY.—ARCHITECTURE.

For several seasons it has been our reluctant duty, when reviewing the architectural department of the Academy Exhibition, to note a gradual falling off, both in the number of drawings and in their merit. This year, unfortunately, we must renew our lament, for a more uninteresting series can scarcely be imagined. Of course, the special Architectural Exhibition has done much to alter the complexion of affairs, and it is but right that the latter should be supported to the utmost; still, as we have before urged, there is abundance of room for the two, and, as they happen to be open at different periods of the year, there ought to be little difficulty in catering for both, besides the incentive of keeping the subject constantly before the public eye. But in respect to the Academy, we may take another ground, and, if needs be, insist on the more equal recognition of the claims of architecture and sculpture with those of painting, in an institution chartered expressly to benefit each. From the time when the profession supinely allowed the encroachment of other paintings on the walls of a room which had hitherto been their exclusive property, the change has been a marked one; after awhile the designation of the room, "Architecture," was exchanged (and consistently, too) for an indefinite phrase, so that oil, pencil, and water-colour pictures now elbow one another, the result being incongruous and ruinous to all:—

"And thus from year to year we rot and rot,
And thereby hangs a tale."

How long this state of things is to continue, it remains with the architectural body at large to decide.

As usual, the architectural drawings occupy the lower portion of three sides of the little room referred to, which this year contains an especial attraction in the beautiful series of historical outlines in pencil by Mr. Maclise: these, however, take up so much space, that the opportunity for examining other works is sadly interfered with.

No. (1006), "The Casa Stralla, Mondovi," (J. T. Wood), though drawn on a large scale, has really nothing to require it. The building is quite plain Italian, and very monotonous in treatment. Not so its neighbour (1007), Mr. Richardson's "Mansion for the Earl of Harrington," which is shown with its noble approaches and accessories, including a handsome screen of Roman character, whose pilasters have rich running foliage in long panels, while in the spandrils over the principal arch are medallion subjects. The sculptural groups on the summit are not quite satisfactory, and there is an inconsistency in placing equestrian figures longitudinally on the one gateway, and transversely on the others. The archways over the side footpaths are disfigured by a kind of elliptical pediment above the architraves. Praiseworthy attention appears to have been paid to the ironwork of the gates. Mr. Ferrey exhibits two drawings, both of domestic character. In (1008) "Cambridge Asylum for Soldiers' Widows," the chapel forms the central and principal feature: it is connected with the building apparently at the west end, and has a developed chancel, with a stone bell-turret on the east wall of the nave. The general design is Elizabethan, of red brick and stone dressings; chimney stacks are made serviceable objects, and they start from the ground; the windows, however, which are inserted in them on the different floors have by no means a satisfactory look. It may be presumed there is a fireplace beneath each. In (1016) his "Design for a bleaching establishment," we have a plain, low group of buildings, with well overhanging eaves, and a lofty chimney shaft in the centre, altogether very good looking.

Of the Constantinople competition there are several reminders. There is the west elevation, to a large scale, of Mr. Burges' selected design (1009); also in (1012) and (1132) Mr. Street's corresponding elevation, and his interior view. The latter somewhat disappointed us, but the other is masterly in a high degree. The precautions for shelter and screening from heat are excellently managed; the ambulatory also, which forms so important a feature, works in capitally between the boldly projecting buttresses. Mr. Conybeare's design for the same building (1081) is about as much below, as these others are above the average; nor is his "Memorial Church erecting at Bombay," (1047) a whit better.

In close contact with Mr. Burges' "Constantinople," is Mr. Street's "Lille" (1010), giving the south-west view, a portion not shown by the drawings lately exhibited in Suffolk-street, and which comes out much more lofty and in better proportion than might have been anticipated. As we had occasion before to take exception to the mode of filling up the gables in the transept, so is that of the west end equally objectionable. The transepts had a succession of useless dwarf buttresses rising from the general cornice; the nave has a succession of little crocketted gables. The rose-window below is noble, and so are the three deeply-recessed doorways still lower. The buttresses, too, have evidently been carefully thought over. An interior view is also given of this design (1015), which shows a very beautiful pulpit. The groining, we observe, is spherical. (1013), "The Chancel of Eynesbury Church, Huntingdonshire," restored by Mr. Blomfield, is cleverly pictured forth. The east window is of three lights, and appears to have been copied from one at Holbeach. There is very little to commend in the "National Discount Bank, Mark-lane Chambers" (1022), by Mr. Randall. The whole façade is very flat and superficial; if more play of outline could not be introduced, a greater variety might have been impressed on the window and other openings. (1024) is an imaginary "Interior of an Old Abbey Church, in Herefordshire, in the olden time," but what building one is at a loss to conceive. Invention and fancy have been quite let loose on the subject, and the result is a painfully elaborate jumble of the gilt-gingerbread school. What a contrast does the naked simplicity of fact afford in the next picture, "the Bellot Memorial" (1025), G. Chambers; a large oil painting, in which the memorial itself, a puny square obelisk, perfectly plain, would make but a sorry figure but for the adventitious treatment of the light. As a background, part of Greenwich Hospital is introduced, but without the slightest regard to its correct delineation. The "View of the Improvements at Milford, Pembrokeshire" (1026) about to be carried out by Messrs. Wehnert and Ashdown, are on a large scale, and include new docks, large and conveniently disposed. (1027) "Ruins of St. Andrew's Abbey, Fifeshire," G. L. Beetholme, is a picturesque view of a picturesque ruin.

In (1029) is a design for a church, by Mr. J. James, which is good and rather out of the common, and is very suitable for erection in our own country, but not so much so for its proposed destination—Malaga, Spain. The treatment throughout is decidedly "Northern." Mr. Macquoid and Mr. Falkenor exhibit, as heretofore, some very clever reproductions from abroad: the view of "Ephesus, restored," by the latter gentleman (1056) is every way a masterpiece. A bird's-eye view (1031), to a minute scale, is shown of the proposed Metropolitan Omnibus Servants' Almshouses as designed by Mr. Webb, of whose Printers' Almshouses this appears to be a verisimilitude. There are two drawings illustrating the new School for Orphan Girls at Denbigh, to be erected by Mr. Herbert Williams (1032, 1112), but the design is a very ordinary one. This cannot be said of Mr. Teulon's "Projected church for Hastings" (1033), nor indeed of any of his works. It is refreshing to see a novel idea carried out when it commends itself to consistency and common sense, but not when forced into situation and gratuitous. Yet this is unfortunately Mr. Teulon's failing; originality and fancy are sure to be abundantly present, but they often trench on the *outré*. What, for instance, can be more absurd or ugly than the sprawling flamboyant head to the transept doorway in the drawing before us? In his less ambitious attempts, such as the plain brick church shown in (1129), he is much more successful. (1046 and 1079) are devoted to the church at Teddington, as proposed to be rebuilt by Mr. Armstrong. The fault of this is the one just noticed in Mr. Teulon's, a degree of uncalled-for fussiness, a quality evidenced also in Mr. Webb's proposed Hornsey Church (1049). The portion of Little Dalby Hall shown in (1048), as erected from the designs of Mr. Bell, is highly commendable. The style is early Gothic, boldly and simply treated; the masonry appears to be ashlar, and to be worked occasionally in bandings of a darker material. Attached to the house is an elegant conservatory, framed in metal, and suitably designed.

In a totally different style, but good in its way, is the corridor at Merchant Tailors' Hall (1050), E. I'Anson. Another metropolitan building, just finished, is the "Sovereign Life Assurance Office" (1063), by Mr. Horace Jones, in that phase of architecture denominated by a leading writer, "pestilent." The "New Church at Frampton Cotterell, Gloucestershire," (1066), by J. Norton, makes a delightful picture, thanks to artistic handling, for the building itself is very ordinary "Perpendicular," and below Mr. Norton's usual standard. His "Church at Highbridge" (1135) is better, but borders on the opposite extreme.

Mr. G. G. Scott exhibits in (1073) an exterior, and in (1067) an interior view of the "Proposed Town Hall at Halifax"—a very clever blending of the Italian with the English Gothic. The open-timbered roof over the hall is particularly effective; it is of arch form, cusped, and has, intermediately between the arch and principal rafter, a series of open quatrefoils, telling very well. The other drawing exhibited by Mr. Scott partakes of a similar feeling as far as elements are concerned; it shows (1111) the monument about to be erected at Melbourne, in memory of the late Sir Charles Hotham, K.C.B., Governor-in-Chief of Victoria. It may be briefly described as a lofty granite column, standing on a square pedestal, and surmounted with a foliage capital in which sculptured subjects are introduced; above the capital rise four panels or niches containing single figures, and the whole is crowned with a finial and cross. (1068) is the "New Post-office and Electric Telegraph Station at Calcutta, by Mr. Digby Wyatt, a large structure embodying the usual Indian characteristics of their peculiar four-centred arches, and their bulbous domes. Two sketch designs for the "New Government Offices" are next distinguishable; one is an extensive scheme, architecturally founded on the Whitehall building, and the other, by Mr. C. F. Hayward (1071), Venetian Gothic, well grouped. The design, by Mr. Ridley, for Infantry Barracks (1072) must not be overlooked. Simple in the extreme, it shows how much may be done by mere play of form in a plan. (1074) is Mr. P. E. Masey's "Design for Liverpool Free Library and Museum." Tame in conception, and Roman in character, it greatly owes its value as a picture to the ability and care displayed in its tinting. (1082) "Ferney Hall, Salop," in course of erection from the designs of Mr. Norton, is a substantial-looking Elizabethan structure, in excellent keeping throughout. The terrace on which the mansion stands is a vast improvement to the effect.

Mr. Smirke sends but one contribution (1083), and that not a very happy one. It represents a proposed reredos for Lichfield Cathedral, the panelling to be ornamented with the mineral products of the diocese. In point of design this reredos is miserably weak and strippy, a bad imitation of a famous screen at Durham. Mr. Page has a drawing of the Albert Bridge, Windsor, which spans the river in a single four-centred arch, of cast-iron, whose spandrels are filled in with tracery: the dry arches on each side are turned in stone. (1090) is marked in the catalogue—"Town Hall at Cork, Ireland, J. P. Jones," and we looked twice to see that we were right, for we did not expect to find so genuine a transplanting of a continental building into such a locality. (1094), "Cottage erecting in Cumberland," A. Waterhouse, is half-timbered and pretty; and Mr. Billings' "Wemyss Bay House, Greenock" (1095), is unmistakeably Scotch.

Some two or three designs for decorations are exhibited. Two are by Mr. Warwick (1103, 1107); these are too flimsy to look well, and remind one of the same kind of work by the Adams', a century ago. Not much invention is displayed in Mr. Lane's "View of Interior of the principal Library," as sent in to the Liverpool competition (1100). It is quite a plain apartment, with some Corinthian pillars; the plan a square with canted angles, and a lantern light above of a similar form. One of the boldest and most architectural drawings in the room is (1101), "Church, Parsonage-house, and Schools, now erecting at Burntisland, near Edinburgh," by Mr. Slater, but designed originally, we believe, by the late Mr. Carpenter. The style is, of course, Gothic, and rather plainly treated; the nave and chancel roofs are continuous, and the tower is on the north side, almost detached.

Mr. H. R. Newton's design for the "Proposed Eton Memorial," would occupy the centre of the quadrangle, displacing the ancient statue of the founder, Henry VI.; besides which it is of unmeaning character, but very much like in form the old market-crosses at Salisbury or Chichester, being octangular, open below, and covered with a sort of dome, seemingly in metal.

Some few other pictures are instrinsically, or from association, interesting; such as—the old rectory at Stoke Newington (1091), just pulled down; ruins of Sudeley Castle, Gloucestershire, (1089); the Interior of St. Martin's-in-the-Fields (1109); the Hotel de Ville, Louvain (1113); the Ambulatory of the Church of San Lorenzo, Naples, (1130); and the Waterman's Hall, at Ghent.

PROFESSOR FARADAY'S VIEWS OF FORCE.

Since the article on the "Conservation of Force," which appeared in the April number of the *Journal*, was written, Professor Faraday has published the lecture he delivered at the Royal Institution, and we are thus enabled to examine more correctly the opinions expounded. The difficulty we understood him to express in reconciling the force of gravitation with the principle of the conservation of force is very distinctly admitted in his published statement, wherein he says that the ordinary idea of gravity, viz. that it is a simple attractive force exerted between the particles of matter varying inversely as the square of the distance, appears to him "to ignore entirely the principle of the conservation of force, and by the terms of its definition, if taken in an absolute sense, 'varying inversely as the square of the distance,' to be in direct opposition to it, and it becomes my duty now to point out where this contradiction occurs, and to use it in illustration of the principle of conservation."*

This paradoxical manner of proving the principle of the conservation of force is distinguishable throughout Professor Faraday's endeavour to establish the proposition. The lecture, as delivered at the Royal Institution, though illustrated by many striking experiments, seemed so paradoxical and illogical, and presented such extraordinary views of the action of gravitation, that we conceived that in the hurried delivery, and in the suppression of matter to bring the subject within the accustomed hour, his reasoning was imperfectly developed; but now that the lecture is in print before us, it appears more paradoxical and less logical than we were willing to believe. We cannot, for instance, appreciate the selection of gravitation, which is supposed to ignore the principle of conservation, as a proof of principle to be established, nor can we perceive the difficulty which Professor Faraday experiences in reconciling the received definition of gravitation with the conservation of force. It appears, indeed, as if he created the difficulty, in the first place, and then advanced it as a proof against the correctness of the principle he wants to establish. The variation of the strength of the attraction of gravitation as the square of the distance, is the great obstacle that Professor Faraday cannot surmount, and that his meaning may not be misrepresented, we quote his own words:—

"Assume two particles of matter, A and B, in free space, and a force in each or in both by which they gravitate towards each other, the force being unalterable for an unchanging distance, but varying inversely as the square of the distance when the latter varies. Then at the distance of 10 the force may be estimated as 1, whilst at the distance of 1, *i. e.* one-tenth of the former, the force will be 100; and if we suppose an elastic spring to be introduced between the two as a measure of the attractive force, the power compressing it will be a hundred times as much in the latter as in the former. But from whence can this enormous increase of power come? If we say that it is the character of this force, and content ourselves with that as a sufficient answer, then it appears to me that we admit a *creation* of power, and that to an enormous amount."

It would almost seem from this extraordinary exposition, as if Professor Faraday were entirely ignorant of the principle by which all radiating forces obey the same law of diminishing in power inversely as the square of the distance. The difficulty he experiences in regard to this law of gravitation is equally, if not more, applicable to light; and magnetism, electricity, and heat present similar difficulties. We cannot imagine how Professor Faraday could have overlooked in this exposition of his views, the ordinary fact that by removing a body to a greater distance from an operating power, the effect on that body is diminished, without causing any diminution in the power itself; yet he appears absolutely to ignore that ordinary operation of attractive forces when gravitation is in question. That the particles of matter when brought from a distance of 10 to a distance of 1, must have their mutually attractive forces increased one hundred-fold, is

* 'Philosophical Magazine,'—No. 88.

self-evident to any one who has paid any attention to the subject, therefore it is surprising it should present any difficulty in the action of gravitation to a philosopher who must necessarily be familiar with the same law in relation to electricity and magnetism.

The chief object which Professor Faraday has in view, is to establish the principle of the conservation of force, and yet, strangely enough, he advances, in the commencement, a well-established law of nature as inconsistent with that principle; and then he immediately afterwards assumes the principle in dispute to be "the highest law in physical science which our faculties permit us to perceive," and as "a fundamental principle" by which the correctness of the recognised laws of all forces should be tested. If, therefore, he proceeds to argue, we accept the principle of the conservation of force, "the ordinary definition of gravitation must be an imperfect account of the whole of the force, and is probably only a description of one exercise of that power." Having taken for granted the conservation of force as a fundamental principle by which the actions of all forces must be guided, and, assuming further, that the attraction of gravitation as generally understood, does not accord with that principle, Professor Faraday concludes that the ordinary idea of gravitation is an erroneous one, and he is thus led into the following speculation:—"The principle of the conservation of force would lead us to assume that when A and B attract each other less because of increasing distance, then some other exertion of power, either within or without them, is proportionately growing up; and again, when their distance is diminished, as from 10 to 1, the power of attraction, now increased a hundred-fold, has been produced out of some other form of power which has been equivalently reduced." As the well-established laws of gravitation only indicate a concentration of power, and not an increase of it, by the diminution of distance, this speculation of Professor Faraday's, founded altogether on the increase of power, must fall to the ground.

In most of the reasoning of Professor Faraday on the conservation of force, he appears not to distinguish between force and power, and the guiding principle for which he contends, when plainly stated, resolves itself, for the most part, into the generally acknowledged principle of the indestructibility of matter and its properties. The conservation of force, as thus explained, no one will be inclined to dispute. *Power* is the inherent property which one body possesses to influence another, and *force* is the active exercise of that power. The latter is an effect and not a cause; though Professor Faraday seems, at times, to mingle the ideas of power and force together, as if he conceived them to be one and the same. The laws of gravitation, which present a difficulty to him, seem to us in the cases supposed, to be perfectly reconcilable with the principle of the conservation of power; the greater difficulty, to our minds, is presented by mechanical force; which difficulty Professor Faraday considers to be altogether removed by finding its equivalent in the heat generated. We do not understand his proposition to be that force, considered as the active operation of power, is never suspended or destroyed, and viewing it merely as the transference of power, there is no difficulty in admitting its preservation, nor is there anything new in the principle as thus announced.

ARCHITECTURAL IMPROVEMENTS OF LONDON.

No. XI.—Our Streets.

As if to make way for the improvements at the eastern end of St. Paul's Cathedral, which we suggested in a former paper, the offending house which abuts so abruptly on the roadway at the south-eastern corner of St. Paul's has been in a great measure burnt down, so that there can be no reasonable objection to its being cleared away and rebuilt in a line with the façade of St. Paul's schools, which, if done, two great objects would be gained, —the widening of the carriage-way, and a fine view of the eastern end of the cathedral would be obtained; we are also constrained most emphatically to put in our protest against building on the triangular space which lays between the southern side of St. Paul's and Cook's warehouses, the latter of which has already so much deteriorated from the effect of the building by its close proximity and excessive altitude. In adverting to this we must still adhere to our original idea previously expressed, that the open triangular space should be appropriated for a monument to the memory of Wren. Wellington is commemorated in bronze to nausea;—Pitt, Fox, and Canning, and our kings all rejoice in black dismal statues in various parts of the metropolis; and yet we have not one fitting monument to the greatest architect England has yet produced; and what more fitting locality can there be for such a work than the base of the building erected by his consummate genius? Should however the Wren monument be abandoned in the particular situation which we have pointed out, we earnestly entreat the city authorities that they may not allow a number of staring warehouses to tower, like great bullies, to the skies, to use the language of Pope, so as to destroy the effect of the finest building we have in London; and whilst the contemplated improvements are in hand, we trust the cathedral authorities will see the necessity of removing the iron railing from the boundary line of the churchyard, and allow a dwarf wall only to remain (properly protected), so that we may be enabled to see the base of the building all around.

Another very great improvement has been effected in the city at the southern end of Mark-lane, which comprises a large edifice recently erected for Messrs. Nissen and Parker, the wholesale stationers, from the designs of Mr. Richard Bell. This building extends partly in Mark-lane and partly in Great Tower-street, and comprises a total frontage of 99 feet, and a height from the pavement of 62 feet 6 inches to the top of the parapet, comprehending five stories, to which there will be an additional one in the roof. The building is in the Italian style of architecture, and corresponds externally in its general characteristics with the structure opposite to it, which was erected a few years ago by the same proprietors, from the plans of Mr. Bell. The new building is a very sound substantial edifice, the entire of its brick-work being set in cement, and every floor rendered fire-proof, on the principle of Fox and Barrett's patent. The steps and landings of the staircase are of Portland stone. The elevations of the structure have wide windows contrived for the admission of as much light as possible, and are glazed with plate glass. The building is entirely faced with Portland cement, and some of its embellishments are of a highly ornamental character, particularly the upper cornice and its friezes, the various heads in which were executed from models, by Mr. Nicholls, the eminent sculptor, of Gloucester Crescent, Regent's Park. The corner of the building does not come to an abrupt right-angle, but is well rounded, agreeably to the City Improvement Act, thus forming a much wider approach to Mark-lane from Great Tower-street, to meet the highly increased traffic in this busy vicinity.

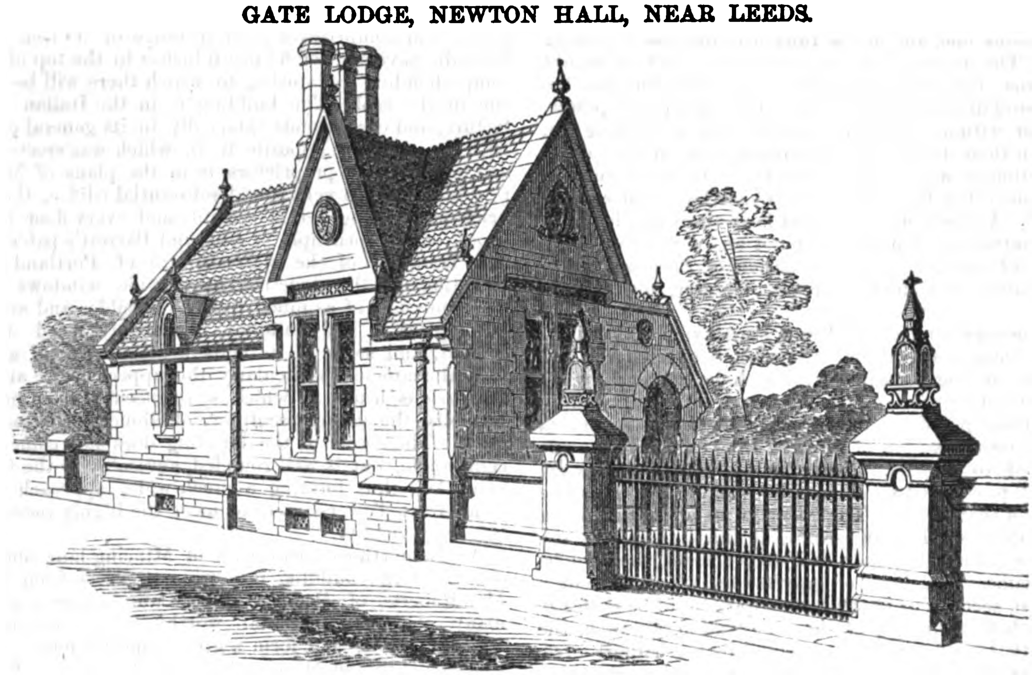
At the north-eastern corner of Mincing-lane and Fenchurch-street, a large building is now in progress from the designs of Mr. Roberts, of Pountney-lane, Cannon-street, which contains many characteristics well worthy of attention, and which, when complete, will form a great improvement. Adjoining to this structure, in Mincing-lane, the Company of Clothworkers are rebuilding their hall, which is the largest edifice now in progress in the City of London. The contract is undertaken by Mr. Jay at the sum of 33,846*l*. Mr. Samuel Angell, is the architect engaged, who has adopted the Italian style as the groundwork of his composition; the principal elevation will display in stone a very large amount of elaborated decoration. Internally, the great hall which is intended to be 80 feet long, 40 feet wide, and 40 feet in height, will be finished with a very great amount of elaboration. It is intended to comprehend two stories in height, the lower one to be formed of a series of five large semicircular-headed arches on each side, and three at each end, which will be divided by plain columns with Corinthian capitals, to be cut in Caen stone. The columns will be surmounted by the usual entablature of the order, over which a certain portion of the roof next the side walls will be vaulted all around, and have the insertions of lucarne windows ranging immediately over those underneath. The central portion of the roof, which is flat, will be enriched by deep sunken coffers filled with highly effective pateræ. The shafts of the columns will be of polished red granite, and the spandrils of the arched vaulting of the upper story are to be filled with figures in alto-relievo, emblematic of the most important commercial cities and towns of the United Kingdom. The stylobate of the order will have insertions of varied specimens of British marbles. The windows will be filled with stained glass, on which will be emblazoned the royal arms, together with those of the principal City companies.

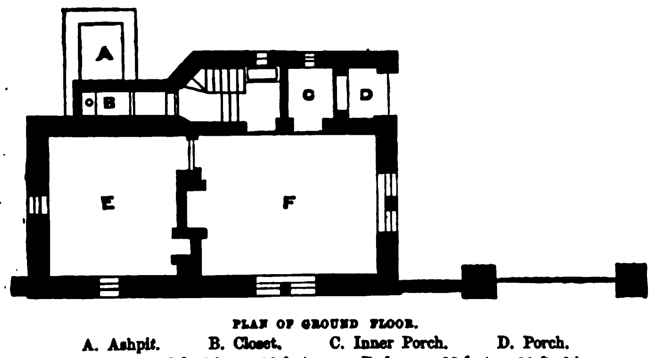
At No. 96 on the eastern side of Gracechurch-street a novelty has been produced with coloured materials on the street front of the premises recently prepared for Messrs. Lloyd Brothers. This consists, in the first place, of forming the blank faces of the walls into panels with cement, and then inserting in them ceramic encaustic tiles in geometric patterns, and in some instances materials in relief, the principal of the latter of which consists of a frieze formed of models of boys, animals, birds, and foliage, which are white on a blue ground, and crossing the elevation above the first-floor windows. The propriety of this mode of decoration (at least, externally) we think may be fairly questioned, for, after all, it is no more than a species of veneering; and however appropriately this surface tiling may be applied horizontally to the floors of churches and conservatories, we certainly doubt the accuracy of applying it vertically, except it may be in the lining of baths.

On the northern side of Lothbury, Messrs. Jones, Lloyd & Co., the eminent bankers, are rebuilding their business premises from the designs of Mr. Philip C. Hardwick. In this structure there is no attempt made at ornate embellishment. The order employed is that of the Roman-Doric, and that not fully enriched. The plain surfaces of the walls externally have been faced with white suffolk bricks, and the moulded work round the windows, the ground-floor story, and the upper cornice at the eaves, are of Portland stone. Adjoining this building is the London and Westminster Bank, erected some years ago, the façade of which is distinguished by bad proportion, poverty of detail, and as a whole, approximates very closely to positive ugliness.

With some few shortcomings it is however a subject for congratulation that the metropolitan architects of the present day, in our street architecture have made a marked and decided advance upon the tame, clumsy and ill-proportioned insipidities that were a few years ago perpetrated in King William-street, and, if they proceed at the same rate as during the last five or six years, we may expect to behold structures erected that will do us honour and deserve the name of architecture, and will not be designated painted compo puerilities.

GATE LODGE, NEWTON HALL, NEAR LEEDS.





PLAN OF GROUND FLOOR.

A. Ashpit. B. Closet. C. Inner Porch. D. Porch.
Dining-room, 15 ft. 3 in. × 12 feet. Bed-room, 12 feet × 11 ft. 6 in.

This lodge and gate have been recently completed, under the superintendence of Mr. William Reed Carson, architect, for Arthur Lupton, Esq., at the entrance to his grounds, on the road leading to Harrogate from Leeds, 1½ mile from the latter town. There is a basement containing wash-house, pantry, and coal-cellar. The walls are of pitched-face delph stone, with mill-stone grit dressings, quoins, &c. There is a panel of mosaic work in one gable, and strings of encaustic tile, by Minton and Co. The carving is by Mawer, of Leeds, and the general mason work by Mr. J. Horner, of Chapeltown.

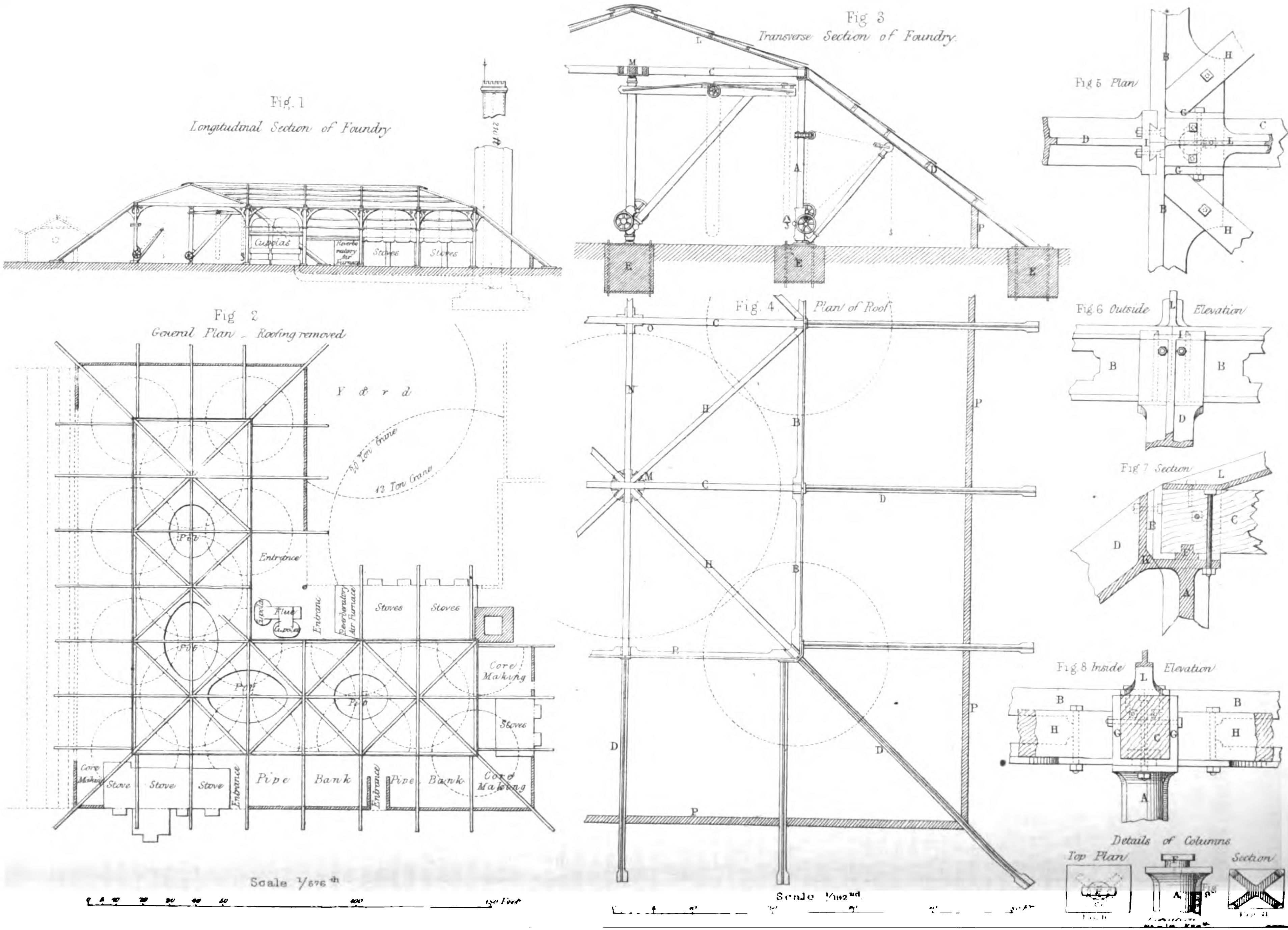
ARCHITECTURAL PUBLICATION SOCIETY.

The annual general meeting of this society was held on the 20th ult. at the Rooms of the Royal Institute of British Architects, Mr. Godwin in the chair. Mr. Wyatt Papworth, hon. sec., read the report. There are now 313 members, and the income for the past year was 419*l.*; the amount expended was about 219*l.* leaving in hand 200*l.* for the works still due to the subscribers of that year. The report said,—

"For the year 1856-7 just concluded, one part, containing eleven plates of illustrations to the letters A and B, has been issued. At the time these plates were formed, the amount in hand would no more than cover their expense, but as subscriptions have been paid in to a larger amount, preparations are being made for another series to contain illustrations to the letter C, which will be put in hand after the next meeting of the committee. Any friends having drawings or sketches referring to the subjects named in the list sent out, or to any article under that letter considered eligible, are requested to submit them for acceptance. The thanks of the society are due to the following contributors who have this year so liberally placed their collections of original sketches at the disposal of the committee, viz.—Messrs. Drake, Starforth, Martineau, Clarke, Walton, Cockerell, Boutcher, Lightly, Teulon, Shout, Fowler, Ashpitel, Hansard, Lewis, Lockyer, and Newton."

NORTH WOODSIDE IRON WORKS FOUNDRY, ERECTED BY JOHN DOWNIE OF GLASGOW

Details of Junction of Columns, Girders and Struts.



NORTH WOODSIDE IRON WORKS FOUNDRY.*

(*With an Engraving, Plate* XVI.)

The subject of the present paper is an improved application of iron to structural purposes, where great lateral strains such as are occasioned by the action of powerful lifting cranes, have to be resisted; which has been carried out in the construction of the North Woodside Iron Works, erected by Mr. John Downie of Glasgow, in 1852.

The large moulding shop of these works is shown in figs. 1 and 2; fig. 1 is a longitudinal section along one half of the foundry, and fig. 2 a general plan of that portion of the works, showing the framing of the roof and the position of the cranes, moulding pits, and stoves, &c. The foundry is constructed wholly of iron, with the exception of the horizontal timber framing for the tops of the cranes. The separate parts of which it is composed are arranged and united together in such a manner as to resist lateral strains in all directions, and the thrust of the cranes is carried down to the ground by a series of sloping struts at the sides and ends of the foundry.

The construction of the foundry is shown to a larger scale in figs. 3 and 4, fig. 3 being a transverse section of half the shop, and fig. 4 a corresponding plan.

The columns A support the longitudinal girders BB, the ends of which form sockets to receive the ends of the transverse timbers C. The girders B are connected outside to the struts D by a dovetail joint and bolts, and the struts thus serve to bind the girders together while they receive the pull or thrust of the strains to which the building is subjected. The foundations for the columns and struts are cubes of brickwork E, well grouted and bound together with top and bottom plates and tie bolts, the earth around them being well rammed and secured. By this arrangement the heavy strains of the cranes are carried down into the ground and distributed over a large area, giving great stability and strength with very little proportionate expenditure of material.

The junction of the columns, girders, and struts, is shown in detail in figs. 5 to 11. The columns, A, fig. 7, are cast with a snug or projecting piece F on the top, in the shape of a T head, figs. 7 and 9, which forms a strong connection between the girders B and the column, and locks them securely together. The flanges G on each girder form a socket to receive the end of the transverse timber C, and the outer corners receive the ends of the diagonals HH. The girders are bolted together by a cross bolt through the transverse beam, and the latter is secured to the top of the column by a vertical bolt. The underside of the beam is notched out to fit upon the head of the snug F, which thus serves as a tenon to take the strain off the cross bolt when the beam is subjected to a pull. The strut D is cast with a dovetail jaw I at the upper end, figs. 5 and 6, which grasps corresponding dovetail pieces cast on each end of the girders B; the dovetail joint serves to bind the girders together, and also takes the pull of the cranes down to the foundations. The thrust is received by the strut by means of the palm K, fig. 7; and the struts, girders, and columns are thus united firmly and securely, in such a manner as to offer an effective resistance to all the strains occasioned by the work of the foundry without any injury or distortion of the framework of the building, which is farther strengthened in the longitudinal direction by corner brackets bolted to the columns and girders, as shown in fig. 1. The upper roof is entirely independent of the rest of the framework of the foundry, and takes no part of the strains. The main principals L rest on the top of the transverse timbers C, immediately over the columns A, and abut against the girders B, so that the thrust is received by the struts D and thrown upon the foundations in the ground, thus obviating the necessity for tie rods to prevent spreading.

The work of the foundry is carried on by means of a set of swing cranes, the larger of which are in the centre of the foundry and the smaller fixed to the side columns. The large cranes are supported at the top by a step or socket M, figs. 3 and 4, fixed on the transverse timbers C, consisting of a bearing cast with sockets on the upper side to receive the longitudinal timbers N and the diagonals H. Similar socket pieces O are employed at the intermediate junctions of the longitudinal and transverse timbers. In the present arrangement accordingly the longitudinal and diagonal beams are supported in their entire depth by the transverse beams, and a good abutment is obtained for the ends in the sockets, instead of the ordinary method of slightly notching the longitudinal timbers on the transverse ones, and then bolting them together. The smaller cranes are principally derrick cranes, working about the alternate columns of the foundry.

The distance between the columns and roof principals is 21 feet, and the width between the two rows of columns 42 feet, with a clear height of 21 feet under the transverse beams. By taking advantage of the sloping struts to form side lean-to roofs, an increased width of foundry is obtained, bounded by the dwarf side walls P, at which the roofing terminates; an uninterrupted floor space of 84 feet total width between the dwarf side walls is thereby left available, a desideratum of much importance in such arrangements.

The upper roofing consists of sheets of corrugated iron, supported on iron purlins carried by the roof principals L. Ample ventilation is secured at the eaves through the girders B, which are cast with a series of openings for the purpose; and also by the top opening running the entire length of the roof, and the openings left at the overlap of the roof sheets. The foundry is lighted entirely from the side roofs with Hartley's rough sheet glass, fixed in metal sash bars which rest on purlins carried by the struts; the skylight runs nearly the whole length of the roof, so as to give a flood of light direct upon the moulding floor.

Since the erection of the works in 1852 this construction of foundry has been found to meet all requirements of resistance and strength, without any apparent giving in any of its parts, although during the period that has since elapsed it has been subjected occasionally to strains of between 45 and 50 tons on the cranes; and the result has thus proved satisfactorily that iron may be successfully applied in preference to any other materials in erections where great strength and power of resistance are required.

Mr. Downie exhibited a half-size model showing the mode of forming the junction between the girders, columns, roof principals, and struts.

The Chairman asked how many cranes were fixed in the building that had been described.

Mr. Downie replied that 17 cranes had been put up in the foundry, and the greatest weight that had been lifted at once by one crane was about 45 tons, the other cranes doing their ordinary work at the same time.

Mr. Fairbairn enquired how the longitudinal and diagonal staying of the roof framing was managed, so as to resist the severe thrust of the heavy cranes in the different directions.

Mr. Downie explained that the present construction of upper roof framing required no diagonal stays or tie rods, the thrust of the principals and cranes being carried down the sloping struts to the ground foundations, so that each portion was directly supported and stayed from the ground.

Mr. Fairbairn observed that the whole building was in fact like a tent without walls, carried down to the ground on all sides. It was certainly an ingenious and economical arrangement, well adapted for situations where land was cheap, but not so admissible where land was dear, from the greater extent of ground covered for the same accomodation within the building.

Mr. Downie said that the reverberatory air furnace and two large cupolas were placed in the internal angle of the building, each within the range of two cranes, and all the cranes communicated with one another through the intermediate ones, two other smaller cupolas being placed at the side. The foundry for heavy work was 84 feet wide, clear between the dwarf side walls, and being right angled was 168 feet long each way; the foundry for light work was a continuation of the same roofing, and the whole area under cover was about 1¼ acre, or 60,000 square feet effective moulding floor room.

Mr. Beyer enquired what was the size of the centre part of the building, and what was the whole cost per square yard upon the ground covered.

Mr. Downie replied that 30*s*. per square yard was the average cost of the whole building divided by the area enclosed within the walls. The centre portion swept by the cranes was 42 feet width between the two rows of pillars and 21 feet height clear under the transverse beams.

Mr. Morrison enquired why travelling cranes were not used instead of the radiating cranes shown in the drawing; there was some objection at first on the part of the men against travelling

* Paper read at the Institution of Mechanical Engineers.

cranes, because the men placed aloft suffered the inconvenience of the steam rising from the hot sand; but his own experience had led him to consider travelling cranes more convenient and economical for working a foundry, and in the construction of foundry now described they would do away with the necessity for the outer struts.

Mr. DOWNIE said that if two or three travelling cranes were used they would interfere much with one another during the process of casting, and it would be impracticable to get through such large quantities of work as with swing cranes. He accordingly preferred radiating cranes for foundry purposes, although for other work, such as in erecting shops, the former might be preferable. The radiating cranes were more readily and quickly shifted than travelling cranes, and none of the men were required aloft, but all remained below, ready to help at any time in the work going on. On these accounts he had been led by his own experience decidedly to prefer swing cranes to travelling cranes for working a foundry.

Mr. MORRISON thought an important objection to swing cranes was that they wasted so much room, causing inconvenience often in extra shifting of the moulds to make room. If a travelling crane were at one end of the foundry it could carry the metal the whole length of the foundry direct, but with swing cranes this could be done only by changing from one to another. In his own foundry, which was 45 feet wide, a single travelling crane was used running the whole length, and served the foundry very conveniently. It was worked by two men, who could come down by a ladder when wanted, but they usually remained aloft, as they were so constantly required there. The crane was constructed with two 14 inch beams of Memel timber, and managed a 15 ton casting readily, or about 22 tons total weight including sand and boxes.

The CHAIRMAN observed there was certainly an advantage in having the men all ready below in a foundry, where their help might be required at any moment. If a travelling crane were worked by hand power the men were required to be aloft pretty constantly, whether wanted or not, so as to be ready without delay.

Mr. McFARLANE decidedly preferred travelling cranes for foundry purposes where a regular run of the same class of castings was made, such as pipes, &c.; but there was no occasion to have the men aloft, especially for the lighter description of castings, he had a travelling crane worked entirely from below by a winch and chain, over a width of 20 to 25 feet; two men could travel the crane with a weight of from 2 to 3 tons. Where much shifting however was required, swing cranes might be advantageously used.

Mr. DOWNIE thought that the advantage that had been named of a travelling crane carrying metal the whole length of the foundry would not be found to exist in practice, as a great number of workmen must necessarily be kept waiting till it was disengaged, and where large quantities were melted this would amount to a serious loss. With the swing cranes the passage of the metal was the work of only a minute or two, and then the cranes were at the service of the intermediate workmen, with scarcely any delay from waiting. At the London Works, Renfrew, in that neighbourhood, travelling cranes had given place to swing cranes, and he believed for the same reasons.

Mr. HARVEY thought it was an important question whether steam power were the cheapest and most suitable for working foundry cranes. He remembered that at Mr. Neilson's Hyde Park Foundry, where there was a set of swing cranes, 12 feet long, lifting 4½ tons each, a trial was made of the comparative advantage of steam and hand power, and it was found that in casting large pipes by hand labour 6 men working 2 hours were required for casting each pipe. A steam cylinder of 5 inches diameter and 12 inches stroke was then applied to one of the cranes, to lift the metal and pour it into the mould, and 35 minutes only were then required for the casting, including drawing the core bar. Four steam cranes were set to work at first at the end of the foundry where there were the largest weights to be lifted, and were found to answer so well that steam power was applied to all the cranes in the foundry except some of small size. The steam pipe was carried through the foundry like a gas or water pipe, and by turning on the steam the cranes were put in motion as easily as by hand labour, and were completely under control. Great economy of time was thus effected, and saving in the amount of labour required in the foundry.

Mr. DOWNIE said that he had found hand labour sufficient, and considered it safer for the moulds and chains, &c.; he thought it more economical for his work than steam power, though it might be otherwise in the case of a different class of work, such as had been referred to, where the cranes would be kept almost constantly in motion.

Mr. McFARLANE was not aware whether steam power was preferable for general jobbing work; he feared it would scarcely be manageable enough; it was more applicable for moulding purposes where a large run of the same kind of goods was required.

Mr. E. JONES thought there was more perfect control over the crane with steam power than with men, and steam was more thoroughly under command for instant application when required. He understood there was a foundry in that neighbourhood where the application of steam power was carried out so completely as to dispense with men for moulding as well as casting, producing greater accuracy as well as economy of work.

Mr. FOTHERGILL observed that much time was unavoidably lost in calling the men together in a foundry, when the power was wanted to be suddenly concentrated for a particular purpose; but with steam power there was the great advantage of the whole power being instantly available at all times.

The CHAIRMAN said that for general purposes he decidedly preferred steam power for working cranes, and in his own erecting shop had found great advantage in working both radial and travelling cranes by steam power. A shop of 45 feet span had a travelling crane running the entire length, and driven by a shaft 100 feet long with a groove in it, which communicated motion to the various parts. Four radial cranes were also employed, the travelling crane working over them.

ON OPTICAL AND OTHER INSTRUMENTS.*

By Sir DAVID BREWSTER, K.H., F.R.S.

THE REFLECTING TELESCOPE.

Although the refracting telescope, formed by glass lenses, was the first form of the telescope, and enabled Galileo, Huygens, and Cassini to make important astronomical discoveries, yet from various causes it was, in the time of Newton and his contemporaries, superseded by the reflecting telescope first proposed by James Gregory, and improved by Newton, Hadley, Hawksbee, Short, Herschel, Ramage, and Lord Rosse. In the Paris Exposition very fine models of the reflecting telescopes of the Earl of Rosse and Mr. Lassell were submitted to the juries.

Reflecting Telescope of the Earl of Rosse.—Having overcome the great practical difficulties which had been experienced in casting metallic specula of a large size, Lord Rosse succeeded in casting one fully 6 feet in diameter, and which, when ground and polished by machinery of his own invention and construction, had a focal length of 53 feet. For this large speculum, weighing nearly 4 tons, a tube was provided, 8 feet wide in the middle and fifty feet in length, consisting of deal staves hooped like a cask. The speculum itself was fixed in a large cubical wooden box about 8 feet in each side, in which there is a door, to allow two men to go in, in order to remove or replace the cover which protects the speculum. This box is fastened to the end of the tube so as to form the lower end of it, and contains an ingenious contrivance for keeping the speculum from moisture by absorbent materials. In order to prevent the speculum from breaking or changing its form, very ingenious and effective means have been provided.

This enormous tube, through which I have walked when it was in a horizontal position, is established between two walls of castellated architecture, about 60 feet high, so as to enable the observer to examine the heavenly bodies for about half an hour before and half an hour after they pass the meridian. The machinery for moving it, and the galleries for observation, along with the telescope, weigh 12 tons; and this mass of matter is very ingeniously balanced by counter-weights suspended by chains fixed to the sides of the tube. The galleries for observers hold twelve persons, and strangers are not a little startled when they find themselves suspended midway between the piers over a chasm 60 feet deep.

With this gigantic instrument the most important discoveries have been made. The great and startling fact of spiral

* Abstract of Report to the Board of Trade on the Paris Exposition.

nebulæ—the resolution of nebulæ into stars—the duplication of stars hitherto reckoned single, and remarkable structures on the moon's surface, are among the achievements of Lord Rosse's telescope.

Mr. Lassell's Reflecting Telescope.—The principle of construction of the twenty-foot equatorial, originally erected at Starfield, is precisely the same as that of the nine-foot equatorial described in the twelfth volume of the Memoirs of the Royal Astronomical Society, and engraved in plates V. and VI. of that volume.

The tube is of sheet-iron, barely a tenth of an inch thick, 20 feet long, and 25 inches inside diameter, united by rivets with the heads inside, so that the outside is smooth and apparently without seam. Its weight is 594 lb.; the square box or casting which encloses the tube is 5 ft. 6½ in. long, 2 ft. 3½ in. in the side, and weighs 992 lb. The *uprights* are 7 feet long, and 3 feet wide at the base, each weighing 450 lb. The cone and large circle to which the uprights are bolted are in one casting, and weigh about 2010 lb. The speculum is 54·1 inches diameter, 240 inches focus, and weighs about 380 lb. There are, indeed, three specula belonging to the telescope, of the same diameter and focus, but varying in thickness from about 2·4 to 2·8 inches.

The speculum is mounted in a sort of skeleton box, the back of which is of wrought-iron, 0·28 inch thick, and when in its place, it exactly fills the end of the tube. The box or plate is held in its place in the tube by three strong equidistant screws tapped into it, and revolving in collars attached to three brackets screwed to the tube, so that these screws having square heads fitted with a key, command the perfect adjustment of the speculum at all times, without interfering in the least with the manner in which it is supported.

When the telescope is pointed near the zenith, the speculum is supported entirely by the back of this box, which receives the three ultimate points of a system of levers, dividing the back of the speculum into eighteen portions of equal area. As the telescope, however, is depressed from the zenith, it is evident that the pressure of the speculum on these levers must begin to be transferred to its lower edge, which, if suffered to rest on any hard substance, would immediately begin to produce distortion. To prevent this, in some degree, the speculum has its lower half resting upon a broad, thin, semicircular hoop, secured at the ends of a horizontal diameter by stout brackets attached to the circumference of the supporting box. This hoop is nearly as broad as the speculum, and not thicker than a piece of ordinary card. Some distortion is still perceptible at low altitudes, by the pressure even of the upper part of the speculum upon the lower, and another system of levers for preventing flexure in this position is also attached to the supporting plate. These take up the support as the others yield it, and render the speculum capable of retaining its normal figure in all positions.

An exact description of both systems of levers will be found in the Report of the British Association, Edinburgh, for the year 1850. Mr. Lassell had not then constructed this second system of levers, but he immediately afterwards carried out the plan there proposed, with so slight a variation as not at all to affect its principle, or vitiate the description. Instead of incurring the labour of casting a new speculum with ribs on the back, he cemented a number of blocks upon the back of the speculum, which serve as bearings for the ends of the levers, and have this advantage over the proposed ribs, that they are so disposed as to be out of the way of the levers for vertical support—an essential condition. He has found twenty-seven levers to be sufficient; the long and short arms being in the proportion of about 12 to 1, and loaded with about a pound weight at the end. As this is a most important and efficacious arrangement of the mode of supporting a large speculum, one of the models exhibited at the Paris Exposition was a full-sized *exemplar* of this method of support.

The equatorial is driven by a clock-movement, which is abundantly powerful, and goes sufficiently well to keep a star apparently immovable in the field, but would scarcely suffice to keep it bisected by a wire for more than perhaps a minute.

The finder of the telescope is a Newtonian reflector, of 4·3 inches aperture, and 42 inches focus, carrying a magnifying power of 27 times. This sort of finder is more convenient than an achromatic one, as it shows objects in the same relative positions as in the great telescope, however it may be directed. It is very essential for the convenience of observing, and especially for the right performance of the telescope, that the mirror should always preserve the same relative position in respect to its movement in altitude being in a plane perpendicular to the horizon, and this is secured by wheel work attached to the cast-iron box containing the telescope, which rotates the tube, and secures the horizontality of the axis of the eye-tube in all positions of the telescope.

Instead of a plane speculum, Mr. Lassell generally uses a prism, which transmits a pencil two inches in diameter, and is therefore just large enough to include all the rays reflected by the large speculum. It was made for Mr. Lassell by M. Merz, of Munich, and is of admirable quality, no test that has been applied being sufficient to reveal any imperfection. The only inconvenience in its use is that on very dewy nights it will scarcely retain its full brilliancy, more than from an hour and a-half to two hours, after which period it must be taken out and wiped. This trouble is, however, less than might be expected, for, having two prisms, each mounted in a frame, which by means of steady-pins can be instantly placed so that the prism shall be in exact adjustment, not more than two or three minutes is occupied in exchanging the prisms.

Mr. Lassell possesses an almost unnecessary variety of magnifying powers, positive and negative, as well as single ones.

The Achromatic Telescope.

The achromatic telescope, in which the object glass is composed of one or two convex lenses of crown glass, and a concave one of flint glass, was invented by an English country gentleman, Mr. More Hall, and also by John Dollond, an English optician. During more than half a century, foreign nations were supplied with this instrument as made by Dollond, Ramsden, and other English artists; but owing to the difficulty of procuring proper flint glass, and the severity of the English excise laws, which prevented artists from improving it, the manufacture of achromatic telescopes has passed into foreign workshops, and England deprived of a valuable source of employment and of revenue.

Great Telescope of M. Lerebours.—M. Lerebours exhibited the object-glass of the great achromatic telescope of the Imperial Observatory of Paris. The flint glass of this admirable object-glass, 39 centimètres, or about 14 inches, in diameter, was obtained, about twenty years ago, by the yonger Guinand from the glass-works at Choisy le Roi. M. Lerebours' father began to grind it in 1836, but after several fruitless attempts with crown glass of a bad quality, though the best which could be obtained, he abandoned the work. He executed, however, before his death, which took place in 1840, an object-glass 12 inches in diameter, and which was perfect, with an aperture of 10½ inches. This object-glass is now in the possession of M. Secretan, the successor and former partner of the present M. Lerebours.

Having obtained, in 1843, from M. Bontemps, at the glass-works of Choisy le Roi, two discs of crown glass, M. Lerebours resumed the construction of his object-glass of 14 inches, and he succeeded in completing it at the commencement of 1844. During the year 1845 and 1846 it was frequently tried and examined by MM. Arago, Mathieu, Laugier, Faye, and Goujon, and at the beginning of 1847 M. Arago advised the French Government to acquire it for the Observatory. M. Salvandy, then Minister of Public Instruction, after some delay, agreed to purchase it for 40,000 francs (about 1670*l.*) Fifteen days afterwards the French revolution broke out, and the arrangement came to an end. Annoyed by these untoward events, M. Lerebours offered it to the Board of Longitude for 25,000 francs (a little more than 1000*l.*), a sum scarcely one half of its cost. The offer was accepted, and the telescope is now the finest in the Imperial Observatory. A medal of honour was adjudged to M. Lerebours for this object-glass.

Dr. Steinhill's Achromatic Telescopes.—Various telescopes of the common size for ordinary purposes were exposed, but by far the most valuable instruments were exhibited by Dr. Charles Augustus Steinhill, of Munich. These telescopes, the largest of which had an object-glass of 6½ Paris inches in diameter, made of the glass manufactured by M. Daguet, of Soleure, were not only fine instruments, but were also remarkably low in price. In those which I had occasion to examine, the distinctness of vision was very great, and the secondary spectrum inconsiderable. Dr. Steinhill gives a greater focal length to his object-glasses, in relation to their aperture, than had previously been done, and he is thus enabled to diminish indefinitely the detrimental effects of the secondary spectrum, when high magnifying powers are used in viewing very bright objects. In a comparison of one of Fraunhofer's best instruments, 34 lines in aperture, and 42 inches in focal length, with one of his own, 27 lines in aperture and 45 inches in focal length, Dr. Steinhill found that, with its highest power of 126, Fraunhofer's surpassed his; but when both were used with eyepieces that gave a magnifying power of 210 and 225 respectively, Dr. Steinhill's telescope showed small dots (defects in a printed page), which were invisible in Fraunhofer's instrument. Upon reducing, however, the aperture of the latter instrument to 28 lines the dots were seen.

These object-glasses of great focal length, beside diminishing indefinitely the secondary spectrum, are much more economical. An object-glass, with 4 inches aperture, 100 inches focal length, a magnifying power of 500, and giving a perfectly black background to a very bright object, can be had for 200 florins (16*l.* 10s.), and with tubes and eyepieces, for less than 300 florins (25*l.*) In order to obtain the same results with the usual object-glasses, one of 6 inches would be required, which would cost from six to eight times as much.

Dr. Steinhill's object-glasses are made of the glass of M. Daguet, of Soleure. Its homogeneity is carefully tested, and its refrangibility accurately determined for the rays B, C, D, F, and G. The spherical aberration is rigorously corrected for the whole object-glass from its centre to its margin, which cannot be done by spherical surfaces.

M. Secretan's Equatorial Telescope with a Clock movement.—This beautiful instrument is 13 feet in focal length, and its object-glass has a real aperture of 9½ inches. The polar axis 16 ft. 4 in. long, and is formed of six bars or tubes, traversed by strong straps of iron bolted to their two extremities, and strengthened by numerous rods of polished steel between them, which form a very rigid prism. There are two prisms of this kind, each composed of three principal rods, between which the axis of the telescope is supported, so that it can move freely in a complete circle between them, in order to take every position in declination.

The circle of right ascension, which is placed on the platform that receives the clock movement, is 2 feet in diameter, and shows seconds of time by means of two verniers. The clock movement has a fly regulator, and a weight made so as to render the clock independent. The circle of declination has a level fixed to the eye-tube, in order to give the optical axis its proper altitude. The illumination near the eye-glass is obtained from a lamp kept vertical in every position of the telescope.

The telescope is furnished with a micrometer having *eight* fixed wires, *five* in one direction, and *three* perpendicular to the five, and also with two moveable parallel wires independent of each other. The motion of one of these is reckoned upon a graduated circle, which counts up to forty revolutions. The other performs the part of a fixed wire, and can be placed in any part of the field. The whole micrometer has a motion round the optical axis of the telescope, so as to enable the observer to measure the angle of position. This motion is measured by a circle divided into minutes, and is furnished with a clamp and endless screw.

Messrs. Chance's Discs of Flint and Crown Glass for Achromatic Telescopes.—Among the most remarkable and valuable products of British manufacture exhibited, we must rank the gigantic discs of glass from the works of Messrs. Chance Brothers and Company.

These articles consisted of two kinds of crown glass, and three kinds of flint glass, the latter varying in specific gravity from 3·2 to 3·8, in order to answer the various purposes for which they were wanted, for cameras, telescopes, and microscopes.

The largest of these discs was a pair of flint and crown, 29 inches in diameter! The flint glass disc was exhibited in the Crystal Palace in 1851, and obtained a Council Medal. Since that time I have entertained the hope that the English Government would purchase these discs, and construct with them the grandest achromatic telescope that was ever contemplated by the most sanguine astronomer: and with this object in view, I brought the subject under the notice of persons of high position and influence, but the only individual who took any interest in the subject was the Earl of Ellesmere, who liberally offered to give several hundred pounds to assist in the purchase of the glass, and the construction of the instrument. In the hope that private munificence might supply the means which national parsimony had refused, I was occupied with a scheme of acquiring for British Science the power of extending widely its boundaries, when I received the mortifying intelligence that M. Leverrier, alive to the interests of science and the glory of his country, had in his possession the Birmingham discs, and had entered into an arrangement, dependent on their excellence, to purchase them at a high price for the French Government for the construction of a telescope.

Messrs. Chance exhibited also a pair of 20 inch discs fo photographic purposes, another pair of 16 inches for telescopes, and a great variety of smaller ones from 9 inches downwards to 1 inch.

Daguet's Discs of Glass.—Very fine discs of flint and crown glass from 16 inches downwards, and prisms of the same materials, were exhibited by M. Daguet, of Soleure, in Switzerland. This glass is in high estimation among foreign opticians, and its maker was honoured with a Council Medal at the Exhibition of 1851. At the French Exposition a Medal of Honour was adjudged to M. Daguet for the discs of glass which he exhibited.

Achromatic Microscopes.

The achromatic microscope, an instrument of modern invention, and of the most extensive use in the arts and sciences, has, from the spirit of competition excited by the London and Paris Exhibitions, been brought to a high degree of perfection.

Messrs. Smith and Beck, who had no English rival, carried off the microscopic prize by receiving a Medal of the First Class. Although the microscope of M. Nachet was not equal to that of the English artists, it had such a high degree of merit, that a Medal of the same value was adjudged to him.

MM. Oberhauser, of Paris, exhibited an excellent achromatic microscope, and also one intended for observations in the vacuum of an air-pump, for which a Medal of the First Class was adjudged.

Mr. Pillischer, of Bond-street, exhibited a microscope with an achromatic object-glass half an inch in focal length and of such excellence that a medal of the Second Class was awarded to him. Mr. Pillischer also exhibited what he calls a lenticular microscope, for examining urinary deposits at the bedside, which has been highly spoken of by the late Dr. Golding Bird and Mr. Queckett.

Mr. Pillischer's "students' microscopes" were remarkable, not only for their cheapness, but the excellence of their construction.

Messrs. Smith and Beck sent two achromatic microscopes namely, one of their very best instruments, and another of an entirely new construction, to which they gave the name of "the Educational Microscope." The first of these microscopes differed very little from the one which they exhibited in 1851 at the Crystal Palace. It had, however, object-glasses of a shorter focus and greater angular aperture.

The *Educational Microscope* exhibited by Messrs. Smith and Beck is an instrument of great value, and from its low price and excellence it cannot fail to have an extensive sale. With object-glasses of one inch and a quarter, and apertures of 22° and 75°, its price, packed in a case is only 10*l.*, and the additional apparatus, including one Lieberkhuan, a Wenham's parabolic reflector, a Wollaston's camera lucida for drawing, and a polarizing apparatus complete, with prisms and selenite, amount only to 5*l.* additional. Since the middle of 1855 no fewer than 100 of these Educational Microscopes have been sold, and two-thirds of this number had the aditional apparatus.

When the Jury were comparing the rival microscopes, M. Amici, of Modena, distinguished by his optical inventions, showed a microscope which exhibited certain striæ in test objects better than any of the instruments under examination. This superiority was produced by the introduction of water between the object and the object-glass; but as M. Amici was not an exhibitor, the Jury was not called upon to adjudicate to him a Medal.

Optical Apparatus for Lighthouses.

Polyzonal lenses, or lenses composed of separate pieces having a common focus, were 40 years ago recommended by myself as peculiarly adapted for lighthouses; and their introduction into the Scottish lighthouses in place of the old parabolic reflectors was pressed upon the Engineer and the Commissioners of the Northern Lights before Fresnel had submitted them to the French Lighthouse Commission. I persisted for many years in urging the Trinity House and the other Lighthouse Boards to adopt this great improvement. The Scotch Board at last authorised me to get one of the dioptric lenses constructed in London. It was executed in flint-glass by the Messrs. Gilberts; but nothing farther was done in the matter till Mr. Alan Stevenson was sent by the Board to Paris in 1834, for the purpose of comparing the dioptric lights, which had so long been guiding the mariner on the French coast, with the parabolic reflectors used in Britain. The result was such as had been long before pressed upon the Board and the British public, and the new lenses have been partially introduced into Scotland, England, and Ireland. Much, however, remains to be done; and as Messrs. Chance and Company have an establishment where the dioptric apparatus can be manufactured to any extent, the Board of Trade could not perform a greater service to humanity, and to the commercial interests of our mercantile navy, than by extinguishing every parabolic reflector on our shores, and replacing them by the new lenses.

The Minister of Agriculture, Commerce, and Public Works exhibited a catadioptric lighthouse apparatus of the first order, with eclipses every minute, constructed by M. Henry Lepaute, under the direction of MM. Leonce, Reynaud, and Degrand. A Great Medal of Honour was adjudged to the Administration of Lighthouses, and a Medal of Honour to M. Lepaute for this beautiful apparatus.

Another lenticular apparatus was exhibited by M. L. Sautter and Co., who received a Medal of Honour from the jury.

M. Blazy Jaliffier exhibited various pieces of apparatus for lighthouses, and for lighting town clocks and railways, and was rewarded with a Medal of the First Class.

The same honour was conferred on Messrs. Chance and Company, the only British exhibitors of lighthouse apparatus, for their catadioptric light of the first order. In the quality of the glass, either in reference to colour or freedom from striæ, and in the fitting up of the various parts, this apparatus seemed to be very little, if at all inferior, to its rival. Its glass seemed to be somewhat whiter than the French glass, having a slight tinge of yellow, that of the French glass having a tendency to blue.

Stereoscopes.

The fundamental principle of the stereoscope, that in seeing objects in relief we unite the two dissimilar pictures produced by the right and left eye, was known to Galen, Aguilonius, Porta, and others. The first person that seems to have thought of constructing an instrument for uniting two such pictures was Mr. Elliot, of Edinburgh, but he did not publish his invention. Mr. Wheatsone, in 1838, communicated to the Royal Society of London, and was the first to publish, an account of an apparatus called the stereoscope, for uniting two dissimilar pictures, and thus producing solidity or relief. This apparatus consisted of two reflecting mirrors, and is known by the name of the *reflecting stereoscope*. To another form of the stereoscope invented by myself, and now in universal use, I gave the name of the *lenticular stereoscope*, from its consisting of half or quarter lenses, which magnified while they combined the dissimilar images.

Only one stereoscope, namely a *lenticular* one, was exhibited in the Crystal Palace of 1851. It was made by M. Duboscq, of Paris (from a model one which I had given him in 1850), and formed part of his fine collection of philosophical instruments.

Although the stereoscope is known principally as an instrument of amusement, it has claims upon science and the arts of no ordinary kind; and the time is not distant when it will be regarded as an indispensable auxiliary in the education of the people.

A great number of stereoscopes besides the one exhibited by myself, were sent. M. Claudet, Mr. Williams, of Regent-street, M. Duboscq, and Mr. Millet exhibited hexagonal stands with six stereoscopes, which were visited by crowds of spectators; Messrs. Lefort, Queilhe, Lamiche, Warren Thomson, and Dejonge also exhibited stereoscopes, and MM. Couppier, Moulier, and Soulier produced admirable binocular slides for the instrument.

Kaleidoscopes.

Although the kaleidoscope has been long used both in England and on the Continent, for creating patterns for carpets, and for analogous purposes in the decorative arts, it is generally regarded as an instrument of amusement.

The kaleidoscopes which I was requested to exhibit were two in number. The *first* was a very fine instrument, constructed with much care by the late Mr. R. Bate, optican, London. It consisted of reflectors of speculum metal, which could be set at various angles which were the aliquot parts of a circle.

The *second* was an *universal kaleidoscope*, constructed so that by a piece of ingenious mechanism the reflectors could separate round an axis and give circular patterns, or take a parallel position at various distances to give rectilinear patterns, or converge to a centre at any required distance, so as to produce curvilinear patterns of any radius of curvature.

No specimen was exhibited of the *telescopic kaleidoscope*, its most interesting form, in which objects at any distance, living or dead, at rest or in motion, can be introduced into the figure or pattern.

Photographic Cameras.

During the last four years, great improvements have been made in the photographic camera, and much ingenuity has been shown in its adaptation for taking binocular pictures. Cameras have also been made for the use of travellers, in which the photograph can be developed and fixed without resorting to a dark apartment.

Among the most eminent improvers of the photographic camera, M. Voightlander, of Vienna, occupies a distinguished place, but he has not exhibited any of his instruments either in the Exposition of 1851 or 1855.

Several photographic cameras were exhibited by the English opticians, Messrs. Horne andThornthwaite, and by Mr. King, of Bristol, who received a Medal of the Second Class; and by the French opticians, M. Jamin, M. Ch. Relandin, and M. J. G. Schiertz.

M. Jamin, who received a Medal of the Second Class, exhibited several fine object-glasses for photographic cameras. He constructs them of three kinds; 1st, on what is called the German system, with two object-glasses; 2ndly for landscapes, and according to the wish of the purchaser, either for rapid operation or for pictures of a large size; and 3rdly, for landscapes and portraits.

However creditable it is to the ingenuity and enterprise of the artist in executing lenses of magnitude and value, it is very difficult to appreciate the advantages which are expected from them. If we require to take a photographic landscape with singular rapidity, or in twilight, a large lens is absolutely necessary. If our object is to take a large picture, it may be taken with a small camera, and afterwards enlarged by an enlarging instrument, and therefore a large lens is by no means necessary for this purpose. The only advantage of large lenses, which would justify an artist in increasing the expense of them, would be in taking almost instantaneously the portraits of animals.

In taking the portraits of human beings such lenses are worse than useless. I have proved, both from theory and experiment, that such portraits so taken are monstrous representations of humanity, even when the lenses have an aperture of 3 or 4 inches. With an aperture of 14 inches the human face would be the most vulgar caricature.

M. Jamin exhibited also another photographic object-glass with new properties. It was what he calls a double combined one, with the optical and chemical foci coincident, and was furnished with a *cone centralisateur*, which is said by the Abbé Moigno to add considerably to the distinctness and to the prompt fixing of the pictures. It has also a variable focus, and may be used either for landscape or portraits. With this lens M. Disderi took colossal pictures nearly 30 inches high by 21 broad.

M. Jamin exhibited also three sets of lenses of great perfection, and of all curvatures, made of crown glass, flint glass, and rock crystal, and also a fine set of prisms of all sizes and forms.

Optical Apparatus for Physical Researches.

The Paris Exposition contained many ingenious instruments for prosecuting researches in physical optics. One of the most important of these was,—

A Solar Telescope.—This instrument, which was exhibited by myself, was constructed for my use, at the expense of the Royal Society, by the late Mr. Dollond, for the purpose of examining the deficient lines in the solar spectrum. For several years I had been engaged in this inquiry with an achromatic telescope by Ramsden, and a prism executed by the late distinguished optician, M. Fraunhofer of Munich. As the part of the spectrum under examination necessarily consisted of homogeneous light, it occurred to me that an achromatic object-glass was unnecessary, and that an object-glass more suitable for the purpose required to be corrected only for spherical observation. The object-glass was therefore composed of two lenses of plate-glass, of which the curvatures were obtained from Sir John Herschel's formula, and the eye glasses were made on the same principle. The focal length of the object-glass is 3 ft. 6 in; the diameter of the object-glass, 4 inches; the height of the large prism executed by M. Merz is 3 inches, and the three sides of its horizontal triangular section, 5 inches, 4·45, and 3·7. Several cylindrical lenses, which have a peculiar action in rendering visible faint lines in the spectrum, and a large hollow prism for holding oil of cassia and other fluids, accompanied the instrument. Its sides were equal, and 8 inches in length.

Arago's Polarimeter.—This instrument, intended to measure the polarisation of the atmosphere, was exhibited by M. Duboscq in his fine collection of optical instruments in the Crystal Palace of 1851. It consists of two parts, not easily explained without diagrams, one of which is to measure the degree of polarisation of the sky at any point to which the instrument is directed, and the other to determine the altitude of that point above the horizon. The first consists of a bundle of glass-plates, 6 inches long, and 1¼ wide. This bundle has a motion round the axis of a graduated arc, which measures the angle of incidence of the light reflected from its surface, when its degree of polarisation is balanced by the opposite polarisation of the bundle of plates. This angle affords, by a well-known process, a measure of the degree of polarisation required. The point of compensation, or the angle at which the polarised light of the sky is reduced to common light, is ascertained by a polariscope with a doubly refracting prism at the eye end, and a piece of rock crystal at the other, which exhibits none of the polarised colours by common light. Another aperture in the polariscope, close to the piece of rock crystal, and receiving directly the compensated light, enables the observer to compare the whiteness of its two images with the whiteness of the other two.

In the polarimeters which I employed in the three years' observations from which I determined the form of all the lines of equal polarisation in the atmosphere, as published in Johnston's Physical Atlas, I employed the ingenious polariscope of Savart, and measured the requisite altitudes with a common quadrant. The determination of the point of compensation does not require nicely divided instruments.

Lithoscope for discriminating Minerals.—This instrument was constructed for me by the late Mr. Dollond, and exhibited for the first time. Without noticing the ingenuity of the artist in fitting it up, it may be described as a small rectangular prism placed horizontally above, and upon, the polished surface of a precious stone or mineral. A drop of one or other of three or four oils having the least and the greatest and intermediate refractive powers, is placed between the lower and larger surface of the prism and the upper surface of the stone. The film of oil being a parallel one, the images of a small candle or disc of light reflected from the common surface of the oil and prism, and the common surface of the oil and stone, are coincident; but if by means of a screw at one end of the prism we lift up that end, we convert the film of oil into a prism, and the two images separate. The brightness of the image reflected from the glass and the oil is a constant quantity for that oil, and the comparison of it with the brightness of the image reflected from the oil and the stone, enables us to tell which of the precious stones we are examining. We can thus, at a single glance, determine whether the stone is diamond, ruby, sapphire, or only glass. Different fluids may, in like manner, be distinguished.

Brunner's Refractometer.—The object of this instrument is to measure with great accuracy the index of refraction of doubly refracting crystals and other bodies. Our countryman, Dr. Blair, first used accurately-divided instruments for this purpose. Mr. Brunner, the Troughton of Paris, has produced an instrument of great beauty and accuracy, which without diagrams it is impossible to describe. Being a juror he received no medal.

Steinhill's Refractometer.—This instrument, constructed by Mr. Becker, Newman-street, London, and exhibited by him, was invented by Dr. Steinhill. It consists of two prisms formed by two plane parallel glasses and one plane convex lens. Both prisms are filled with distilled water, and the cross wire of a micrometer is made to bisect a platinum wire, when the index is at *zero.* One of these prisms is then emptied and filled with another fluid, whose index of refraction we wish to ascertain. The wire no longer bisects the platinum wire as before, and when they are brought again into bisection by the micrometer screw, its divided head will give a measure of the deviation of the wire produced by the larger refractive power of the fluid in comparison with water. This instrument gives measures equal to the $\frac{1}{1000}$ of an inch.

Telescope for measuring Distances.—This instrument, intended for military purposes and for a *coming-up glass* at sea, was exhibited by myself, and was constructed by W. Harris, optician, in London. A pair of wires or points absolutely fixed in the field of view in the focus of the eye-glass nearest the eye was opened and shut optically by the motion of a second object-glass to or from the first, and the change of angle was indicated by divisions engraven on the tubes. In another form of the instrument a divided object-glass which gave double images was made to move to and from the main object-glass, and thus to vary the angle subtended by the images. A patent was taken out by me for these instruments in 1812.

Herapath's Artificial Tourmalines.—These very interesting crystals, to which the name of *Herapathite* has been given, were discovered by Dr. William Herapath, of Bristol, and were exhibited. They are intended to supersede plates of real tourmaline and Nicol's prisms, which have been hitherto used in experiments and researches on the polarisation of light. These plates are thin crystals of the sulphate of iodo-quinine, and so completely do they absorb one of the pencils produced by double refraction, that two transparent plates, scarcely thicker than gold leaf, are totally impervious to light when crossed at right angles. Dr. Herapath has obtained them more than six-tenths of an inch broad. These delicate plates are preserved between two thin plates of microscopic glass, interposing a film of an ethereal solution of Canada balsam. The process of making them is so simple that Dr. Herapath has often prepared a dozen good artificial tourmalines in an hour, and he remarks, "that before long these splendid and useful crystals will be offered for sale by opticians at as many shillings as real tourmalines cost pounds, and certainly of equal value and practical utility."

Varley's Graphic Telescope.—Mr. Cornelius Varley exhibited his graphic telescope, an instrument with which the most distant views or the nearest objects may be drawn of any size that is required. This instrument may be described as resembling a compound microscope having an object-glass, a field-glass, and an eye-glass. A plane speculum placed at an angle of 45° to the axis of the instrument reflects the object to be drawn into the object-glass, which would form an image of it in its focus if the rays were not obstructed by the field-glass which contracts the image, and this image is seen distinctly by an eye-glass. The rays from the eye-glass enter the eye parallel, but being previously received upon a small plane speculum inclined 45° to the axis of the instrument, the eye receives them after reflection; and while one portion of the pupil looks into the speculum, and sees the image projected upon a sheet of paper, the rest of the pupil looks past the edge of the speculum, and sees the paper itself, upon which the drawer can readily draw with a pencil the picture before him. The size of the image may be varied very considerably without altering the size of the apparatus, so that sketches on a very large or a very small scale may be made by the same instrument. This telescope may be converted into a graphic microscope for drawing the magnified images of objects.

M. Duboscq's Polariscope.—The object of this instrument, constructed and exhibited by M. Duboscq, is to enable philosophers to observe the laws of elliptic polarisation produced by reflection from the surfaces of bodies as discovered by M. Jamin, and also the laws of reflection and double reflection produced by crystals having a metallic lustre, as investigated by M. Senarmont.

Arago's Interference Refractor.—This instrument, constructed and exhibited by M. Duboscq, is intended to show and to measure the displacement of diffraction fringes, in order to determine inequalities in the refractive power and densities of solid, fluid, and gaseous bodies.

M. Duboscq exhibited also the new and improved heliostate of M. Silberman, and the ingenious photometers invented by MM. Babinet and Bernard.

Instruments for Scientific Instruction.

Many instruments of great interest were exhibited for assisting the teacher or lecturer in conveying knowledge to his auditors. Several of these were intended for instructing the blind in music and in writing; but the most ingenious and important were those for exhibiting by optical means phenomena and scientific truths to large audiences. Among these stands pre-eminent—

Duboscq's Regulator of Electric Light.—The magic lantern was for a long period the only instrument in use for exhibiting phenomena to large audiences. From the faintness of its light, however, and the imperfection both of the optical apparatus employed and the drawings which it projected magnified upon the wall, the effect was very unsatisfactory. The lime-ball light of Mr. Drummond became an excellent substitute for the oil or the gas-lamp of the magic lantern, but the expense of bringing the lime-ball to a white heat with alcohol, and the danger of doing it with a mixture of oxygen and hydrogen gases have prevented it from coming into general use.

The brilliant light produced by placing charcoal between the two poles of a galvanic battery being subject to none of these disadvantages, M. Duboscq had contrived an apparatus by which the electric light produced at the contact of the two charcoal points traversed by the electric current is maintained with a high degree of brilliancy, continuity, and equality of intensity. He has, therefore, been enabled to employ this light either for the ordinary purposes of illumination, or for producing and exhibiting the various phenomena of physical optics, the structure of organic bodies, physical phenomena of all kinds, chemical compositions and decompositions, microscopic objects, and objects of natural history.

In exhibiting with this apparatus very minute microscopic objects, such as the globules of blood of different animals, where a magnifying power of 1000 or 1200 diameters is required, the loss of light is so great that the objects themselves would disappear. This difficulty has been surmounted by M. Duboscq in a very ingenious manner. With the electric light, which is highly photogenic, he takes negative pictures of the globules of blood with a power of 300 diameters, which does not extinguish too much of the light that he employs. With these negative pictures he obtains positive ones upon albumenised glass. These positive images are then placed as objects in the tube of a double apparatus, and when illuminated by the electric light, which diverges from the focus of the lenses, they are represented upon the white screen of an enormous size, being magnified 1000 or 1200 times.

In order to measure the dimensions of these minute objects thus highly magnified, M. Duboscq places in one of the tubes which receive the divergent light a plate of glass, on the surface of which is a micrometrical scale cut with a fine diamond point. A magnified image of this scale is projected upon the scene, and by a slight motion of the tube which contains it, it is made as distinct as the image which it covers, in order that the observer may see and measure the dimensions, that is, the diameters of the spherical globules of blood, or the axes of the elliptical ones, so that he not only sees, but has the power of appreciating the magnitude of the different bodies and their parts, which are submitted to his observation.

Nachet's Multocular Microscope.—M. Nachet, of whose microscopes we have already spoken in high terms, exhibited various new forms of the instrument, by which their utility has been greatly extended. In order to adapt the microscope for anatomical demonstrations, so that two or three persons may see at the same time the result of microscopic dissections, M. Nachet has constructed two microscopes—a *double* and a *single* one. By means of the first, one person can examine the progress and result of a dissection which is performed by another person; and by means of the second, two persons can enjoy this advantage.

In the microscope for two persons, this result is obtained by placing above the object-glass a prism, the section of which is an equilateral triangle. The rays from the object-glass entering the lower face of the prism perpendicularly, the two halves of the pencil are reflected in opposite directions from the other faces of the prism at angles of 45°, and thus enter two separate tubes, in each of which they form an image of the object. These images are, in a certain sense, erect, but in order to see them in exactly their natural position, in which case alone the anatomist can use his scalpel, a prism is placed in each tube between the former prism and the eye-pieces, so that their planes of reflection are perpendicular to those of the other prisms. By this means the images are perfectly erect, and the demonstrator can proceed with his work without fatigue or difficulty. If the demonstrator and observer should have eyes of different focal lengths, the adjustment is effected by moving the eye-piece to or from the object-glass.

When the microscope is constructed for three persons, the pencil of rays from the object-glass is divided by three prisms placed in the same plane, and whose reflecting faces, if brought together, would form a triangular pyramid. The pencil from the object-glass is then divided and directed into three separate tubes in which three prisms erect the three images, and place them in their natural position.

M. Nachet has also constructed the instrument for the use of *four* persons.

Nachet's Binocular Microscope.—The idea of a binocular microscope can hardly be called an invention, if constructed on the same principle as the binocular telescope with two object-glasses as well as two eye-glasses. The additional expense of such an instrument will not be repaid by any advantage which it may be supposed to possess. An instrument of this kind was constructed by Père Cherubin about 1670, but in so far as we know, no other binocular microscope has been made.

In 1851, Professor Riddell, of the University of New Orleans, devised and constructed a binocular microscope with the view "of rendering both eyes serviceable in microscopic observations.

"Behind the objective," says Professor Riddell, "and as near thereto as practicable, the light is equally divided and bent at right angles, and made to travel in opposite directions by means of two rectangular prisms which are in contact by their edges somewhat ground away; the reflected rays are received at a proper distance for binocular vision upon two other rectangular prisms, and again bent at right angles, being thus either completely inverted for an inverted microscope or restored to their first direction for the direct microscope."

"With these instruments," the author adds, "the microscopic dissecting knife can be exactly guided. In looking at microscopic animal tissues, the single eye may perhaps behold a confused amorphous or nebulous mass, which the pair of eyes instantly shapes into delicate super-imposed membranes with intervening spaces, the thickness of which can be correctly estimated. Blood corpuscles, usually seen as flat discs, loom out as oblate spheroids. In brief, the whole microscopic world as thus displayed acquires a ten-fold greater interest in every phase, exhibiting in a new light beauty and symmetry indescribable."

With this instrument, Professor Riddell obtains dissimilar drawings of solid objects by the aid of the camera lucida, and by uniting them in the stereoscope, he brought them out in their natural relief.

When the two tubes of M. Nachet's double microscope are placed vertically and parallel to one another, and are brought so near to the central prism that their distance is equal to 2½ inches, the distance between the two eyes, the instrument becomes a binocular one, similar to that of Professor Riddell, to whom we must ascribe the merit of the invention, and of that ingenious combination of prisms which constitutes the most important part of the multocular microscopes of M. Nachet.

Foucault's Pendulum for showing the Earth's Motion.—M. Foucault's celebrated experiment for showing the motion of the earth was exhibited in a new and highly interesting form. Above the centre of a large circle divided into 360 parts, there was suspended from the ceiling by a wire 35 feet long, a ball of soft iron, 5 inches in diameter, terminating below in a point. When the pendulum oscillated, this point passed along a diameter of the circle, at a short distance from its surface, so as to show any change in the plane of oscillation of the pendulum, or in the divided circle. The plane of oscillation of the pendulum being invariable, a fact which we need not here explain, the divided circle, with the building in which it stands, and the observers who are watching it, are all turned round by the earth's daily motion, so that if the index below the iron ball begin its motion along the radius corresponding with zero, it will in thirty-two hours appear to have made the round of the complete circle.

In so far this is the experiment exhibited some years ago by M. Foucault in the cupola of the Pantheon in Paris with a pendulum about 200 feet long, and repeated in every part of Europe; but in all those experiments the oscillations of the pendulum continually diminished, and ceased before the index had completed its round. In the present experiment, however, M. Foucault has employed a singularly ingenious contrivance for restoring to the pendulum the force which it loses at every oscillation. This is done by the agency of an electro-magnet of a cylindrical form, resting vertically upon a very flexible spring, and reaching nearly to the centre of the divided circle. When the ball of soft iron is at the extremity of its oscillation, the galvanic current is established, and the magnet, now active, attracts the ball in its descent, and restores to it the force which it had lost from the resistance of the air in its previous ascent. But the moment the index reaches the centre with the ball, the electro-magnet is raised with the spring which carries it, so as to interrupt the current, and deprive the electro-magnet of its magnetism, and therefore it ceases to act upon the ball during its ascent. In giving an account of this beautiful invention, the Abbé Moigno remarks that the motions of the pendulum are so regular that it will soon be made to indicate the time of the day, and thus become the most extraordinary of clocks.

Ouviere's Uranoscope—This astronomical instrument was exhibited in the garden of the Palace of Industry, and was intended to be, as it were, "a popular observatory," in which every passer by could study the phenomena produced by the daily motion of the earth. In the instrument itself there is no novelty. It is nothing more than a gigantic armillary sphere in which is represented the earth's axis, the plane of the meridian, the celestial equator, the plane of the ecliptic, and the zenith and nadir of the place. M. Ouviere, of Marseilles, who constructed it, proposes that one should be established in every town in some public and frequented locality. When erected on a lofty pedestal, 20 or 25 feet above the ground, the axis of the instrument is placed parallel to the axis of the earth, and its meridian in the meridian of the place. By looking along the axis the observer below will see the place of the pole-star, round which the starry vault seems daily to revolve. By placing himself in the plane of the equator he will trace in the sky the true celestial equator which divides the vault of the heavens into two hemispheres. He will observe the sun at the vernal equinoxes follow that line in his daily movement, approaching gradually to the northern point of the ecliptic as he advances to the summer solstice, returning again to the plane of the equator at the autumnal equinox, and then descending to the lower end of the ecliptic at the winter solstice.

The daily motion of the stars will also be understood from the Uranoscope. The observer will trace them from their rising till they pass the meridian of the instrument, and with the aid of his watch he will observe them descending in the same time to the horizon. Day after day they will repeat the same perennial movement, quitting the horizon at the same point, and reaching it where they reached it the day before.

The planets, on the contrary, will, like the sun of their system, pass from their highest northern to their lowest southern declination, varying in their meridian altitude and in their semidiurnal arcs, with a rapidity of change depending on the lengths of their years.

In the great departments of reflecting telescopes and achromatic microscopes, England occupied a place above all other nations. In the department of achromatic telescopes, and in that of philosophical instruments of the highest class, as well as in those for educational purposes, she was far behind France and Germany; and unless the British Government look with more favour upon inventions and inventors, upon science and scientific men, she must be content with occupying the place of a second-rate power in all those phases of civilisation which depend upon inventive genius, and the still higher forms of intellectual power.

IMPROVED LADDER FOR DREDGING MACHINES.*

By Michael Scott.

In the course of operations undertaken with the view of improving the harbour of Blyth, in the county of Northumberland, it became necessary to remove from the bed of the river some very obdurate material, consisting of boulder gravel, rotten rock, and very tenacious clay with boulder stones in it. A breakwater is in progress, but it is not sufficiently advanced to afford protection from the swell of the German Ocean; and during spring tides there is a very rapid stream in the channel of the river.

As it was considered that the above material could be removed only by dredging, a single machine was procured, the ladder of which was formed of timber strongly put together and trussed with tension rods underneath. Very soon after this machine was carefully repaired, new timbers put in, and plates of iron added on each side, the whole being strongly bolted together; but in vain, for it broke a second time. As it was now evident that a new ladder must be provided, the first step to be taken was to set to work, the ladder got strained, and ultimately gave way at the distance of about one-third the length from the lower end. It make enquiry as to the construction and strength of ladders employed elsewhere; and attention was naturally first directed to the Clyde, where dredging operations of such extraordinary extent have been carried on; but the writer was informed that both there and elsewhere the ladders were formed of timber, some being plated with iron. Feeling convinced however that this mode of construction would not bear the strains to which the Blyth machine was exposed, he devised the arrangement forming the subject of this paper, which has proved quite successful.

In investigating the causes of the breakage of the original ladder, it appeared to arise chiefly from lateral weakness; for when the machine was at work, and the lower end of the ladder in the bottom of the trench formed by the working of the machine was pressing the buckets against the face of the bank, if whilst in this position a beam swell came against the vessel so as to move her sideways, then the ladder broke at that part where it came in contact with the bottom of the side of the well in the dredger. It therefore became a primary condition that the new ladder should possess great lateral strength. The other leading conditions were obviously—that the ladder should have vertical strength sufficient to carry the chain of buckets with their load;—that it should be sufficiently rigid;—that it should be capable of resisting compression in the direction of its length;—that there should be a free passage for stones, &c., falling out of the buckets when over full;—that the ladder should be durable under the influence of sea water;—and lastly, that it should not be over heavy so as injuriously to affect the displacement of the vessel.

In attempting to fulfil these conditions, several arrangements of material suggested themselves. If the body of the ladder were formed wholly of timber, it appeared difficult to obtain the necessary strength combined with a free exit for the stones, &c. Again, if the ladder were made in the form of a wrought-iron girder and of thick plate, it would be too heavy; if of thin plate, there would be danger of the upper flange buckling; and if with a cellular top, then the cells would be too small to admit of painting the interior, and the ladder would suffer from oxidation.

For these reasons the writer decided upon adopting the construction shown in figs. 1, 2, and 3. Fig. 1 is a longitudinal section of dredger, showing the general position of the ladder in the dredger when at work; fig. 2 is a side elevation; and fig. 3 is a transverse section of the ladder to a larger scale.

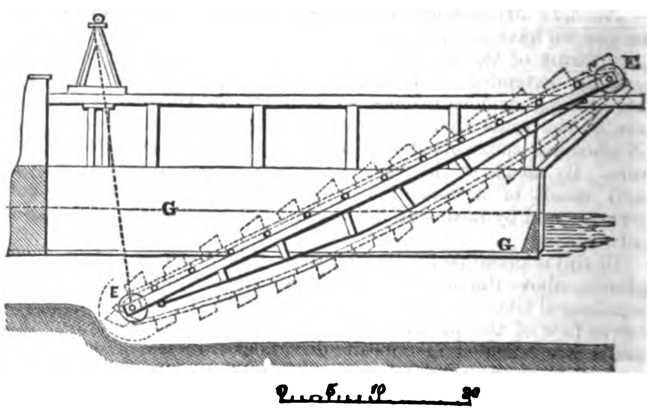


Fig. 1.

The ladder consists first of a tubular wrought-iron girder A, composed throughout of plates ½-inch thick riveted together with suitable angle irons and covering pieces. The spaces formed by the projection of the upper and lower flanges are occupied by two beams of timber B secured by bolts both to the webs and flanges. At each end of the ladder are strong wrought-iron straps, riveted to the plates and bolted through both plates and timber; these straps or jaws carry the plummer blocks in which the tumblers work, and it should be noticed that the inner set

* Paper read at the Institution of Mechanical Engineers.

of these blocks bear against the ends of the timber beams, with which they are kept in contact by cotters acting upon the outer blocks. After the beams were fitted into their places, the plates F were riveted on outside them, the angle irons above and below being bent so as to prevent them from catching the sides of the well G of the dredger, when the ladder is lowered or raised. Underneath the body of the ladder are wrought-iron struts H and tie rods I, forming a truss of the ordinary kind. There are openings in the top and bottom plates of the girder A to permit stones, &c., falling out of the buckets to escape, the upper opening being perpendicular over the lower when the ladder is at an average working inclination.

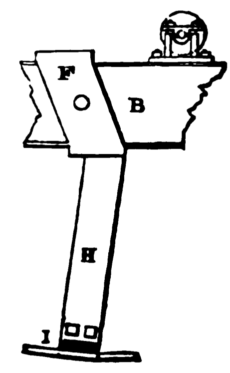


Fig. 2.

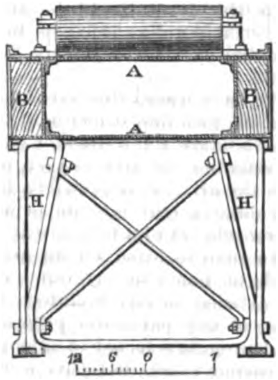


Fig. 3.

It is submitted that several advantages are obtained by adopting this form of ladder:—

Firstly, vertical strength: assuming the body of the girder to constitute a sufficient upper flange to resist compression, the sectional area of the iron plates alone being more than three times that of the tie rods, and therefore considering the strength of the ladder to be limited by the tensile strength of the tie rods, the vertical strength of the ladder calculated from the sectional area of the tie rods would be nearly five times the greatest weight ever put upon it, which will not exceed 14½ tons distributed load, including the weight of the ladder. For, the sectional area of the tie rods which form the lower flange is 7 square inches; the distance between the supports, or the length of the girder, is 56 feet; the depth of the girder from centre to centre of flanges is 3½ feet. Hence, taking the tensile breaking weight of wrought-iron bars at 20 tons per square inch, the breaking weight would be 35 tons in the middle of the girder, or 70 tons distributed over the entire length of the ladder.

Secondly, lateral strength: assuming the ladder to be laid on its side, and considering the strength to be limited by the tensile strength of the bottom flange, the lateral strength of the ladder calculated from the area of the bottom flange would amount to a breaking weight in the centre of 36 tons. Thus, the sectional area of the iron plates constituting the bottom flange is 8½ square inches; the length as before 56 feet; the depth 3 feet. Then, taking the ultimate tensile strength of wrought-iron as before at 20 tons per square inch, the breaking weight in the middle of the girder would be 36 tons.

Thirdly, the form here adopted affords considerable rigidity and power to resist compression in the direction of its length.

Fourthly, the new ladder is much superior to the old one in the facility which it affords for stones, &c., falling out of the buckets to escape.

Fifthly, it is expected to be durable; for there is no part of the surface exposed to the action of the water which is not readily accessible for painting.

Lastly, this ladder was easily and quickly made, and at a moderate cost.

Mr. Scott observed that the special reason for making the ladder of the dredging machine so strong was that, when imbedded in stones at the lower end, the shifting or heaving of the dredger caused a severe lateral strain acting at a long leverage. The strength of the ladder had been severely tested by an accidental fall, that had occurred when it was resting on the dredger at one end and elevated 20 feet above the ground at the other end; the suspending chain broke, and the ladder fell on one end, but did not sustain any injury. The ladder had been in constant work night and day for two months, and had stood the work quite satisfactorily; its durability was now a question chiefly of oxidation. He did not think it would be possible to combine timber so as to give sufficient strength for the purpose, as the resistance to be overcome was so great; the rocky material lifted by the dredger was so hard as to tear the steel off the edges of many of the buckets in two months. The ladder was constructed with a small expenditure of material, and was not more expensive than one of timber; and the whole was made in about thirty days.

THE LIFE AND WORKS OF CHRISTOPHER WREN.

By T. Roger Smith.*

About one o'clock in the morning of Sunday, the second of September, 1666, the inhabitants of Pudding-lane, New Fish-street, in the city of London, were roused by a cry of fire, and soon found it no idle alarm. A furious fire had broken out in the house of Farryer, the king's baker, and was raging among the timber houses in the narrow lanes, which then, as now in some continental cities, were the only thoroughfares. All night long, alarm and confusion spread through that neighbourhood, and the first news that ran all over the city the next morning was, that a dreadful conflagration had been blazing all night, and was still raging with more fury than ever.

All that day and night, and all through Monday, a fierce east wind fanned the flames, and spread devastation throughout the city. On the Tuesday, Mr. Evelyn, whose diary furnishes the best cotemporary account of this, the Great Fire of London, writes: "The burning still rages......The stones of St. Paul's flew like granadoes, the melting lead running down the streets in a stream, and the very pavement glowing with fiery redness so as no horse nor man was able to tread on them, and the demolition had stopped all the passages, so that no help could be applied."

It was not until Wednesday, the 5th, that the approach of the fire to Whitehall and the Palace seems to have roused the authorities to take active measures. Evelyn says: "Now they began to bestir themselves, and not till now, who had hitherto stood as men intoxicated, with their hands across." Vast gaps were made by blowing up houses with gunpowder in every direction towards which the flames were advancing; and though the fire continued that day and that night, yet it was sensibly abating.

The Thursday was a day of labour and activity, and now the disastrous fire might be said to have spent its strength. On the ensuing day (7th), Evelyn says: "I went this morning, on foot from Whitehall as far as London Bridge, thro' the late Fleete-street, Ludgate-hill, by St. Paul's, Cheapside, Exchange, Bishopsgate, Aldersgate, and out to Moorfields; with extraordinary difficulty climbing over heaps of yet smoking rubbish, and frequently mistaking where I was.........I was infinitely concerned to find that goodly church, St. Paul's, now a sad ruin, and that beautiful portico (for structure comparable to anything in Europe, as not long before repaired by the late king) now rent in pieces; flakes of vast stone split asunder, and nothing remaining entire but the inscription on the architrave, showing by whom it was built, which had not one letter of it defaced. It was astonishing to see what immense stones the heat had in a manner calcined, so that all the ornaments, columns, friezes, capitals and projections, of massive Portland stone, flew off, even to the very roof, where a sheet of lead covering a great span (no less than six acres by measure) was totally melted. The ruins of the vaulted roof falling, broke into St. Faith's, which being filled with the magazines and books belonging to the Stationers, and carried thither for safety, they were all consumed, burning for a week following. Thus lay in ashes that most venerable church, one of the most ancient pieces of early piety in the Christian world, besides near one hundred more. The lead, ironwork, bells, plate, &c., melted; the exquisitely wrought Mercers' Chapel, the sumptuous Exchange, the august fabric of Christchurch, all the rest of the Companies' halls, splendid buildings, arches, entries,—all in dust!"

Maitland gives a summary of the devastations, from which it appears that the buildings on four hundred and thirty-six acres of ground were laid waste and consumed, comprising 13,200 houses, the cathedral church of St. Paul's, 86 parish churches, 6 chapels, 52 companies' halls, 4 prisons, and various other public

* Abstract of a Paper read before the Architectural Association.

buildings; the aggregate loss being computed at 10,730,500*l.* sterling. The number of lives lost, strange to say, was happily only six.

I need not to mention the name of the august man who, ere the embers were cool, had devised a noble plan for the rebuilding of the city, to which, had it been adopted, we should have been indebted for one of the best arranged capitals in Europe;—who, foiled in this, laboured with heart and soul to carry out in the best way the rebuilding of our metropolis on its old plan;—whose skill and genius enriched the rising city with a series of churches and other edifices of a beauty eminently original, and showing a diversity that none but a genius of the first order could have accomplished; while, as a worthy crowning-piece to so much that was distinguished, he planted in their midst a cathedral church which owns no equal (of its style) in Europe, and is surpassed only, in the single elements of size and richness of material, by the church built to serve as the metropolitan cathedral of the world by the greatest artist who ever saw the light.

CHRISTOPHER WREN was born at East Knoyle, in Wiltshire, on the 20th October, 1632. His father, Dr. Christopher Wren, was a learned divine, descended from an ancient English family of Danish origin, and was a fellow of St. John's College, Oxford, chaplain in ordinary to Charles I., Dean of Windsor, and registrar of the Order of the Garter. He was an associate of most of the learned men of the day, and himself a person of considerable attainments. He had given attention to the art of architecture, and it appears from an estimate preserved among the state papers that he had been employed by the court to design a building to be erected for the queen of Charles I.

Wren was from his earliest years a mathematician and natural philosopher, and for the first thirty years of his life was mainly occupied on pursuits relating to these two branches of knowledge, and chiefly known to fame by his scientific discoveries and inventions. There is but little account extant of anything like a professional education, in our sense of the word; and I cannot help believing that it was to his familiarity with practical geometry, that Wren was chiefly indebted for a mastery over the art of planning which few, if any, have ever equalled,—for the stability and sound construction of his edifices, and perhaps too for that nice sense of proportion and (if I may adopt the word) rhythm which eminently distinguishes his buildings.

Wren, in his early years, was sickly and weak, and was brought up at home by his father; his own ingenuity and his good use of his father's instructions are both displayed by his inventing, at the age of thirteen, an astronomical instrument, which he dedicated to his father in a latin letter, written with ease and correctness. The "Parentalia" contains various dedications in latin verse, which prove his classical attainments to have been very considerable.

When fourteen, Wren was entered at Wadham College, Oxford, and here he resided eleven years, having been elected a fellow of his college in 1653, when he was twenty-one years of age. He also studied anatomy with great success, and at the early age of fifteen was employed by Sir Charles Scarborough as anatomical demonstrator; and several ingenious experiments and investigations were made by him in this science and communicated, as were most of his discoveries, to the Philosophical Society, a club of literati which deserves a passing mention, on account of its subsequent celebrity.

In 1645, a scientific club was formed by Dr. Willis, an eminent mathematician, which, commencing in London, was afterwards transferred to Oxford. Here Wren joined it, and became an active member. Upon the removal of Wren and other scientific men to London, in 1657—that is to say, when political affairs were beginning to be tranquil under the Protectorate—the meetings of the Philosophical Society were transferred to the rooms of Gresham College. As the Society continued to grow in importance, it was, two years after the Restoration in 1660, incorporated by the king as the Royal Society, and from that period it has continued to be the highest scientific body in the kingdom. Wren took an active share in the incorporation of it, and his suggestions for the charter and constitution of the Society are in existence,—one of the many interesting and very able papers from his pen, contained in the "Parentalia." The same work contains a catalogue of fifty-three scientific inventions communicated to that Society; and among his achievements we may mention that there is reason to believe he was the real inventor of mezzotint engraving,—that he, unaware of Torricelli's experiments, re-invented the barometer,—and that he solved a problem proposed by Pascal to the mathematicians of all Europe for solution.

In 1657, Wren, then twenty-five years of age, was chosen Gresham professor of astronomy, and removed to London to lecture, and by his eloquence and learning gained at once a great celebrity as a professor; and soon after the Restoration he was chosen Savilian professor at Oxford, one of the highest honours which could then be conferred on a scientific man. He took the honourable degree of Doctor of Common Law in 1661, and held the Savilian professorship till 1673, when his many avocations compelled him to resign it. In 1680, he was elected President of the Royal Society, previous to which date he had been, in 1673, knighted by Charles I. He also sat as member in two parliaments.

We have traced thus far the course of the man of science, and we shall soon find it merge in that of the architect; but it is not easy to follow the transition or to show when Wren first turned his attention to architecture, or how he gained his acquaintance with the art. It is probable, however, that his father had given him some insight into its principles, and that his own instincts afterwards led him to follow it out; for it is difficult to suppose that a man so fitted for an architect could have been quite as much at home in any other calling. Certain it is, that he was not articled to any architect, nor is he known to have been the pupil of any particular professional man; nor are any architectural projects referred to among the occupations and exercises of his earlier years. It rather would seem that architecture was the deliberate selection of his matured powers, as the noblest pursuit to which so great a man could be devoted.

It is said that his first commission was to design a new chapel for Pembroke Hall, Cambridge, the foundation of which was laid in 1663; but as early as 1661, at the age of twenty-nine, he was sent for from Oxford by the king, to assist Sir John Denham as surveyor-general of his Majesty's works. By 1665, we find him to have been engaged on various architectural works of magnitude for both the Universities; and in the summer of that year he visited Paris, when at that time the immense works at the Louvre and Versailles were actively going on. He afterwards went through France, and returned to this country in the spring of 1666. Some of his letters from France are extant, and are written with a degree of spirit and enthusiasm which one does not often see in the cumbrous effusions of that day.

After Wren's return to England, he and certain other commissioners were ordered to survey the cathedral of St. Paul's, then in a dilapidated condition, and to report upon what was to be done to restore it. Their report was sent in, and the scaffolds were already fixed, when the Great Fire, which we have briefly described, swept away the object of their trouble, and with it a hundred other noble edifices,—leaving for Wren, just at the moment when his powers were at their brightest, and when he was becoming well known to fame, the fairest field that ever architect enjoyed; and nobly was it occupied.

The rebuilding the city was of course the first care: and ere the smouldering embers were cold, Wren had surveyed the ruins, and produced a plan for the rebuilding which would have secured to us a metropolis of surpassing beauty and great convenience. John Evelyn also drew a plan and presented it to the king, and thus alludes to it: "It was the second that was seen within two days of the conflagration, but Dr. Wren had got the start of me."

Wren's proposal is described in the "Parentalia," but a digest of this description may be interesting. He proposed to rebuild with fireproof materials; to widen the streets, and carry them all as straight as might be; to make the parish churches conspicuous and insular; to form the most public places into large piazzas, the centres of eight ways; to unite the halls of the twelve chief companies into one regular square annexed to Guildhall; and to embank the Thames, forming a commodious, uninterrupted quay from Blackfriars to the Tower. The three principal streets were to be 90 feet wide, the main streets 60 feet, and the alleys 30 feet. St. Paul's would have been at the meeting point of two of these main streets, and the Exchange in an open piazza of great size at the heart of the metropolis, and in a spot from whence all the streets were made to radiate.

This scheme was shown to be practicable, but had to be given up owing to the obstinacy with which the citizens refused to exchange the positions occupied by their houses and businesses for any other. So the rebuilding began, and went on without any material alteration in the plan of the city.

Two years were consumed about the ruins of St. Paul's, fitting the portion least consumed for temporary use, and doing slight and partial repairs to the fabric, which, in 1668, it was found could not stand any longer. Preparations then began to be made for rebuilding the whole structure; not, however, till Wren had written to remonstrate on the folly and danger of this delay, and, in reply, been invited by the Archbishop of Canterbury and the Bishops of London and Oxford, to confer with them. "They unanimously resolved," says the letter, "that it is fit immediately to attempt something, and that without you they can do nothing." The result of this interview was a most able report by Wren, followed by the appointment on the 25th July, 1668, of a Royal Commission to superintend the demolition of the ruins. It was not, however, till 1675, that the ruins were all removed, the designs settled, and the rebuilding commenced.

A variety of sketches and designs were made, till Wren, thinking he had arrived at what would satisfy the world and himself, embodied his ideas in the large model now existing, half decayed, in the cathedral, upon which his son says: "In private conversation he always seemed to set a higher value on this design than on any he had made before or since; and (had he not been overruled by those whom it was his duty to obey) what he would have put in execution with more cheerfulness and satisfaction to himself than the latter." The clergy, however, objected to it, as not enough cathedral-fashion; and at last it had—unfortunately, I think—to give way to the present building. But though not erected, it is extant in a form in which the architect can well judge of its excellences; and, as Wren's masterpiece in his own estimation, well deserves our consideration.

The leading idea in this design was to make the cathedral a large church for Protestant worship, where a vast congregation might see and hear. This was to have been the destination of the vast circular choir under the dome; a series of exquisite vaulted spaces surrounded it, and the short nave (without aisles) and the transepts formed so many vestibules or ante-chapels. There was to have been one lofty order supporting the cupola, and a lower one from which the nave arches would spring.

Nothing in Europe exists comparable to this design for the magic and beauty of the cross vistas which would be obtained at every point. From the entrances, from the spaces between the piers, from the centre of the dome, the eye would have been led on every side along wonderful avenues of architectural forms, each terminating in a niche or an apsidal chapel. The model, or even an inspection of the plan, will satisfy anyone how much has been lost of internal beauty by the rejection of this design. The vast ring of light in the drum, the beautiful way in which the dome is placed on the piers, which in the present building is somewhat clumsy, are some among the many excellences to be found here. The exterior would also have been very fine, though the great point of contrast between the model and the executed design is, that the former would have excelled in internal as the latter does in external effect. The building would have appeared less lofty, but I think simpler, and perhaps grander, than the present. There would have been a wonderful play of light and shade on its varied outline, and the beauty of the perspective effect which its curved sides would have had is only, I think, to be imagined by those who have visited the semicircular cortile behind the Villa Papa Giulio at Rome.

Upon the definite rejection of this design, Wren, who had up to this time endeavoured to arrive at the opinions of every one, resolved to exhibit no more of his sketches or models for general criticism. The design since executed was then worked out, and on 14th May, 1675, a royal warrant was issued for commencing the work, the king allowing Wren to make such variations in his design as he thought fit, and leaving the whole to his management.

There is a most interesting account in the "Parentalia," of the taking down of the ruins of the old cathedral, a work of much difficulty and risk. After proceeding by ordinary methods till he reached the walls of the tower, he found these to be so strong and thick, as to render blasting advisable. The first blast, managed under his own superintendence, was eminently successful; but the second, which an inferior officer had in hand, was managed with less judgment, and caused great alarm to the neighbourhood. So the blasting was prohibited for the future, and Wren had to find other methods to demolish the immense mass of masonry, and determined to try that ancient engine of war, the battering-ram. He took a strong mast 40 feet in length, armed at one end with a great spike of iron, and slung in chains to a three-legs. Thirty men swayed this to and fro for a whole day with no apparent effect, and it was not till the evening of the second day that the wall attacked began to give way. In a few hours after, it fell. Wren afterwards made good use of this machine in beating down all the lofty ruins.

When the ruins were cleared away, Wren investigated what he had to build on, and found that the old cathedral had rested on a layer of pot-earth, in places only 4 feet thick, below which was nothing but loose, dry shifting sand for a great depth. Thin as was the layer of hard soil, he with the most acute intelligence decided that as the old church had stood there before, the same ground which had borne so weighty a building might reasonably be trusted again, and proceeded prosperously till within 6 or 7 ft. of the north-east angle, where he came upon a pit from which all the pot-earth had been taken by the potters of old time, to form earthen vessels, of which abundant fragments were found. In this dilemma his artificers proposed to him to use piles, but Wren refused, saying piles would rot some day, and he proposed to build for eternity; so he sunk a pit about 18 feet square and over 40 feet deep, till he came to the solid clay; building up a pier of masonry 10 feet square, to within 15 feet of the present ground, he turned a short arch from it to the former foundation, where it had been stopped at the brink of the pit. Upon this the north-east angle of the choir rests, and no doubt will stand as solid as the remainder of the building.

The foundation stone was laid on the 1st of June 1675, and the top stone laid by Wren's son and the son of Mr. Strong, the master-mason, thirty-seven years after, the whole having been accomplished by one master builder, under one architect and one bishop of London. The total expense of the cathedral was 736,752*l.*, and Wren's salary for the rebuilding was only 200*l.* a-year.

It would be superfluous to enter into a detailed description of the cathedral as it stands, and I will merely call your attention to one or two less obvious peculiarities. The grand feature is the arrangement of the piers that support the central dome. In most similar structures this has been done by four large masses of masonry, their inner faces ranging with the inner line of the nave piers, while their greater bulk causes them to reach back far enough to intercept any continuous view along the aisles. With consummate judgment, however, Wren has distributed the weight over eight oblong piers, made but little wider than the nave piers, not merely preserving the main vistas from east to west and north to south, but also opening out a view from end to end along the aisles.

The elevation presents another remarkable arrangement, to which undoubtedly we owe much of the beauty of the church. A line drawn from the top of the cross to the ground-line at the end of either of the transepts will touch the outside of the dome, the balustrade round the drum, the apex, and almost every prominent moulding in the campaniles. The section will show how the supports of the dome get wider toward the ground, how the colonnade acts like the pinnacle in a flying buttress in giving a vertical direction to the thrust, and how the columns are made to lean inwards, so that the weight of their entablature resting against the foot of the dome at the point where the triple domes unite, may both tend to equalise the weight and act something like an iron ring to tie the whole fabric together.

It has been customary to compare and contrast St. Paul's with St. Peter's at Rome. This latter church was designed much more square on plan than St. Paul's, and in this respect more nearly resembles the model than the present building. St. Peter's is on a larger scale altogether, and this, with its rich marble and mosaic, renders the interior far more impressive than that of St. Paul's; but the effect of the front has been quite spoiled by the lengthening it, so as to hide the cupola from a spectator standing in front. To view the building as Michel Angelo designed it should be seen, it is necessary to go to the rear. That Wren must have had St. Peter's in his mind, as he had every other noble work of its class, while designing our cathedral, is undoubted; but a glance at the very different plan and section of the two buildings, will suffice to show how little there is in the later one that can be said to have been borrowed from the earlier.

Besides the great work of St. Paul's, Wren was engaged on a vast number of other churches and public buildings. The number of parish churches erected under his superintendence was considerably over fifty, and for this labour he was not overpaid. He received for the rebuilding the city churches a salary of 100*l.* a-year, to which the parishioners of St. Stephen, Walbrook, added of their own munificence a donation of twenty guineas, to mark their satisfaction at the completion of their church. These churches have all a character of their own,—simple, grand, commodious, they are all conspicuous externally for the grace and beauty of the spires, which Wren justly deemed the distinctive feature of a church. Internally, they are eminently well adapted for Protestant worship, and bear marks of the strong good sense and sound judgment brought to bear upon them, both in the comprehending the requirements of such buildings and in adapting them to those requirements.

His vastest and most successful secular building was Greenwich Hospital, a noble pile, which would have been rivalled by the palace commenced, but never completed, at Winchester. At Hampton Court, Wren was not left to his own judgment, and is less happy. But still his work in these three edifices, not to mention Chelsea Hospital, shows how complete a master he was of grandeur, dignity, and palatial splendour in buildings where such a character had to be expressed.

Another class of buildings, more original perhaps than any we have yet mentioned, are his circular and octagonal theatres. That of the College of Physicians is a perfect master-piece of optical and acoustic adaptation to its purpose. There is also the theatre at Oxford.

Among miscellaneous works may be classed the Royal Observatory, at Greenwich, Temple Bar, the Monument, and the scientific repairs done to Salisbury spire; and even now we have not nearly exhausted the list of his greater works. Especially is this the case with his churches, among which are several—as St. Mary-le-Bow, St. Stephen's, Walbrook, and St. James's, Piccadilly—each claiming a long and careful study, and each unrivalled in some one particular excellence.

True it is, as pointed out by the most illustrious living critic in our art, that when Wren set to work to devise a building, he followed the same plan that seems to have regulated the design of every portion of the material world of nature. When the hills were to be peopled, antelopes and goats were created, swift of action; sure of foot, timorous, and hardy; their frames were made light, their joints supple, their motions active, their stomachs capable of bearing abstinence. The plains were to be filled, and beeves and fat cattle are placed there, slow of motion, gregarious in habit, built, not for activity, but for sloth, and made tame and easily approachable by man. To each class, too, is given an external appearance bespeaking its habits and character, and perfectly harmonising with and growing out of its structure. So should it always be with architecture,—so was it always in the works of Wren. He seemed to comprehend perfectly all that was required to be accomplished by his building; he formed it so as perfectly to fill all its purposes in the best manner; and he made its appearance so to harmonise with its intention and uses, that, from his slightest work to his noble cathedral, there is not one that does not bear witness, as much in its appearance as in its disposition, to the skill which had fitted it for the part it has to fill.

Wren's later days were disquieted by factious opposition and the intrigues of court favourites. In the eighty-sixth year of his life he was deprived of his patent as surveyor-general, in favour of Sir John Benson, an incompetent sycophant of George the First. He retired from public life, not to fret and repine, but to spend the evening of his days after such a fashion as might have been expected of so noble-minded a man. He retired to Hampton Court, and lived there the last five years of his life, in dignified retirement, dividing his time between the reading and study of the sacred scriptures and the revision of his mathematical and philosophical works. His limbs began to fail him, though his faculties did not; and it was his greatest delight to be carried once a-year to gaze on his great work, St. Paul's.

It is of him in these years of his life that his son writes in the 'Parentalia': "The vigour of his mind continued with a vivacity rarely found in persons of his age, till within a short period of his death: and not till then could he quit the great aim of his whole life, to be (to use his own words) a benefactor to mankind; his great humanity appearing to the last in benevolence and complacency, free from all moroseness in behaviour or aspect. He was happily endued with such an evenness of temper, steady tranquility, and Christian fortitude, that no injurious incidents or inquietudes of human life could ever ruffle or discompose."

With these utterances of filial piety, and what we have already had occasion to say, we leave the exalted personal and scientific character of Sir Christopher Wren. It remains to say a few words on him as a professor of our own noble art. And here we cannot but be struck at the care, caution, skill, and design which Wren possessed. He was a man pre-eminently a model for his profession. To an aptitude for business, evinced by his successful discharge of most onerous and multiplied duties—a general capacity and wonderful versatility of talent—he added a genius for design which has never since been rivalled, and a caution and skill in construction which have rendered even his most daring buildings as stable as monumental edifices. Nor was this all: to so many brilliant qualities, he added graces of spirit which appear to have disarmed envy, and procured for him universal esteem and regard. He possessed, in a pre-eminent degree, the modesty of true genius; and every grace was heightened, every talent sanctified, by that Christian piety which pervaded his whole life and character, and without which even in this life he could hardly have attained the success which crowned his career.

The greatest marvel in this extraordinary man was that he was at once a mathematician and an artist. Seldom is the character of the man of science greatly expanded on the side which has to do with the fine arts. If he even appreciate and admire them, it rarely happens that he can practice them, and still more seldom does the artist show one particle of the man of science in his character or habits. Wren was both: we have seen his celebrity in the scientific world of his day; we ourselves can bear testimony to his skill and power as an artist; and I do not recollect a single great name—not excepting the mighty Leonardo da Vinci—of which the same is true to anything like an equal extent.

As an architect, we believe the highest of Wren's many excellences was his fine feeling for form and proportion. You may, if you please, call it a sense of the beauty of outline, for it is in the outline of his buildings that this faculty had most opportunity of developing itself, although it is as clearly evinced in the harmonious balance of his masses and in the arrangement of his plans.

Wren was such a master of *plan* as architecture has seldom seen, and an ill-proportioned, badly-disposed edifice was almost an impossibility with him. His master-piece in this respect is the original design for St. Paul's, and next to that will perhaps come St. Stephen's, Walbrook. In the interiors of both these churches he has with the simplest means, and an arrangement of plan apparently the most natural and artless possible, produced a complexity of perspective effects, a richness, a beauty, a harmony, that ten times the amount of materials and labour would fail to give, less skilfully disposed.

Another great excellence in Wren is the economy of his constructions, and their stability. There is the more credit due to him for the latter excellence, as it is known not to have been always in his power to procure such materials as he would have wished to use, for the excessive demand for them in rebuilding London rendered it impossible always to obtain good stone and brick. In corroboration of this, I have been informed by one who had lately an opportunity of examining the interior masonry of part of the walls of St. James's, Piccadilly, that they are built of the most slight materials. Yet Wren's buildings have none of them fallen—few of them have cracked or settled, and there is, I suppose, no edifice of its size in Europe showing so few signs of failure as St. Paul's. But this is not owing to excess of material; on the contrary, there is in Gwilt an interesting table showing how small the points of support are here compared with those of St. Peter's and the Cathedral at Florence; they exceed those of the Pantheon at Paris, and the Pantheon has proved itself too weak. The fact is, that the material which *is* used is none of it wasted; and though amply sufficient strength is employed wherever strength is needed, the heavy weights and large masses are confined to these points only. A few minutes' study of the section of St. Paul's Cathedral will illustrate this better than could many pages of description.

The foundations of St. Paul's, already alluded to, and of St. Bartholomew's church, described by Prof. Cockerell in an interesting paper communicated to the Royal Institute of British Architects, are instances of this economy. In each case, Wren found that the old building had been sufficiently carried by the original foundations, and judged that he could safely avoid the expense of excavating and removing and re-forming what had already done the work so well, and therefore upon these old foundations he built,—and the successful results prove the soundness of his judgment.

Wren has been attacked upon two points. It is charged against him that his mouldings and detail were not refined, and he was not a Gothic architect, nor an appreciator of the style.

The mouldings, to take up the first topic, are not in *themselves*, we at once confess, equal in refinement to those of the Parthenon and the Theseum, nor yet to those of many buildings erected in Great Britain since the introduction of Greek refinement; nor are they so graceful as those of Bramante and his school. But, on the other hand, it can never be said that they are placed where they ought not to be found, or that they are the wrong mouldings for their position; nor even, I think, that from the point of view from whence the building is designed to be seen, any others would be more effective, or even as much so. The mouldings, then, are not inappropriate, and the sum of what can be said after all is, that Wren, like many great painters, put in his effects with a heavy hand, and his buildings, compared with those of some other artists, are as Turner's landscapes compared with Claude's —each moulding in the building, each touch in the picture, less able to bear close inspection: the general effect, however, not one whit the less graceful, and the ideas and genius displayed far more masterly. Nor is it easy to see how Wren *could* have attained to all the refinement either of architects who have worked in white marble all their days, and their fathers before them, as was the case with the Italians, or of those who have had the advantage of Greek models to study from, as is the case with ourselves.

The enrichments, as far as the smaller carving goes, are, to say the least, as good as the mouldings; and that Wren would not encourage and make use of good carving when he could get it, is abundantly disproved by the simple fact, that he brought out and employed, and no doubt helped to train, the greatest carver England can boast of—Grinling Gibbons.

An answer of much the same class can at once be given to the objection that Wren was not a Gothic architect, nor an admirer of Gothic. I ask you to run over, for one moment, the history of his times, the state of public feeling, the tide of taste, and I ask you—I ask the most devoted admirers of mediæval art amongst you—How *could* such a man be a follower of Gothic? What possibility is there of it? We have occasionally seen a great artist go on far *in advance* of his time; but there is no instance of a man of highly successful genius being thoroughly *opposed* to the prevailing taste of his age and country. Human energy, to be thoroughly successful in the highest degree in the arts, must have the support and encouragement, the concurrence and the approbation of cotemporaries. Had Columbus had to paint a picture, instead of to make a voyage, the opposition he met with would have destroyed the happy cheerfulness needful for the free play of his fancy, and he would have failed. Had Raffaelle lived in an earlier age, he would not have far excelled Cimabue; and had the architect of our own House of Lords been alive, and been called to execute them, in the days of the Adams or of Sir William Chambers, there is not one of you who would suppose that they would have been—even had he been left uncontrolled to the exercise of his own taste—anything like what they now are.

So was it with Wren; he lived in an age when the whole European world was filled with admiration for the Renaissance style. The impulse which had been given by the discovery of the remains of ancient art, and the revival of classic learning in Italy, had turned the taste of all artists and architects in one direction. The strong protestant feeling in our own country coincided with it, for we had had next to no architecture connected with the Roman-catholic religion in this country, save what was Gothic; and hence there must have been a national partiality for Renaissance architecture, as the architecture of protestanism; and a repugnance to recognise any excellence in Gothic art; an art which would be felt to be inseparably allied with the old religion, now so entirely forsaken and so heartily abhorred. Men of literary taste, too, had their reasons for calling the mediæval ages times of darkness; and Wren's intimate associates would have stigmatised as illiterate barbarism, the same things which the populace would have termed popish wickedness; so that it is really hard to conjecture what influence could have come to the mind of Wren, to induce him to think favourably of mediæval art. You ask me, is not the beauty of the things themselves enough? and I answer, unhesitatingly, not enough to produce an entire revolution in feelings, principles, taste: and I would point to the opinions held by many men of the present day, whose skill as mediæval architects cannot be questioned, as a proof that it is possible for a style to be followed, even by a large-minded man, so exclusively, as to prevent his recognising the true beauty that exists in other styles.

But Wren, though he never studied Gothic detail, and though he said a few hard things about the "Gothick fashion," introduced infinitely more of novelty, drawn from a study of mediæval buildings, into Renaissance architecture, than any architect before or since. He used, it is true, the materials of his time, but he employed them upon the forms which are the common property of *all* time, and I do not think even the introduction of the dome itself to have been such a step in advance in the history of Renaissance art, as was Wren's adaptation of the mediæval church tower and spire to the purposes of his class of buildings. Look at the outline of St. Michael's, Cornhill; St. Mary-le-Bow; St. Bride's, St. Margaret Pattens, St. Magnus, or a dozen others, and tell me whether Wren had not learned something from the mediæval architects. Or, compare the section of St. Paul's with that of a mediæval cathedral, and say if the study of the two does not show a deep acquaintance with the laws of structure and proportion observed by the Gothic artists: and rest assured that it is asking an impossibility to require that a man living in the country which Wren inhabited, and among the persons with whom he associated, should have done more than Wren did, to introduce the ideas and modes of working them out, which prevailed among the mediæval artists.

We ought not at the present day, with the rich inheritance that has come down to us from every part of the globe, and every period of time, to divide into factions, and fight the battles of Gothic against Classic—Roman against Greek—Chinese against Romanesque. *Our* study, our aim, should be *architecture*, not *an* architecture; *style*, not *a* style; and as we have, more than any past generation, the means of knowing, appreciating, and collating the works of the skilful in every country, and in all time, we should glean the instruction they all convey, recognise the points of excellence in each, and endeavour by these means to cultivate a large-minded, comprehensive view of our art; and so fit ourselves to prosecute it with a skill and a success that may make us not quite ashamed to remember that we are of the same nation, and labour in the same metropolis, as our great master and pattern—Sir Christopher Wren.

ELECTRIC CURRENTS.

Simple Electric Machine.—M. Thore united the ends of a strip of paper about eight inches in width, so as to make a continuous band of it, and stretched it on two wooden pullies covered with silk, one of which was rapidly turned around by a handle; the electricity was developed by pressing a warmed flat-iron upon the paper as it passed over one of the pulleys. He describes the effects as remarkable. There is nothing new in the observation of the electricity developed by paper, and many of our machinists have noticed how often the bands of their machinery became electrically charged. But the apparatus is simple and cheap, and capable of working under atmospheric conditions which arrest the action of our ordinary machines.—*Paris Academy of Sciences.*

Simultaneous and Opposite Electric Currents in the same Wire.—M. Petrina has investigated this disputed phenomenon by means of the reduction of temperature which Peltier discovered to take place when an electric current passes from bismuth to antimony. A metallic bar of these two metals soldered together in the middle, was introduced in the bulb of an air-thermometer, and divided currents from the same battery, carefully equalised, were passed through it in opposite directions. In this case, if no current passes, no effect should be produced; but if both pass, since the cooling effects are known to be much less than the heat produced by the same current, when passing in the opposite direction, the thermometer should indicate such heat. In fact, no effect was produced when the currents were equalised, and when they were allowed to be unequal, the heat was that due to the difference of the currents.—*Cosmos.*

RAILROAD ACROSS THE BLUE RIDGE MOUNTAINS, VIRGINIA, U.S.*

CHARLES ELLET, jun., C.E.

The Mountain Top Track is a part of a continuous line of railroad in course of construction through Central Virginia, from Richmond to the Ohio. The Commonwealth of Virginia undertook the construction of 17 miles of this route embracing the passage of the Blue Ridge, and the tunnel which was supposed necessary for this passage; but finding after four years' work on the tunnel, that at least three years more would be necessary for its completion, and that in the meantime, the Company of which he was the engineer, could not enjoy the revenue of the capital expended in the incomplete works, Mr. Ellet formed the design of crossing the Ridge by a temporary track to be worked by locomotive power, and intended to maintain a complete connection of the roads at the eastern and western base. The description of this route, the degree of success which it has attained, and the means by which this has been secured, are given in Mr. Ellet's pamphlet.

Description of Road.

The Mountain Top Track crosses the summit of the Blue Ridge at Rock Fish Gap, where the elevation of the mountain is 1885 feet above tide. The crest of the ridge is very narrow, and is passed on a curve of 300 feet radius. There is barely room for an engine with an ordinary train to stand on the summit, before the road slopes off, descending both towards the east and west, to the valleys on either side of the ridge.

Western Side.—The length of the descent on the western side, from the summit to what is here assumed to be the foot of the mountain, is 10,650 feet, or $2\frac{2}{100}$ miles. The track descends in this distance, on the west side, 450 feet—or, at the average rate of one foot in $23\frac{2}{3}$ feet. The *average grade* on the western slope is, therefore, $223\frac{1}{10}$ feet per mile, and the *maximum grade* $5\frac{3}{10}$ feet in 100, or $279\frac{84}{100}$ feet per mile. On both sides of the mountain the ruling curves are described with a radius of 300 feet, on which the grade is $237\frac{6}{10}$ feet per mile.

The excess of the maximum over the average grade is occasioned by the attempt to compensate, in the distribution of the necessary ascent, for the effect of curvature. There was no experience to guide the writer in the arithmetical determination of the influence of such curvature as it was necessary to introduce upon this road and the proper diminution of the slope required on the curves to compensate for the increased traction which would there be due to the curves. On this point professional information is still very deficient, even for curves of ordinary radii, traversed by engines of common construction propelled at the usual velocities of freight or passenger trains. For such an anomalous line as the writer was about to construct, there was absolutely no guide; and his allowance was therefore almost entirely conjectural.

When the road was first opened, it speedily appeared that the difference of 43 feet on the western side, and 58 feet on the eastern side, between the grades on curves of 300 feet radii and those on straight lines, was not sufficient to compensate for the increased traction due to such curvature. The velocity, with a constant supply of steam, was promptly retarded on passing from a straight line to a curve, and accelerated again on passing from the curve to the straight line. But, after a little experience in the working of the road, it was found advisable to supply a small amount of grease to the flanch of the engine by means of a sponge, saturated with oil, which, when needed, is kept in contact with the wheel by a spring. Since the use of the oil was introduced the difficulty of turning the curves has been so far diminished that it is no longer possible to determine whether grades of $237\frac{6}{10}$ feet per mile on curves of 300 feet radius, or grades of 296 feet per mile on straight lines, are traversed most rapidly by the engine.

Eastern Side.—But the more difficult portion of the work was on the eastern side of the mountain, where the ascent was greater, and the slope, in order to reach a certain level, which became a necessary condition of the problem of location, was required to be greater. The length of the line of descent from the summit to the foot of the grade, is 12,500 feet, or $2\frac{37}{100}$ miles. The road descends in this distance 610 feet, or at the average rate of one foot in $20\frac{1}{2}$ feet. The *average grade* on the eastern slope is, therefore, $257\frac{7}{10}$ feet per mile; and the *maximum grade* is $5\frac{6}{10}$ feet in 100, or $295\frac{68}{100}$ feet per mile. This maximum grade is found in a continuous line of half a mile in length.

The shortest radius of curvature on this side of the mountain was intended to be 300 feet; but in the construction of the work a more abrupt curve was introduced at one difficult point, in order to throw the track further into the hill and keep the embankment off a face of sloping and treacherous rock. At this ravine, which is found about half way down the mountain, the radius of curvature is only 234 feet, and the grade upon that curve is $237\frac{6}{10}$ feet per mile.

The total length of the track from the foot of the mountain on the west side, across the summit, to the foot of the mountain on the east side, is $4\frac{38}{100}$ miles. But, in consequence of delays which occurred in the construction of other parts of the road, it became necessary to extend the track $3\frac{1}{2}$ miles further, running it around unfinished cuts and embankments at four different points, so that the distance actually worked by the mountain engines is about 8 miles.

Locomotive Engines.

This road was opened to the public in the spring of 1854, and it has now, in autumn of 1856, been in constant use for a period of more than $2\frac{1}{2}$ years. In all that time the admirable engines relied on to perform the extraordinary duties imposed upon them in the passage of this summit, have failed *but once* to make their regular trips. The mountain has been covered with deep snows for weeks in succession, and the cuts have been frequently filled for long periods many feet in depth with drifted snow: the ground has been covered with sleet and ice, and every impediment due to bad weather and inclement seasons has been encountered and successfully surmounted in working the track.

During the last severe winter, when the travel upon all the railways of Virginia and the Northern and Western States was interrupted, and, on many lines, for days in succession, the engines upon this mountain track, with the exception of the single day already specified, moved regularly forward and did their appointed work. In fact, during the space of $2\frac{1}{2}$ years that the road has been in use, they have only failed to take the mail through in this single instance, when the train was caught in a snow drift near the summit of the mountain.

These results are due, in a great degree, certainly, to the admirable adaptation of the engines employed to the service to be performed; but they are due, also, in no small degree, to the skill and energy of the superintendent in immediate charge of the track and machinery.

The locomotives mainly relied on for this severe duty were designed and constructed by the firm of M. W. Baldwin and Co., of Philadelphia. The slight modifications introduced at the instance of the writer to adapt them better to the particular service to be performed in crossing the Blue Ridge, did not touch the working proportions or principle of the engines, the merits of which are due to the patentee, M. W. Baldwin.

These engines are mounted on six wheels, all of which are drivers, and coupled, and 42 inches in diameter. The wheels are set very close, so that the distance between the extreme points of contact of the wheels and the rail, of the front and rear drivers, is 9 ft. 4 in. This closeness of the wheels, of course, greatly reduces the difficulty of turning the short curves of the road.

The diameter of the cylinders is $16\frac{1}{2}$ inches; and the length of the stroke 20 inches.

To increase the adhesion, and at the same time avoid the resistance of a tender, the engine carries its tank upon the boiler, and the footboard is lengthened out and provided with suspended side boxes, where a supply of fuel may be stored. By this means the weight of wood and water, instead of abstracting from the effective power of the engine, contributes to its adhesion and consequent ability to climb the mountain.

The total weight of these engines is 55,000 lb. or $27\frac{1}{2}$ tons, when the boiler and tank are supplied with water, and fuel enough for a trip of 8 miles is on board.

The capacity of the tank is sufficient to hold 100 cubic feet of water, and it has storage room on top for 100 cubic feet of wood, in addition to what may be carried in the side boxes and on the footboard.

To enable the engines better to adapt themselves to the flexures of the road, the front and middle pair of drivers are held in

* 'The Mountain Top Track: A description of the Railroad across the Blue Ridge at Rock Fish Gap, in the State of Virginia.' By CHARLES ELLET, jun., C.E. [From the Journal of the Franklin Institute.]

position by wrought-iron beams, having cylindrical boxes in each end for the journal bearings, which beams vibrate on spherical pins fixed in the frame of the engine on each side and resting on the centres of the beams. The object of this arrangement is to form a truck, somewhat flexible, which enables the drivers more readily to traverse the curves of the road.

There were three engines constructed expressly for this track, of which two answer to the description here given. The third engine was built by Mr. Joseph R. Anderson, of Richmond, and is an excellent machine and capable of doing good service. Resting on eight wheels, and being more rigid than the others, it does not yield so easily to the very short curves of this track. It is therefore kept on hand as a reserve engine, and is frequently employed to relieve the regular engines of the road.

Duties and Speed of the Engines.—The writer has never permitted the power of the engines on this mountain road to be fully tested. The object has been to work the line regularly, economically, and, above all, *safely*; and these conditions are incompatible with experimental loads subjecting the machinery to severe strains. The regular daily service of each of the engines is to make four trips, of eight miles, over the mountain, drawing one eight-wheel baggage car, together with two eight-wheel passenger cars, in each direction.

In conveying freight, the regular train on the mountain is three of the eight-wheel house cars fully loaded, or four of them when empty or partly loaded. These three cars, when full, weigh with their loads from 40 to 43 tons. Sometimes, though rarely, when the business has been unusually heavy, the loads have exceeded 50 tons.

With such trains the engines are stopped on the track, ascending or descending, and are started again, on the steepest grades, at the discretion of the engineer.

Water, for the supply of the engines, has been found difficult to obtain on the mountain; and since the road was constructed a tank has been established on the eastern slope, where the ascending engines stop daily on a grade of 280 feet per mile, and are there held by the breaks while the tank is being filled, and started again at the signal and without any difficulty.

The ordinary speed of the engines, when loaded, is 7½ miles an hour on the ascending grades, and from 5½ to 6 miles an hour on the descent. Greater speed and larger loads might doubtless be permitted with success, but the policy has been to work the track with perfect safety, to risk nothing, and to obtain and hold the public confidence.

Breaks, Couplings, &c.—The rule was adopted that no car should be suffered to cross the mountain that did not possess a break for every wheel, of power sufficient to clutch the wheel firmly and prevent its rotation. All fixtures by which the breaks might be acted upon by the engineer, and the power conveyed simultaneously to all the wheels through a common bar or chain, were rejected, because the giving way of this connecting bar would render all the breaks which were made dependent upon it powerless.

The breaks were required to be inspected at every trip by an experienced man, and to be in perfect order for service before the mountain engine could be attached to the train.

The giving way of a coupling was another source of danger to be guarded against upon such grades; for, if the breakmen on the ascending train should be neglectful, and fail to apply their breaks when a coupling bar or bolt should break, the disengaged car might be carried down the grade. To guard against this danger, reliable couplings were provided for all the cars; and, for further security against the possibility of such an accident, two powerful tug chains were attached as extra couplings between the locomotive and the forward car, and also between each two separate cars, which are reserved couplings, coming into service only in case the regular coupling bar or its connexions should part. These guard chains are always attached as soon as the mountain engines, or "climbers," as they are called, are put on.

When the track is in good condition, the breaks of only two of the cars possess sufficient power to control and regulate the movement of the train—that is to say, they will hold back the two cars and the engine. When there are three or more cars in the train, the breaks on the cars, of course, command the train so much the more easily.

But the safety of the train is not dependent on the breaks of the cars. There is also a valve or air-cock in the steam chest, under the control of the engineer. This air-cock forms an independent break, exclusively at the command of the engineer, and which can always be applied when the engine itself is in working order. The action of this power may be made ever so gradual, either slightly relieving the duty of the breaks on the cars, or bringing into play the entire power of the engine.

A supply of sand is not neglected; for, though the breaks completely control the train in ordinary weather, yet, when the cold is intense, and the track, wheels, and breaks are all covered with snow, frozen into hard ice, they will not hold. Then, as usual, sand is applied in the front of the forward drivers or in front of the middle drivers, as is under the circumstances most expedient; and the friction may be increased to whatever amount is necessary for the safety of the train.

With the passenger trains, there is a man at the break on every platform, who never leaves his post while on the mountain, whether the train be ascending or descending. For the freight trains, four breakmen are required to attend to the breaks of three cars, or five breakmen to those of four cars.

Such tracks as this over the Blue Ridge are very dangerous under negligent or unskilful management. But with care to observe the rules prescribed, and to keep within the authorised loads and speed, they are quite as safe as, if they are not safer than, ordinary railways worked with ordinary care.

Current Expenses.

The current expenses of maintaining and working this track are scarcely as great as might be expected from its anomalous and difficult character. The ordinary consumption of fuel by one of the mountain engines, ascending the eastern slope of the mountain, from the foot of Robinson's Hollow to the summit—a distance of $2\frac{62}{100}$ miles—in which an elevation of 660 feet is overcome, and many curves of 300 feet radius are turned, is 42 cubic feet, or very nearly one-third of a cord. The total weight of the engine and train, or mass moved, is 70 tons. The cost of fuel is there $2·00 a cord.

The fuel used in traversing the whole length of the track, from the Greenwood Station to the western base of the mountain, a distance of 8 miles, including both the ascent and descent of the mountain, is two-thirds of a cord, costing $1·33, exclusive of the cost of firing up.

The total cost of working the two engines when making two round trips each per diem, is as follows:—

2 Engineers,	at $75	each per month,	... ...	$150·00
6 Breakmen,	,, 20	,, ,,	... ...	120·00
2 ,,	,, 25	,, ,,	... ...	50·00
2 Firemen,	,, 25	,, ,,	... ...	50·00
2 ,,	,, 17·50	,, ,,	... ...	35·00
1 Machinist,	,, 75	,, ,,	... ...	75·00
Wages of engine and train hands, per month				$480·00
Fuel, oil, &c., for two engines, per month, when making each four trips a day,			... ...	350·00
				$830·00

Annual locomotive expenses, $9960.

Maintenance of the Road.

Salary of Superintendent, per annum, ...	$1200·00
2 Section Masters, each $400, ...	800·00
12 Laborers (negroes), at $150 per annum	1800·00
1 Laborer at wood station, ...	150·00
2 Watchmen at trestles, $240, ...	480·00
1 Night Watch at terminus, ...	365·00
Annual Cost of Superintendence and Maintenance,	4795·00
Add Locomotive expenses, ...	9960·00
Cost of Maintaining and Working, ...	$14,755·00

or, per mile per annum, $1845.

To this total must be added, of course, the cost of repairing the locomotive engines and cars; and also the depreciation, properly due to this track, of the cars and engines and the track itself.

The engines, when delivered to the Company, were all exceedingly substantial, and have needed but small current repairs beyond what the machinist of the track has been able to give to them and to the cars. No separate account has been or could be kept of the other repairs of the cars—the track being worked in connection with the road east and west of the mountain.

BLOCKS AND BRICKS FOR BUILDING.

J. Briggs, Fleet-street, *Patentee*, June 4, 1856.

(*With Engravings, Plate* XVII.)

This invention consists in constructing the parts of blocks and bricks for building, whether of wood, stone, iron, earthenware, clay, or other suitable substance, in various forms corresponding with each other, and so that each separate block or brick has apertures into which may be inserted rods, bars, pins, ties, or bolts, so as to hold the blocks or bricks together. The apertures are so formed and placed that upon any two or more blocks being brought together in the position they are intended to occupy, one or more of the apertures in each block shall correspond with or come opposite to one or more apertures in the next block or blocks to allow of the passage of the tie rods through them, or of their being slipped on the tie rods.

Fig. 1, is a side view of a brick constructed according to the invention; fig. 2, a vertical section, and fig. 3, a plan of the same, showing the apertures for the admission of pins or bolts; fig. 4, a section through the line *a*, *b*, of fig. 3; fig. 5 is a side view of another form of brick which is used in conjunction with that shown at fig. 1; fig. 6, a section, and fig. 7, a plan of the same; fig. 8, a cross section through the line *c*, *d*, of fig. 7; fig. 9 is a side view of a foundation or tie block or brick of different shape to those before given; fig. 10 is a plan thereof showing two rows of apertures for the insertion of pins; fig. 11, a vertical section through the line *e*, *f*, of the same, and fig. 12, a cross section through the line *g*, *h*, of fig. 10; fig. 13 shows a side view, and fig. 14, a plan of another form of brick; fig. 15 is a view of a piece of brick or stone work composed of that form of brick or stone shown at figs. 1 and 5; fig. 16 represents part of a wall built with the description of brick shown at fig. 9; and fig. 17 shows a course of masonry or brickwork supported by columns, pedestals, or balustrades, showing the manner of attaching the improved bricks to the same and the columns to the other parts of the structure. A is the brick, the end B of which is formed of half the thickness of the central part, and the end C on the opposite side is made in a similar manner, the two ends B and C have holes or apertures *i*, *i*, moulded in them. In fig. 5 the ends D and E are formed opposite to one another, the holes *k*, *k*, in the ends being of the same size as those in fig. 1. To put the brickwork together, the part marked D is placed on the end C, the end E at the same time resting on the end of another brick similar to the part marked C, when the holes or apertures *i* and *k* will correspond; a pin or plug, formed of wood, iron, or any other suitable material, is then driven through the holes *i* and *k*, and mortar or other adhesive substance being placed between the bricks the whole is made perfectly secure, and, when several layers have been formed, present the appearance shown at fig. 14. The blocks, shown at figs. 9, 10, 11 and 12, are secured with pins or plugs in a manner similar to those before described; they are laid in the same way as ordinary brickwork, so that the joints of the different bricks shall not correspond. Grooves or channels, *l*, *l*, may be formed on all the sides, ends, and faces of the bricks and blocks which will admit of mortar, cement, or other suitable material being employed as well as the tie pins.

To attach the brickwrok to columns as in fig. 17, the description of brick shown at figs. 1 and 5 is used. Through the column or pedestal is placed a pin or plug, the bottom part fitting into one of the improved bricks, having apertures therein; on the top is fitted the end of one of the bricks shown at fig. 1 or 5, the plug passing through the hole in the end thereof; other bricks of similar form are then placed upon it, and so on until the work be completed.

A paving of these blocks may be made with the tie rods placed horizontally as shown at fig. 18, which gives a good foot-hold for horses by chamfering off the upper edges of the blocks and making grooves in them.

Claim.—The patentee does not limit himself to the four forms shown, or to the number of holes or apertures made in each brick or block, as the same may be varied according to circumstances; but claims the construction of blocks and bricks for building with two or more apertures made therein, for the purpose of receiving two or more pins to tie, hold, and unite together any number of the same employed to build a wall, or paving, or other structure.

BRICKS.

T. Schwartz, New York, *Patentee*, June 19, 1856.

(*With Engravings, Plate* XVII.)

Fig. 1 is a bottom perspective view of a mould brick on the improved plan, showing a cavity with vertical corrugations and a top moulding; fig. 3 is a longitudinal section in perspective, showing one half of a similar brick, differing only from that shown in fig. 1 by the introduction of a countersunk shoulder (*a*, *a*, *a*,) in the lower edge of the cavity, to indicate that the form may be modified by that means for the purpose of attaching separately moulded projections like the one fig. 4, when deemed desirable either to facilitate the manufacture or improve the working qualities of the brick. Fig. 5 is a view of a brace such as may be used as lateral strengthening in the cavity of the brick; fig. 2 is a longitudinal section in perspective of a mould brick, having longitudinal corrugations on the interior of the cavity and mouldings at top and bottom. Fig. 7 is the plan view of a perforated brick on the improved plan, made on the expression system by means of a single core; fig. 6 is a modification of fig. 7, in which the principle of the zig-zag arrangement is carried out longitudinally as well as transversly.

The object of this invention is to produce a brick realising certain practical desiderata not combined in any hitherto devised, without altering the general external form or losing any of the properties of the common brick. The following description and illustrative figures given in Plate 17, shows the nature of the invention. This object is attained by removing vertically from its central portion, by a variety of means, such a quantity of the material as can be advantageously dispensed with, and by giving a peculiar configuration to the cavity or cavities thus produced.

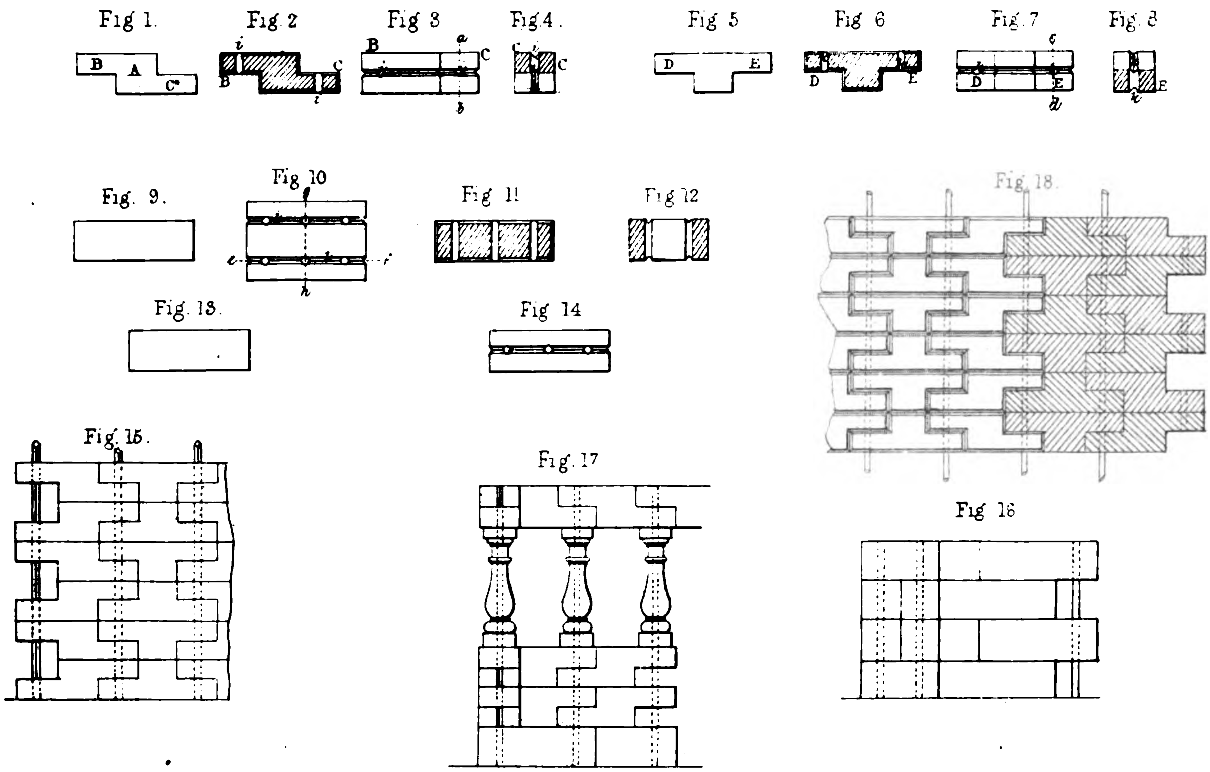
The principle of these improvements may be embodied in several forms of brick, one or another being preferred according to the character of the masonry to be executed, or the particular mode of manufacturing the article that may be found most desirable or convenient. Five such forms are seen in figs. 1, 2, and 3 showing bricks on the new plan formed in moulds, while figs. 6 and 7 show bricks made on the same principle by the ordinary expression brick machine. The forms of the latter, although dissimilar, realise the same aim and advantage as the first; these advantages are superior lightness, increased facility of drying and burning, greater non-conduction to damp, sound, and heat, ready ventilation, improved bearing, binding, and keying, an economical mortar surface, and a form that can be cut to advantage; the aim being to produce a light non-conducting ventilating brick, which is so perforated as to afford an effective and uniform distribution of the material, and whereby the thickness of the article may be increased to any desired extent without prejudice to the drying and burning.

In the moulded brick fig. 1, the cavity *a* extends from the top to the bottom of the article, and leaves it in fact an open hollow frame of clay. The interior surface of this frame is moulded into vertical corrugations, ridges, or ribs *a*, *a*, of any desired form and number, to impart the maximum of strength to the material. The bottoms and edges of these corrugations afford superior bearing and bonding surfaces. The corrugations do not, in this instance, extend to the top of the brick, but are cut off by and merged into a horizontal moulding or fillet *b*, which, spreading out above them contracts the cavity at the top to a narrow elongated aperture, reducible into a mere slit or fissure or fissures of whatever configuration, thus leaving an ample and properly situated receiving surface for the mortar.

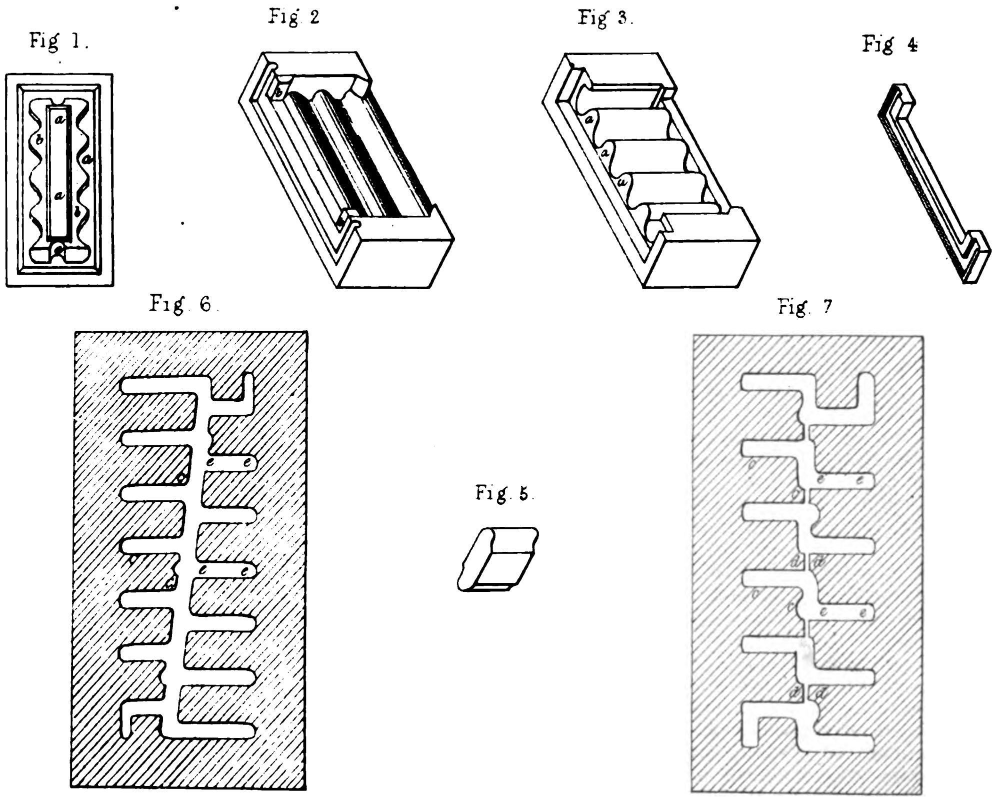
The form thus produced may be strengthened for handling in the green state by the insertion of one or more transverse braces or supports, like fig. 5, of any convenient shape, made of clay, separately moulded and put in place after the brick is formed; braces thus inserted become incorporated in burning with the body of the brick, and greatly diminish the liability to breakage in transportation. Fig. 2, shows another form of moulded brick, differing from fig. 1, in having longitudinal instead of vertical corrugations.

The two styles of brick require to be made in moulds, whether by hand or by machinery; they cannot be produced by the systen of expression through dies without modification; as it is desirable, however, to apply that mode of manufacture the patentee has devised a variation of form, which secures the combination of advantages stated to be his aim, while it is easily produced by

BRIGGS' BLOCK AND BRICKS' FOR BUILDING.



SCHWARTZ'S IMPROVED BRICK.



J R Jobbins.

the application of a single core to the die of an ordinary expression machine. The nature of the modified form is to secure a proper mortar surface, by reducing the hollow spaces or grooves between the ribs, so as to dispense with the moulding *b*, fig. 1, carrying the ribs through and through, thus producing a brick whose top and bottom surfaces are alike, without abandoning any of the objects or principles involved in the construction of the mould bricks, figs. 1 and 2.

Figs. 6 and 7 are illustrations of forms proposed to apply as above to the expression system of brick making. The adaptation to the process in question is accomplished simply by enlarging the ribs or corrugations, and changing the shape of the central cavity into that of a tortuous line of slits or narrow elongated passages of angular or undulated configuration or network of contracted cavities, arranged as seen in figs. 6 and 7, so that the projections or ribs *c*, *c*, on one side of the middle line shall be opposite the slits or perforations *e*, *e*, on the other, in other words alternating the position of the ribs and slits one with the other, the object being to attain the maximum strength of the material in the bonding of the masonry. To prevent the brick fig. 7 from losing its proper shape by the sagging of the upper side while in the green state, a slightly raised or arched form is given to that side, and to the ends of the ribs *c*, *c*, (on either or both sides) is added projections like *d*, *d*, so that when the clay has yielded or sagged far enough to make the raised side of the brick quite straight, the said projections *d*, *d*, will come to bear firmly upon each other, and prevent any further depression or sinking. These projections thus brought into contact may or may not unite in burning; if united, they leave the brick perforated by a succession of transverse slits or angular cavities; the connections, however, though united in a wet state, are likely to crumble away during the drying, so as to leave the whole perforation one continuous space.

The patentee does not confine himself to placing the ribs *c*, *c*, opposite to the slits *e*, *e*, but prefers to place the slits opposite to each other. It is contemplated to make the slits so narrow that the mortar will have little or no tendency to enter them (considering the absorption by which it becomes thickened), but if found desirable in practice, the cavities may be made wider by being narrowed at the top, by indenting the ribs *c*, *c*, in such a manner as to widen their surface.

Claim.—The patentee does not claim "making bricks by forcing clay through a moulding orifice having a series of cores to form holes or perforations in the brick," and he intends in no case to use more than a single core; but claims.—

1st, the formation of bricks or building blocks, substantially as herein described and illustrated.

2nd, the use of elongated perforations of undulated or angular form, as exemplified in figs. 6 and 7, and of ribs, ridges, mouldings, fillets, or other analogous forms, as in figs. 2, 3, and 7.

3rd, the zig-zag arrangement of the ribs, as a means of securing strength.

4th, making perforated bricks on the expression system, with two or more connected cavities or independent holes by means of a single core.

5th, the application of indentations, depressions, or grooves for the purposes of contracting the perforations, to enlarge the surface on which the mortar is to be spread, and increasing its hold.

6th, the insertion or attachment of parts separately moulded, and the making the improved brick of any size that may be found desirable in practice.

ROOFS AND FLOORS.

R. A. Brooman, Fleet-street, *Patentee*, September 4, 1856.

The object of this invention is to provide economical means of constructing roofs, roof frames, and other buildings or parts of buildings in iron. The parts are made in pieces, and so that they may be easily set up, taken down, and carried from place to place. Carcase roofs, or framework for roofs, are formed of tie beams or wall plates, placed on and along the walls of a building, and fastened by knee pieces and bolts, spaces being left at the angles for the rafters to hook in. The wall plates may be strengthened by an inside arch or curved ribs. An improved truss is formed of two bars, bent in an "ogive" or pointed arch shape, and connected to the ridge piece by knee pieces, leaving a dovetailed space at top for the king post to pass. The arch springs from the level of the wall, and terminates in a knee piece built into the brickwork. Another of the improved roofs, especially adapted for barns, is constructed of two slanting holdfasts or ribs, fitting into a cap or joggle at the bottom of the king post, and terminating at the beginning of the wall. To guard against pressure on the king post from outward strain, two horizontal holdfasts or tie beams are employed, connected by screw ties or struts to the main tie beam. For boarded buildings the binding is not employed, but a tie beam or wall plates are used instead thereof, or intermediate trusses. The king posts are made slanting to support the ridge pieces. To avoid the outward strain space may be left behind the fastening of the truss.

The supports of the longitudinal rafters or purlins, are of iron, their inner ends being held by screw bolts, and morticed, for the insertion of a tightening wedge or key; the end of the support projects a little beyond the mortice to receive the end of the rafter. The longitudinal rafters or purlins consist of straight bars, fixed in the angle of the building by screw bolts, and chamfered off at the ends to take the square shape of the rafters, according to the slope; the ends of the purlins are fastened to the gables, or project beyond, and are supported by a volute bracket. For certain buildings the ridge piece is made of a straight beam or bar, with a "lanterne" knob or turret at each end, resting on the two gable ends. The "lanterne" is made of rolled iron, fitted in the ridge piece, provided with a cap at top and bottom, and having an orifice at bottom to receive the king post, and at top for holding a lightning conductor or weather cock.

The common rafters are made of T iron, with one leg shorter than the other, and are fitted to the ridge piece to which they are fixed, and hook on to the purlins, to which they are bolted. The rafters are formed with holes to receive rods for carrying various descriptions of roof covering.

The angle or hip rafters, are composed of a bar, having another bar fixed to it at each end at right angles, and held by clamps, in which the ends of the purlins are placed.

For flooring, improved joists are employed, consisting of two bars held together by a clamp. In introducing the lower bar it expands by heat, and on cooling down the upper end is stretched. The two bars are united and held by stirrups, and connected by clamps, which are not placed close together, so that materials for the flooring may be passed between them.

Improved gates are constructed of iron plates, bolted together and held in T iron frames, supported by other bars; the doors are made folding, and closed by an espagnolette, and are fastened by a hook; the gate rests on friction rollers or wheels, and are held in caps or castor frames, which run on a rod or rail at bottom, and being also provided with wheels or rollers at top, working in a groove formed by two bars clamped together. The rail is set in a wooden bed let into the earth.

The roof may be covered with slates, tiles, zinc, or other roofing material. The wall plates consist of a holdfast resting on the wall forming the frame of the building, held together and connected with knee pieces, leaving room at the corners for the hooks of the hip rafters. These wall plates mark the space of the truss and the dimensions of the structure, so that roof frames may be prepared beforehand.

Claims.—1. The roofing of buildings in the manner described.

2. The construction and arrangement of roofs, roof frames, or carcase roofs, as described.

3. The construction of joists and flooring as described.

4. The improved construction of door or gate as described.

BUILDING WALLS.

J. Taylor, Hounslow, *Patentee*, September 10, 1856.

This invention proposes an improvement in building walls. For this purpose face plates or slabs either of brick, earth, stone, or artificial stone, or composition are used, each being made with a flange or projection on its inner lower edge. These facing plates or slabs are used in combination with concrete in the following manner:—They are employed in pairs, so as to form blocks of concrete faced on the two surfaces; or, several of the facing plates or slabs are arranged end to end in two parallel lines, at a distance apart depending on the intended thickness of the wall, the flanches being inwards. Concrete is to be poured into the space between the parallel lines of facing slabs or plates, but only so as to partially fill such space, and the concrete is to be allowed to set. The space is then to be completely filled with concrete, the upper surface therefore being struck off or made level with the upper edges of the facing slabs or plates. Other facing slabs or plates are then placed in a similar manner in parallel lines on those previously mentioned, these slabs or plates breaking joint with those below, and the spaces between the slabs or plates are then to be filled, as described, with concrete.

INSTITUTION OF CIVIL ENGINEERS.

April 28.—Robert Stephenson, M.P., President, in the Chair.

The discussion on Mr. Hunt's Paper, "*On Electro-Magnetism as a Motive Power*," occupied the entire evening.

In commencing the discussion, it was remarked, that Mr. Joule's researches on the subject appeared not to be sufficienty known to either theoretical or practical men. In a series of papers, in the 'Philosophical Magazine,' that gentleman had shown, by an able combination of theory with experiment, what the total mechanical effect, derivable from the consumption of a stated quantity of zinc, in any of the ordinary galvanic batteries, amounted to: and, in conjunction with the late Dr. Scoresby, he constructed an electro-magnetic engine, driven by a Daniell's battery, which actually performed more than 50 per cent. of the whole theoretical duty. The theoretical duty of a grain of zinc, used in a Daniell's battery, was 145 foot-lbs. Now the engine referred to actually performed 80 foot-lbs. of work per grain of zinc consumed, or 54 per cent. of the full duty. Among other conclusions that might be drawn from these experiments was this—that until some mode was invented of producing electricity, as many times cheaper than that of an ordinary galvanic battery, as coal was cheaper than zinc, electro-magnetic engines could not supersede the steam engine. For supposing an electro-magnetic engine to perform 75 per cent. of the theoretical duty, instead of the 54 per cent. obtained by Joule, then such an engine, as near perfection as could be reasonably expected, would use 5 grains per second, or 2·6 lb. per hour of zinc, per horse-power. A perfect electro-magnetic engine, driven by a Daniell's battery, would use 2 lb. of zinc per hour, per horse-power. Some of the best steam-engines would perform 143 foot-lbs. of work, per grain of coal, or would use 20 lb. of coal per hour, per horse power. In a scientific point of view, the electro-magnetic engine was stated to be most interesting, as having been the means of solving the problem of converting a large per centage of the whole energy of chemical forces (those of combination of zinc with oxygen and acid) into mechanical effects, without letting it into the form of heat at all, making in fact the combustion of zinc not generate more than 46 per cent. of its equivalent of heat, and directing it to raise weights with the remaining 54 per cent. of its energy. But this very circumstance took away from its practical importance, since it showed how little could be expected from electro-magnetism, more than had been done by Joule and Scoresby. On the other hand, Joule's theory showed that the full theoretical duty of the combustion of the coal was about eight times as much as had been obtained in the best steam-engines, and left a very wide margin for improvement in engines, deriving mechanical effect from coal fires. It ought, however, to be added, that although steam-engines fell so far short in the duty they rendered, for the consumption of the coals, the best steam-engines did, in reality, perform 50 or 60 per cent. of the duty of a perfect engine, taking in heat at the actual temperature of their boilers; and that to attain more than double, or even to attain as much as double the present economy of a good steam-engine, it would be requisite to introduce engines taking in heat at a much higher temperature than the highest of the actual high-pressure boilers.

It was explained, that the author's knowledge of this subject was founded on an extensive series of experiments which he had made at Falmouth, for the Russian Imperial Commission, as well as on another series, made subsequently, at the request of some gentlemen connected with the copper trade of the Port of Swansea, on both of which occasions he had arrived at the conclusion, that it was only at an enormous cost that electro-magnetism could be applied as a motive power. It had been stated, that it might possibly be advantageous to employ this power in ships engaged in the copper trade with South America, even if the cost was thirty times as great as steam power in this country.

It was remarked, that Professor Botto, of Turin, had estimated that with a Grove's battery there would be a consumption of 45 lb. of zinc per horse-power per day. Starting with this, and assuming a battery of one cell, the equivalent of zinc being 32, and one third of an equivalent of nitric acid being 18, there would be consumed for 45 lb. of zinc, 25·3 lb. of nitric acid, equal to about 50·6 of commercial acid. Taking the zinc at threepence per pound, and the nitric acid at sixpence per pound, and setting off the small quantity of mercury used for the amalgamation and the sulphuric acid against the salts formed, the estimated cost would be 1*l*. 16*s*. 10½*d*. per horse-power for every twenty-four hours. Then came the theoretical difficulty of the equivalents of power. The idea, was, that the same quantity of matter, being changed, would produce—if all the force could be utilized—the same amount of power, so that, theoretically, whether a lb. of zinc was employed, by burning under a steam-engine, or in decomposing water, and then exploding the gases, or in turning an electro-magnetic machine the result would be identical in each case, as to the amount of power obtained. Then there was the difficulty, not only of employing zinc, but also other materials,—sulphuric acid, for instance, which was the cheapest; all these went through a costly process before they could be employed for these purposes. Thus manufactured, and consequently expensive materials were used, instead of a crude matter. Therefore, unless the power could be utilized, to a greater degree than in the steam-engine, the difficulty was apparently insuperable. With the present form of magnets, it was believed, that those powers could not be utilised to the requisite extent. The main advantage, in using this kind of power, was due to the fact, that the instant the machine ceased working, the expenditure of power also ceased, and it was not until the power was again applied, that any consumption of material occurred, and then only according to the work performed. This advantage was not, however, sufficient to compensate for the disadvantage of having to use 50 or 60 parts of manufactured materials for the production of force, instead of 6 parts of crude matter. If electricity could be obtained from coal and water, or from coal and air, the problem would be solved. It was known, that an electric current could be obtained by the combustion of charcoal, or from flame, but the utilisation of such combustion was far distant, so as to convert its force, entirely, or substantially into an electric current, although an infinitesimal portion of that form of force could be obtained from the burning of fuel. Practically speaking coal had not hitherto, in any form, been made to act as the positive element of a battery. It had been imagined, that the difficulty might arise from carbon forming a compound with two equivalents of oxygen, which was not electro-lytic, or practically soluble; and this idea was partly corroborated, by the discovery, that carbon acted better as the positive element, in an alkali, as potash, or soda, where the carbonic acid would be immediately absorbed, than in an acid solution; but the current with an alkali was feeble.

The great desideratum was considered to be, not so much the form of the machine, as improvement in the source of the power itself, the battery, or furnace. The forms of machines might be divided into three types. First, there was the principle of suspension, or making and stopping the magnetism, followed in the machines of Dal Negro and of Botto; second, the principle of the 'inversion of polarity,' adopted by Ritchie and followed by Jacobi; and third, the deflecting, or galvanometer principle, where the needle was deflected with a coil round it: this was first practised by Petrie. All the larger machines, which had been constructed, were on the suspension, or the inversion principle, the latter being thought to be the best. The boat, referred to by the author, was worked upon the inversion principle, and in it three persons had travelled at a rate of three miles an hour, but the expense put it out of the question as a practical application. At present electro-magnetism must be confined to special purposes, where the danger of steam and the creation of vapour were sought to be avoided, or where economy of space was a consideration. But it was far removed from general application as a motive power.

It was thought, that the shape of the magnet might be altered, by widening the poles, so as to have a still slower diminution of the forces. The alteration of the force of the current, by the motion impressed upon the apparatus, was thought to be due to the generation of induced currents, whose action was opposed to the primary current, and therefore lessened its power. It was suggested to envelope the electro-magnet in a closed coil of wire, not in contact with the battery, which coil, when the motion was set up, should have an induced current formed in it; this induced current might then be carried to a second electro-magnet and wound round in a manner so that the current should assist the primary magnet. The relation between heat and mechanical effect was a subject of great practical importance, both to the man of science and the practical engineer, and it was suggested that experiments of so momentous a character should not rest on the unsupported testimony, valuable as it was, of one individual, but that another series of independent experiments should be instituted so as to place the question beyond doubt.

The results obtained from various machines were mentioned. One with a fixed horse-shoe electro-magnet, and a revolving straight bar electro-magnet, and driven by a single cell of Daniell's battery, raised 3 lb. one foot high in a minute, with the consumption of one ounce of zinc in 8 hours. A considerable advantage was derived from making the revolving bar of several thin plates of iron, instead of making it solid. It then received and parted with the magnetism more rapidly. The commutator was made of silver, to avoid oxidation, and the sparks were suppressed by causing the rubbing wires to touch one segment of the commutator before leaving the adjoining one. A bobbin and fly had been driven, and cotton had been spun by this machine.

A larger machine with several magnets produced less power. In the first machine, the magnetism must have been reversed in less than one thousandth of a second, otherwise the machine could scarcely have produced any power at all.

Another machine was described, in which a cranked or eccentr[illegible] shaft, was alternately attracted by two electro-magnets, or two [illegible] of electro-magnets. This machine ran 4000 revolutions per minute unloaded, and from 1800 to 2600 revolutions per minute with the best load. It raised 21 lb. one foot high in a minute, with six Smee's batteries.

Another machine, consisting of an iron clutch, or toothed disc, wound with copper ribbon, and revolving over a similar fixed clutch, or disc, raised 21 lb. one foot per minute, with two of Lemolt's nitric acid and carbon batteries.

These results tended to show, that the cost of electro-magnetic power was enormous, in proportion to steam power. It was suggested, as probable that one atom, or chemical equivalent, of zinc consumed or oxidised, in driving a perfect electro-magnetic engine, would not produce more power than one atom, or chemical equivalent of coal consumed, or oxidised, in driving a perfect steam engine; while the cost of the equivalent of zinc was two or three hundred times that of the coal.

It was observed, that in all forces the primary change of matter, or the new attraction set up, to produce the phenomena which were manifested, must be regarded. In the steam-engine, the source of power was the attraction which was created between the coal and the oxygen of the atmosphere. In the battery, it was the attraction between the zinc and the oxygen of the water. It was considered that the most perfect results, with regard to the primary changes, were obtained with the voltaic battery, because in a well constructed instrument, the initial change, which took place to produce the power, could be used with a very small per centage of waste. Theoretically, battery power ought to be had at a profit, but it was difficult to find a market for the sale of the sulphate of zinc, though it might be different, when it was produced in large quantities, as in the preparation of the plates of the Ordnance Survey, where the sulphate of zinc had been sold, and had become a matter of consideration in a commercial point of view. When, however, the cost was taken into account, the difference was greatly in favour of coals as a source of power. The use of hydro-carbons had been tried for the positive pole of a battery, but they were not practically efficient. It might be taken as a fundamental principle, that, up to the present moment, zinc was the best material for the purpose. Where batteries were employed, they exceeded, it was believed, every other mechanical force in two things. The first was, the great distance at which it could be applied; and the second, that when once set at work, the battery would continue in operation over a long period of time. Although motive power could not be produced, at the same expense, on a large scale, by the agency of the battery, as it could with coals, yet the achievements of the electric telegraph might be regarded as an application of motive power by electricity, which was by no means to be despised. The fall of the ball at Deal, by which the chronometers of the mercantile navy were regulated, and also the means of regulating the time at the General Post Office, the Great Western Railway Station, the Telegraph Office, West Strand, &c., were due to this cause.

It was stated, that the object in view, in constructing a machine for deflective action, was to get rid of the short distances over which the power acted, in the case of ordinary electro-magnets. Success had so far attended these efforts, that the deflective action had been extended to one foot, instead of only a fraction of an inch. A pressure of about 18 lb. had been obtained round a surface 20 inches in diameter, but that was reduced, directly it was allowed to attain any velocity. The reduced current was the cause of this great reduction of force, and in proportion to the motion, so was the action of the reduced current increased. It was believed, that the cost of the nitric acid, in the estimate which had been given in the early part of the discussion, might be omitted, as it could be reconverted by a simple process.

A comparison, which had been instituted, as to the cost of different means of producing power, showed that for every shilling expended, there might be raised by

Manual Power	600,000 lb.	one foot high in a day.
Horse	3,600,000 lb.	ditto.
Steam	56,000,000 lb.	ditto.
Electro-magnetism......	900,000 lb.	ditto.

It was explained, that the results recorded in the Paper, as to the diminution of magnetic force through space, were the mean average results actually obtained from a number of experiments with magnets of various forms, some having long and others short arms. The plan of winding round the magnet a closed coil of wire not connected with the battery, the induced current in which might be employed to produce magnetism in another bar of iron, had been tried by Hjorth and had been abandoned, owing to the difficulty of dealing with the current when the magnet was in motion. It had also been found, that the power from the second magnet, thus created, was of very inferior moment in any form of machine then devised—and was not practically available.

With regard to the relation between heat and mechanical effect, it was remarked, that the experiments of Joule had been confirmed by the researches of Professor Wm. Thomson, of Glasgow—that Dr. Scoresby worked with Joule on this problem—that it had engaged the attention of Professor Bunsen, of Marburg, and more recently of M. Favre, who had arrived at the same conclusions as those recorded by Joule.

It was regretted that, in France, the delusion as to the possibility of electro-magnetic engines superseding steam still prevailed. Fifteen years ago, it had been proved, experimentally, that the heat evolved by any voltaic circuit in which an engine was not included, was exactly that due to the chemical actions taking place, the conducting wire merely presenting the means of evolving the heat in any given locality, instead of it being all evolved where the chemical action took place. This discovery, which had been erroneously attributed to M. Favre, whose experiments were only three years old, was followed up by the discovery, that if an electro-magnetic engine be placed in the voltaic circuit, the heat evolved corresponding to a certain chemical action, was diminished, the heat which appeared being converted into the mechanical force given out by the engine. The greater the quantity of heat which disappeared from the voltaic circuit, relatively to the heat due to the chemical actions, the more perfect would be the economy of the electro-magnetic engine; and as it was possible to make the engine work, so as to reduce the intensity of the current to a very small fraction of its strength, when the engine was not working, nearly the whole of the heat due to the chemical actions of the battery might be evolved as work. Supposing all of it were converted into work, there would result 145 foot lbs. for each grain of zinc consumed in a Daniell's battery. It was the weakness of the chemical actions of a voltaic pile, as compared with that of the combustion of coal, and the relative cost of zinc and coal, which decided so completely in favour of the steam engine. As regarded the strength of the chemical actions, one grain of zinc consumed in a Daniell's battery gave out heat equivalent to 145 foot lbs.; but one grain of coal burned in air produced heat equivalent to 1261 foot lbs., or nine times as much—so that if a steam engine was so bad as to convert only one-ninth part as much heat as the electro-magnetic engine, the two would still be on a par. As to expense, it was obviously impossible that the cost of coal could ever become more than a minute fraction of that of zinc, to say nothing of that of other necessary materials.

It was observed, that those who had hitherto attempted the solution of the problem of electro-motive power, seemed to consider that the whole question resolved itself into producing a certain amount of electricity at a given cost. The chemical question, in fact, was first considered, instead of the mechanical application of a given force. Magnetic force died rapidly away through but a short space. If the geometrical curve of the dynamic force of magnetic attraction was drawn, and was divided into ten parts, then it would be found, that if the tenth nearest the magnet gave a mean power equal to 1000 lb., the mean force of the tenth-part furthest from the magnet would only be 3 lb., though the same amount of electricity would be used in the one case as in the other. Taking the mean of the whole attraction of a magnet, only a small power was obtained through a short distance. In Jacobi's engine, in which the rotary principle was adopted, the minimum portion of the magnetic attraction only was applied, giving but a small power with a large consumption of electricity. In another electro-magnetic engine, in which a different form of magnet, with 4, 6, or 8 poles placed upon a plate, had been adopted; it had been endeavoured to apply the maximum portion only of the dynamic force, and this, by a succession of magnets, was successively and continuously brought into action, giving a comparatively large power, with a small consumption of electricity, and producing, in a machine, a continuous motion analogous to the overshot water-wheel.

It was hoped that, though apparently impracticable now, in process of time electricity might be applied as a motive power. For when it was considered what had taken place with regard to electricity, how, it had first been obtained from friction upon amber or glass—was then developed by chemical action from metals—and was subsequently manifested by the influence of heat on solid bodies, as shown in the form to which the name of thermo-electricity had been given,—it was felt that a series of industrious researches into the undeveloped secrets of this marvellous element, might result in the means of producing the power which would render it as economical and advantageous as the heat which was now obtained so easily. It was only a few years since Sir Humphrey Davy was compelled to employ a thousand pairs of zinc and copper-plates, to do the work which twelve of the same agents would perform in a modern battery.

It was thought, that the subject under discussion ought to be divided into two distinct parts—first, the mode of producing electricity, and second, the apparatus to which such electricity was to be applied. If possible, the natural products to be found in the earth, ought, for the sake of economy, to be employed in both cases, instead of products manufactured at considerable cost. It was remarked, that, hitherto, electro-magnetic engines had not been constructed in accordance with a power varying inversely as the square of the distance; for which certain remedies were suggested. It was also recommended, that a modification of the waves of contraction in muscular fibre should be adopted in electro-magnetic engines. Allusion was made to certain peculiarities common both to muscular fibre and to the electro-magnet; and attention was particularly directed to sound, which was developed in both, on the production of a pulling power, and to both being a substitute for nervous energy. Electricity could be used either directly by means of the electro-magnet, or indirectly by the explosion of gases. Heat, electricity, electro-magnetism, magnetism, and pulling power were all only different manifestations of one and the same force, and each was convertible into any other. The mechanical effect of a flash of lightning was analysed, and it was shown that, in a certain instance, the power developed through 50 feet was equal to a 12,220-horse power engine, and that the initial explosive power was equal to a pressure of three hundred millions of tons. The desirability of obtaining a motive power requiring less weight per horse-power than the steam-engine, was then adverted to, and reference was incidentally made to some experiments which had been tried at different times, with this object in view. In this way it had been ascertained that the motive power derivable from the chalk formation near London, would cost four times more than that obtained from coal. The power to be derived by the production of the vapour of a volatile spirit by the condensation of steam—from the explosion of a mixture of hydrogen and oxygen by electricity—from the condensation of the vapour of a highly volatile spirit by ice—and by a certain quantity of solid hydrogen and oxygen, by means of the steam-engine and by means of the muscles of the horse, were then adverted to; and it was stated that the latter gave out nearly ten times as much power as the most perfect present arrangement of the steam-engine in Cornwall.

In closing the discussion it was remarked, that there could be no doubt, from what had been said, that the application of voltaic electricity, in whatever shape it might be developed, was entirely out of the question, commercially speaking. Without, however, considering the question in that point of view, the mechanical application seemed to involve almost insuperable difficulties. The power exhibited by electro-magnetism, though very great, extended through so small a space as to be practically useless. A powerful magnet might be compared, for the sake of illustration, to a steam-engine with an enormous piston, but with an exceedingly short stroke. Such an arrangement was well known to be very undesirable.

In the mechanical application of power, velocity, or in other words, the space passed over, was made as large as possible, and in proportion as this was accomplished had the efficiency of the machine been extended. Now, this was precisely the difficulty under which the application of magnetism laboured; the space through which it could be made to extend being so exceedingly small.

With respect to the very imperfect use made of heat, in the ordinary steam-engine, some reasonable doubt might be entertained as to the correctness of the methods employed to arrive at the unit of heat now employed by scientific men; for when it was stated, that the ordinary duty obtained by a good steam-engine was about 1-10th of what the quantity of heat actually generated by the consumption of a given weight of carbon was really capable of performing, some doubts naturally suggested themselves, as to the correctness of the mode by which such a result was arrived at; for it appeared impossible to conceive where such an enormous loss could take place.

This part of the subject would seem to require further investigation, and it might be suggested, that the power necessary to destroy molecular attraction might not be comparable with the ordinary mode of developing power, by imparting heat to elastic vapours. The one being an enormous force exerted over an infinitely small space, and the other, on the contrary, being a limited power exerted over a very large space. This view would seem to be corroborated, or might derive illustration from considering the well-known mechanical difficulty of comparing a given pressure at rest, wlth another pressure with a given velocity. It was well known, in fact, that they were not comparable.

May 5.—The Paper read was "*On the Employment of Rubble Beton, or Concrete, in works of Engineering and Architecture.*" By Mr. RENNIE, M. Inst. C.E., F.R.S.

The author commenced by succinctly tracing the history of the art of construction, or building, from the earliest periods, as exhibited by the architectural remains, in Egypt, Assyria, Greece, Etruria, Rome, and China, and in South America;—thence to the comparatively more recent structures of the continent and of this country, whose condition evidenced the care and attention devoted to the selection of materials, and the due proportioning and mixing of the mortars and cements.

The authors on this subject were also noticed, from Vitruvius, onwards to Philibert de L'Orme, who took up the subject of building in 1648, and whose example was followed by numerous excellent writers, among whom stood prominently, Belidor and Rondelet as great authorities on engineering construction, followed, on the more immediate subject of the paper, by Vicat, and Treussart, the former of whose labours had been made more generally known in this country by General Pasley's corroborative experiments.

A long quotation was given from the report of the jury of the XIVth class of the International Exhibition of 1855, at Paris, bearing honorable testimony to the merits of Monsieur Vicat, when, in awarding him a medal of honour, it was stated, that he had devoted himself entirely to that important subject, and had successfully demonstrated that France possessed all the elements of the pozzuolanas, and that by the simple admixture of calcined, or of raw clays with lime, in due proportions, artificial cements, fitted for almost all hydraulic purposes, could be produced. In his extensive researches he had discovered nearly three hundred quarries in France, whence hydraulic cements could be derived.

This led to the more immediate object of the paper, which was to introduce the system advocated by Monsieur Gariel, the manufacturer of the Vassy cement, of building bridges and other similar structures with rubble-beton, or concrete, in the prosecution of which he had been very successful. After enumerating a long list of structures executed in this material, in all parts of France and Algeria, the author described more minutely the construction of the Pont de l'Alma, traversing the Seine, immediately adjoining the lower end of the building of the Annexe, and which being in progress during the period of the International Exhibition of 1855, had directed his attention to the subject.

The Pont de l'Alma consisted of three elliptical arches *(en anse de panier)*, whose spans were, for the two side arches, 38·50 metres (126·23 feet) each, and the middle arch, 43· metres (141·40 feet); the height or conjugate axis of the two side arches was 7·70 metres (25·25 feet), and the middle arch, 8·60 metres (28·2 feet). The thickness of the arches at the centres was 1·50 metre (4·92 feet); the breadth between the faces of the arches was 10·30 metres (33·78 feet), and the total length of the bridge was 139·69 metres (458·18 feet).

The peculiarity in this bridge was the mode of construction, the materials employed being, for the hearting, or body of the structure, rubble stone, *pierre de meule*, concreted by Vassy cement. The stones of the intrados of the arches were roughly squared and laid as voussoirs, whilst the rest of the structure consists entirely of rough stones, as they left the quarry, being only well washed with water to deprive them of any earthy particles adhering to their surface, which would have prevented the adhesion of the cement, in which they were well bedded, and which was poured in as grouting to fill up all the interstices. The outer faces of the bridge and of the piers were built in cut stone, very carefully tooled and finished, like all the other bridges in the French capital.

The bridge only occupied nine months in construction, and would have been finished sooner but for an accident which occurred to one of the piers, during a heavy flood. This injury was stated to have been since repaired by injecting a considerable quantity of Portland cement, which had consolidated the whole structure.

The method employed for striking the centres was simple and ingenious, and had been previously tested in bridges of considerable span. It consisted in supporting the centres on several cylinders filled with dry sand. which was permitted to flow very gradually through an aperture in the bottom of each, and thus to lower the pistons and centres, without risk of the inequality of motion arising from slackening the wedges as in the ordinary system.

The author then noticed the labours of British engineers, architects, and others, in introducing the use of concrete, citing the names of Smeaton, Semple, Higgins, Barker, Frost, White, Walker, Rennie, Smirke, Brunel, and Pasley, and the Essay by Godwin, on the subject, which, though now somewhat ancient, had scarcely been improved upon. Their recorded labours in that branch commenced in 1774, when concrete was first noticed in the works of Smeaton, who gave the proportions which had been found practically the best, by Mr. Foster Nickoll. Copies were then given of the letter of Mr. T. Hardwick, and of the Report, in January, 1813, by Messrs. Rennie, Lewis, Cockerell, and Browne, advising its use for the foundations of the Penitentiary; thus clearing away the erroneous impression of Mr. (now Sir Robert) Smirke having introduced concrete into that building, upon which he was not consulted until December 1817, three years subsequently to the Report, which had in the mean time been acted upon.

The Paper was illustrated by numerous drawings and models of bridges constructed of rubble and Vassy cement, and by specimens of the concrete formed, exhibiting its hardness and soundness.

Several specimens were also contributed by Members taking part in the Discussion. A cube of 12 inches of concrete, composed of one part of Dorking lime, with eleven parts of sand, and washed shingle, weighing 136 lb.,—of the same materials and density as the river wall, 1200 feet in length and 25 feet in height, in front of the new works of the Chelsea Water Company, at Seething Wells, near Kingston, showed that its density was very nearly equal to that of Bramley Fall stone, a cubic foot of which weighed 138 lb.

Specimens of concrete and brick-work from the Ruins of the Library at Alexandria, and of cement from Pompeii, exhibited the remarkable soundness of the material after the lapse of so many ages.

Specimens were also shown of the concrete composed of White's Portland cement and shingle, forming the massive blocks used in building the piers and harbour works at Dover, Alderney, Cherbourg, and other places, demonstrating the great solidity attained by these masses, which enabled very extensive works to be constructed with great rapidity.

May 12.—The discussion upon the above subject took place, and a Paper was afterwards read on the "Method of Building Bridges upon Brick Cylinders, in India," by G. B. Bruce, which our space compels us to postpone till next month.

May 19.—The Paper read was "On the Disturbances of Suspension Bridges, and the modes of counteracting them," by A. S. Lukin and C. E. Conder, which will also appear next month.

The President's Conversazione.

The President's annual conversazione was held at the rooms of the Institution, on 26th ult. The rooms were filled with choice collections of pictures, drawings, sculpture, gems, and ceramic art. A variety of models of new inventions were exhibited, and some of the latest applications of science. Among those especially attractive were M. Lambert Alexandre's self-acting log, for indicating and registering the speed of ships. This invention, in its simplest state, is called the sillometer, and visibly indicates, with mathematical accuracy, the speed of a ship in its smallest variations, a hand on the dial following all the variations of the ship's course. When the instrument both indicates and records or registers the speed, it is named sillographe, and writes down by itself all the variations of speed which the sillometer only marks. Clifford's new and superior method of lowering boats was also illustrated by models. A great variety of achromatic microscopes and improved stereoscopes were exhibited by M. Pillischer. Specimens of various new modes of laying and fastening rails, and numerous other improvements adapted to various portions of our railway system, were also shown. A collection of porcelain, earthenware, and glass, shown in the drawing-room, by Alderman Copeland, was very much admired for its fine execution, beauty of design, and brilliancy of colour.

MEMORIALS OF WATT.*

The Watt Club of Greenock, the native town of the illustrious James Watt, have published memorials of his life collected from local sources, to which the collator, the late perpetual president of the club, had peculiar means of access. The work is remarkably well got up. It is printed in quarto, on fine thick paper, and is illustrated by several well-executed engravings, including a profile of Watt, from an original in the possession of Mr. Gray of Greenock, taken in 1803, when the great mechanical philosopher was sixty-seven years old, and representing him with a pig-tail! The countenance of the venerable man had still impressed on it the character of thoughtfulness and energy, but the portrait bears little resemblance to the well-known likeness taken when Watt's intellectual faculties were in their maturity. The illustrations also include a highly-finished engraving of Papin, and a representation of his digester; the model of Newcomen's engine in the University of Glasgow, in repairing which the idea suggested itself to Watt of a separate condenser; there is a representation of the first British steamboat, the *Comet*; and the facsimile of several letters by Watt, the first bearing date the 9th December, 1773, when he was in his 38th year, and the last is dated January 13th, 1816, rather more than three years before his death. The character of the handwriting is well preserved in the latter, but the letters are, curiously enough, much smaller, and with the exception of some blots and interlineations, there are few indications of age in the penmanship, though Mr. Watt was then eighty years old. The work is further illustrated by three large engravings of the West India Royal Mail steam-ship *Atrato*, built by Messrs. Caird and Co. of Greenock, and with a map of the river Clyde from Glasgow to Portincross, from an actual survey made by John Watt, the father of the mechanician, and advertised as "sold by James Watt, at his shop in the College of Glasgow, price 2*s*. 6*d*."

We are thus particular in noticing the getting-up and illustrations of this quarto volume published by the Watt Club, because, in truth, there is little else to recommend it. The object of the author seems to have been to collect together all the facts, however minute and generally uninteresting, by which Watt was associated with the town of Greenock, whilst he has disregarded those greater matters which gave the philosopher an European reputation and an undying name. The performance of the play of *Hamlet*, with the omission of the Prince of Denmark, which is usually considered the climax of absurdity, seems to be surpassed in memorials of Watt without any notice of the invention of the steam-engine. The name of Dr. Black, who was so intimately connected with Watt and his scientific experiments and speculations, and with his success in life, does not occur in the text; and the author disposes in a few lines of Watt's apprenticeship in London, respecting the circumstances of which he appears to have been ignorant.

A great part of the volume is occupied with the lineage of Watt, which the writer regrets cannot be traced further back than his great-grandfather, who was killed in one of Montrose's battles. Some excuse is, indeed, offered for giving so prominent a place to the ancestors of the great mechanician, on the plea that their scientific and practical attainments formed the germs which fructified so admirably in their illustrious descendant. Some points of interest, connected with the school days of Watt, present themselves as redeeming pages in the general mass of local insignificance. His father lived, during the early part of Watt's life, in what was considered in Greenock, in those days, "a superior style;" as an illustration of which it is stated that a venerable lady, who when a girl visited at the worthy baillie's house, informed the author that she was surprised to see *two* candles lighted on the table. The mother of Watt was described by the same authority to have been "a braw, braw woman—none now to be seen like her." The feeble constitution of Watt, when a boy, and his pensive character, tended to gain him little credit at school, where he was considered, by his fellow scholars, dull and stupid, and he suffered much from their persecutions. His intellectual birth is dated from his fourteenth year, when he commenced the study of mathematics, for which he appears to have had a natural aptitude.

We have looked through this volume of "Memorials," hoping to find at least some illustrative anecdotes of the great man whose character it attempts to depict, but there are absolutely none; and the author seems to have regarded everything immaterial that was not connected with the town of Greenock, the glorification of which town he seems to have had much more at heart than the illustration of the life and character of Watt. After the very interesting work by Mr. Muirhead, "On the origin and progress of the mechanical inventions of James Watt," noticed in the *Journal*, Vol. XVIII. p. 230, this pretentious quarto volume of "Memorials" is most "flat, stale, and unprofitable." We pick out of it, for extract, the following letter by Watt, in reference to improvements in the harbour of Greenock, a lithographic copy of which is inserted with the sketch referred to:—

"*Glasgow, December* 9, 1773.

"Sir,—I only returned from a survey of the Forth two days ago, and have been so much indisposed since, that I could not consider your subject. I am to be at Port-Glasgow to-morrow, with our magistrates, where I hope to have the pleasure of seeing you, as I understand you are to dine there with them. I refer most of what I have to say till that time, and hope you will come provided with the necessary queries, and the plan of the harbour. In the meantime I send you the dimensions of the breast-walls, which I find I intended to be fifteen feet high; that is, I supposed them to be founded as low as the ordinary spring-tides, low water;—you will at Port-Glasgow see the contract for their pier, which I propose for a model for yours. The breast should be founded seven feet thick, and should, by two intakes in the first two courses, be taken in off the outside to six feet thick, from which it should batter to four feet thick at tops, the greatest part of the batter should be off the outside, thus:—[Here a drawing is given of the section.]

"Thickness at bottom, seven feet	7	0
Thickness at top	4	0
The two searcements at bottom	1	0
The inside bottom	0	6
The outside ditto	1	6
	7	0

On second thoughts, as it will not much increase the expence, I believe it will be best to give it no inside batter, but to make the top thickness four feet six inches, and make the inside perpendicular, which will strengthen it against the earth that presses it outwards. I would build in treshes of old ships'-oak to fix the sliders for bearing off ships' sides, as proposed in Port-Glasgow new quay; but these particulars and others necessary I will explain to-morrow, and furnish articles of contract. Such a wall will contain twelve yards of masonry, of two feet thick in the running yard, and should cost as follows:—

"For the hewn stone in the facing, average length 2⅓ feet, 105 cube feet, at 4d.	£1	15	0
For the capping long stones quite across the wall, 13½ feet, at 5d.	0	5	7½
For the rabble stones and leading, 5½ yards of two feet thick, at 1s. 3d.....	0	6	10½
Building hewn stone and rabble, 12⅓ yards of 2 feet thick, at 1s. 2d., that is, 42s. a rood	0	14	4⅔
Total expense of stone-work per running yard, casting the foundation, and drainage	£3	1	10⅔

"Excuse haste. I have not time to copy this, and will be obliged to you for copy when we meet.—I remain, with regard, &c., &c.,

"James Watt."

* 'Memoirs of the Lineage, Early Life, Education, and Development of the Genius of James Watt.' By George Williamson, Esq., late Perpetual President of the Watt Club of Greenock. Printed for the Watt Club, by Thomas Constable. 1856.

ROYAL INSTITUTE OF BRITISH ARCHITECTS.

At a meeting held on the 18th ult., the Earl de Grey, president, in the chair, the testimonials were presented to the following gentlemen.:—

To Mr. Tarn, the medal of the Institute, for his essay on the "Application of Mathematical Science in Architectural Practice."

To Mr. Green, the Soane medallion, for a design for a Metropolitan Hotel.

Another medal was presented to Mr. Parkin, for his design for the same subject; and a present in books to Mr. Underwood, for his Student's Sketches.

The chairman then proceeded to present the Royal gold medal to Mr. Owen Jones. In doing so, he expressed the pleasure he felt in attending on occasions like the present. Her Majesty's medal was a gift which the Institute should be proud of, and he had had much gratification in presenting it on former occasions. It would now be presented to one known by his works; works which had certainly been of great service to his profession. They had not fallen within the reach of every one, but in the Crystal Palace, which was accessible to all—whether connected with art, science, or manufactures—the genius of Mr. Owen Jones was manifestly displayed. He had the greatest possible pleasure in presenting to that gentleman a testimonial of the respect and esteem of all his brethren in the noble and honourable profession of which he was so distinguished a member.

Mr. Owen Jones briefly acknowledged the award.

Mr. Tite, M.P., said with reference to the gold medal of Sir William Chambers, which his friends had resolved to present to Mr. Pennethorne, that the compliment which it was proposed to pay that gentleman was as well deserved as it was unusual. For many years there had been an office under the Government, similar to that which Mr. Pennethorne now held. Sir Sir William Chambers, the favourite architect of George the III, had left Somerset House in an unfinished state; but the Government had entrusted its completion to a man of judgment, taste, and skill; and the work had been most successfully carried out.

Professor Cockerell considered the tribute to Mr. Pennethorne a mere measure of justice. He himself belonged, if not the same family, to the same school as Mr. Pennethorne.

Mr. M. Digby Wyatt then read a paper on the Sacred Grotto of St. Benedict, at Subiaco, and its Monastic Institutions.

NEW GOVERNMENT OFFICES COMPETITION.

Model and Design, No. 138.

We have been favoured by a correspondent with a few notes, descriptive of the large model and design No. 138, which we insert with much pleasure, believing that the model embodies some excellent suggestions, and that it is deserving of particular attention.

It is proposed to remove Westminster Bridge, and reconstruct it lower down the river. The bridge as it now stands, would intercept the view of the Houses of Parliament and of the new Government Offices, and the advantage of its removal will be evident. As shown in the model, one proposed new bridge leads to Charing-cross, running almost parallel with the Hungerford foot-bridge (which latter is very elegant and effective *now*, but would not be improved by flitching and pieceing it to give strength for a general traffic, as suggested by the Bridge Company). The new Charing-cross Bridge way is proposed to be 80 feet wide inside parapets, being 26 feet wider than London Bridge, and would afford a direct and quick route for commercial and general traffic from Charing-cross to the Town Hall in the Borough; the new road forming an easy curve through Lambeth and Southwark, and adapting itself to main street levels at crossings, and to the parallel positions of blocks of houses, lines of streets, &c., so as to prevent destruction of property by avoiding the cutting squares into angles, such as is shown must occur in the other routes laid down in brown and purple colour on the model. The new roads and diversions of roads to and from the old and new bridges are all shown in white on the model.

The centre area of Lincoln's Inn Fields is proposed to be laid out for intended new Law Courts. A new street is shown running on the east of the great square, which street it is contemplated to extend ultimately to the angle of Temple Gardens, and from thence cross by a new bridge (not in the model); which bridge road, on the Surrey side, would be prolonged through the present line of Princes-street, and so onwards; forming an important new route and river crossing, midway between the Waterloo and Blackfriars Bridges.

The rebuilding of Blackfriars Bridge is imperative; reducing the number of arches and giving free scope to the tides, and, at the same time widening the bridge betwixt parapets, as shown on the model.

A new composite bridge is shown crossing from the new proposed street line running parallel with the Post-office and east end of St. Paul's, and thence over to the Surrey side, to be called "St. Paul's Bridge;" from whence, on the Surrey side, a new railway runs to the Bricklayers' Arms Station, bringing in all the continental mails direct to the Post-office, without delay or change of carriages. These mail-cars would pass by a cellular or tubular way under the general carriage-road of the bridge, and thence by tunnel direct into the Post-office yard.

It is hoped the time is not far distant, when the proposed railway belt around London, in one continuous lineo f about twenty, seven miles extent, will intersect and connect every railway running into the Metropolis; and thus accomplish two great objects—"The quick and safe delivery of letters to and from the General Post-office," and, "avoiding the lumbering traffic of goods through our over-crowded streets, from one railway station to another."

The proposed widening of the area around the east end of St. Paul's, by removing St. Paul's School, and other buildings in line with the same, is followed up by commencing at the foot of Ludgate-hill with a set-back of twelve feet on each side, fanning or radiating towards St. Paul's Cathedral; so as to afford an improved view of that magnificent building; with a noble range of houses and shops, having Cannon-street on the one side, and Cheapside on the other, opening two distinct roads of traffic to and from each, instead of one crowded way as at present.

It will be seen by the model that a new bridge is proposed to cross from near Lambeth Palace to Holywell-street, on the opposite shore, with improved roads leading to it on each side. This new bridge is arranged for a double purpose, similar to the new St. Paul's Bridge; excepting that in the new Lambeth Bridge, the railroad is proposed to run parallel with, instead of underneath the general traffic road. The terminus of the railway, the "New Western," is shown on the Middlesex shore; forming a west end terminus. From thence the rail crosses the river, taking a curve, and running alongside the South-Western Railway for some distance, from whence it is intended to branch, and run into Clapham, Brixton, Dulwich, &c.

The improvements suggested in the model are of a very decided character in the neighbourhood of Charing-cross; consisting of an improved National Gallery, by appropriating for that purpose the present areas of barracks and workhouse, in the rear of the present building. It is also proposed to widen St. Martin's-lane; also, to open the Mall drive into the Strand, erecting a new Academy of Arts building at the angle; together with new Police-offices, hotels, and other buildings, flanking Northumberland-gardens, and the new road to proposed Charing-cross Bridge.

One of the distinctive features of the proposed improvements, as shown in the model, is the narrowing the river to an average of 800 feet througout. By this arrangement, a truly noble stream will be maintained, and the present filthy mud shores will be got rid of. Underneath the boundary walls, on each side of the river, it is proposed to construct conduit tunnels, below the low tide levels and shores, for the purpose of receiving and removing the whole of the sewage. Arrangements are made in constructing the new river walls, so as not to interfere with wharves, manufactories, stores, landing places, or docks; but, on the contrary, affording superior advantages, by providing floating docks, so that barges and boats can load and unload at all times of the tide, without being stranded on the mud shores as they now are between the two tides. Promenade walks and drives are proposed, and can be introduced at such points as the front of Temple-gardens and Somerset-house, the space from Charing-cross Bridge to the Houses of Parliament, and the opposite shore to the Houses of Parliament and New Offices, which could be easily made available for the public benefit and recreation. The new river walls would also form one continuous promenade walk throughout its length on either side, and afford facilities for landing steam-boat passengers on both sides, at any required point.

THE CROYDON WATER QUESTION.

The decision of the Court of Exchequer Chamber with reference to the important question which has been raised in the action by Mr. Chasemore against the Croydon Local Board of Health, has been delivered. The decision was in favour of the latter. It being a question of general importance, we give the judgment *in extenso.*

Mr. Chasemore, by his counsel, contended that the Croydon Board of Health had no right to pump water from their own freehold well for the supply of the town, because some of the water so pumped was on its underground way into the Wandle river, which turns his mill. And the board, by their counsel, contended that though it would be actionable to take water out of the river itself or out of any stream or visible feeder, yet as to underground water, which is all they pump up, they have a right to pump and use as much as they please, whether or not it is on its subterranean way to Mr. Chasemore's mill.

The only chance that the board had of getting out of their difficulties was to reverse the judgment in "Dickinson *v.* the Grand Junction Canal Company." They, therefore, arranged at the assizes, when the cause came on, to refer it to arbitration, with power in the arbitrator to move a special case to raise and try again the question of right to underground water. This was argued for the board in the Exchequer, and the board obtained a decision in their favour, the Court of Exchequer reversing their own decision in "Dickinson *v.* the Grand Junction Canal Company." Mr. Chasemore, not satisfied with this decision, appealed to the Court of Exchequer Chamber, and there the decision is in favour of the board.

Mr. Justice Cresswell—I am of opinion that our judgment in this case must be in favour of the defendant in error. In coming to this conclusion, I adopt the statement of the law with regard to the right to flowing water made in Embrey *v.* Owen, 6th Exchequer 389, and it may be convenient to read the passage as printed in that book. "The owner of a mill on a flowing stream is in the same position as a riparian proprietor; he can have no larger right than that which he has by nature against those above or below him, unless it has been acquired by adverse user. A party, whether a mill-owner, or a riparian owner, suing for abstraction of water, must establish a right either *jure naturæ* or by user, and in the latter case the user must be such as to establish a servitude affecting the land through which the water flows. Every riparian owner is by nature subject to the natural rights of those lower down which are in the nature of a servitude imposed on this land—a servitude *ne facias.*" Let us inquire whether this servitude, imposed by nature or by user, can extend to water oozing through land near a flowing stream, and which, if not intercepted, would find its way into that stream. None of the text books or decisions in which an attempt has been made to define the rights of riparian owners to flowing water have extended them beyond some defined ascertained flowing stream, with the exception of Dickinson *v.* the Grand Junction Canal Company. To extend them further would interfere with the rights of the landowner, which have never yet been disputed. Thus a riparian owner cannot divert the stream for any purpose, whether for irrigating or draining his land, or any other to the prejudice of the riparian owners. But it has never yet been held, nor was it contended in the argument of this case that a man might not drain his land, and so abstract water oozing through it, although such water would have otherwise found its way to a flowing stream. Nor has it been contended that an owner of land situate near a flowing stream may not make a pond for use or ornament, although water would ooze into it which otherwise would have gone into the stream, but he would not for any of these purposes abstract water from a flowing stream.

Again the owner of land near a flowing stream has hitherto been supposed to have the right of preventing water from oozing into his land from higher ground provided he does not throw it back upon his neighbour, but he can no longer do that if water so percolated is to be put on the same footing as a natural flowing stream, for that he cannot lawfully divert even for the purpose of preventing injury to his land. But if he may prevent the water from coming into his land, why should he not allow it to come and then collect and use it, and to allow this would be in direct conformity to recent decisions of the Court of Exchequer in Rawston *v.* Taylor, 11 Exchequer 369, and Broadbent *v.* Ramsbottom, 11 Exchequer, 602. There are two cases in our books, and I believe two only which support a claim to water not in a flowing stream. Bilston *v.* Benstead, 1 Campbell 462, and Dickinson and the Grand Junction Canal Company, 7th Exchequer 282. In the former of these cases, Lord Ellenborough said that there could be no doubt but that twenty years exclusive enjoyment of water in any particular manner affords a conclusive presumption of right in the party so enjoying it. His lordship is not reported to have explained the nature of the presumption to be made, but at that period it seems to have been supposed that the right of a riparian owner arose out of some presumption of a grant by those higher up the stream. It is therefore probable hat in the case then before him, which related to the water springing up in the plaintiff's land, he meant that the enjoyment of it for 20 years raised a presumption of a grant; a presumption not generally made against those who had no knowledge of the existence of that which they are to be presumed to have granted; and I do not understand that any one has insisted in this case upon the doctrine of presumption, which was altogether repudiated in the other case alluded to, Dickinson and the Grand Junction Canal Company, where Lord Chief Baron Pollock in giving the judgment of the court says—"We consider it as settled law that the right to have a stream running in its natural course is, not by a presumed grant from long acquiecence on the part of the riparian proprietors above and below, but it is *ex jure naturæ* and an ingredient of property, as much as the right to have the soil itself in its natural state unaltered by the acts of a neighbouring proprietor, who cannot dig so as to deprive it of the support of his land." It would seem, therefore, that the Court of Exchequer, as constituted when that judgment was given, would not have rested that opinion in favour of the plaintiff in Bilston and Benstead, on the ground stated by Lord Elllenborough. But in the case of Dickinson and the Grand Junction Canal Company, which was a case stated by order of the Master of the Rolls for the opinion of that court, questions were put involving the right of a man to sink a well in his own ground and intercept water which would have percolated and gone through the intervening streams into a flowing stream; amongst others, two questions were put, namely, "whether the company, by digging the said well at Cow Roast, and pumping the water thereout, and thereby diverting and preventing it from flowing into the river Bulbourne, and pumping into the said summit level of the canal, a quantity of underground water, which would otherwise have percolated and gone through the intervening chalk and earth underground, and would in the natural and accustomed course of the rivers Bulbourne and Gude have flowed to the mills of the plaintiffs, and been applicable to the working thereof, and have thereby prevented the plaintiffs from working their mills so beneficially as they otherwise might and could and would have done, have violated the 38th George 3rd, chap. 16, or the articles of the agreement of the 11th of September, 1817, or either and which of them, or have rendered themselves liable to an action, irrespective of the said act of parliament and agreement; and whether the digging of the said well at Cow Roast, and the pumping thereout by the company, so as to draw off out of the river Bulbourne, through the intervening chalk and earth into the said well, and pumping into the said summit level of the canal a portion of the water of the river Bulbourne, which would as the usual and natural course of the river have flowed to the mills of the plaintiffs and been applicable to the working thereof, whereby the plaintiffs have been prevented from working their mills so beneficially as they otherwise might and could and would have done, are a violation of the 38th George 3rd, chap. 16, and the articles of agreement of the 11th of September, 1817, or either and which of them, as would render the company liable to an action, irrespective of the said act of parliament and agreement." The Lord Chief Baron says: "We are of opinion that the taking away the water of the rivers, or the supply of the rivers from springs and percolations, by means of the well is a breach of the agreement and also of the act of parliament." The subject is dismissed with this simple assertion of the right, and we are not in possession of the reasoning by which the court arrived at that conclusion. Another point decided in that case, namely, that the company by sinking the well had broken their agreement, rendered the rights of the parties at common law immaterial to the decision of the case, and which may account for the dismissal of this novel point with so little observation. And in Broadbent and Ramsbottom, 11th Exchequer, 602, the case having been cited in arguments, Baron Parke observed that only decided that if a person had a right to a stream *jure naturæ* he had a right to its subterranean course.

If it went beyond that it appears to have been repudiated by the same court, in both Rawston and Taylor, and Broadbent and Ramsbottom, and I think rightly, and adopting the law as laid down in these two latter cases, I am of opinion that the action cannot be maintained, and that the judgment of the court below must be affirmed.

Justices EARLE, CROMPTON, WILLIAMS, and CROWDER. } Concurred with Mr. Justice Cresswell.

Justice COLERIDGE dissented.

Judgment of Exchequer in favour of the Croydon Local Board of Health affirmed.

PROGRESS OF RAILWAYS IN WESTERN INDIA.*

BY DR. BUIST.

THE author proceeded to describe the general physical features of Hindostan, as bearing upon the construction of railways. The physical character of the country gave rise to three separate systems of railways,—the Deltoid, the Ghautee, and the Concanny, each with its separate facilities and difficulties. The Deltoid, traversing the deltas of the Indus and the Ganges, with an ascent of four or five feet per mile, relieved the engineer of all anxiety about curves and gradients; but then there were the inundations to be encountered, enormous viaducts to be constructed, and river courses to be crossed. For hundreds of square miles not an ounce of stone was to be found; and the clay required to be burnt into a sort of mongrel brick, to be broken up for ballasting. In the Ghautee system materials of all descriptions, and of the best quality, were abundant; but the skill and ingenuity of the engineer were taxed to ease curves and gradients in surmounting a mountain mass from ten to twenty miles across, and from 2000 to 3000 feet in elevation. The great difficulty with the Concanny railways lay in the vast rivers and ever-recurring salt-water creeks, sometimes a mile in breadth, which had to be crossed, and where a cheap and easy sea conveyance had to be competed with.

The lecturer then proceeded to give a history of the introduction of railways into India, from the period when Mr. Vignolles, in 1838, brought before the Court of Directors a scheme for constructing, at the government charge, great trunk lines from Bombay to the nearest accessible point of the Ganges, and so down to Calcutta; from Bombay across the Deccan to Madras; and from the Coromandel to the Malabar coast; and all these lines have, of late years, been taken up, nearly as originally projected. After going over the history of the difficulties and delays to be surmounted, with special reference to the provisions of the guarantee, the lecturer proceeded to describe the operations on the spot, restricting his observations to those on the great Peninsular line. The work was commenced in 1851, and the first twenty-four miles were opened in 1853. Further sections were opened in the following years. Up to May last nearly ninety miles were completed, and in use; 220 more, now far advanced, were engaged to be finished in 1859, with the exception of a break of fifteen miles at the Bhore Ghaut, the completion of which could not be depended on before 1862. There were at present 30,000 native workpeople employed by the contractors, and they were found docile, peaceable, and orderly, happy in realising three or four times the amount of income they had ever before enjoyed.

Working surveys had now been completed by the Peninsular Company, the gross estimated cost of construction being nine millions sterling. Of this, nearly two millions were incurred by the Ghaut ascents, which cost upwards of 40,000*l.* a mile, making the net cost, including many heavy bridges and viaducts, 5000*l.* a mile. Between June 1855-56, when only a small portion of the line now open was completed, 40,000 tons of goods, and 500,000 passengers, had been carried without the occurrence of a single accident. The following were the mileage rates and charges:—First-class travellers, 2½*d.* per mile; second-class 1½*d.*; and third-class, ¾*d.* The average distances travelled by each class were, first-class, 31 miles; and second and third-class, 17 miles each journey. 10,000 people were employed in the Ghauts, and the same number on the works to Sholapore. A very high eulogium was passed on the engineers and contractors, whose skill and conduct were spoken of as sources of pride to Englishmen. In the Bhore Ghaut there were 17,000 persons employed, and a ton of gunpowder was expended daily in blasting the rocks. The cost of this cutting was estimated at 620,000*l.*

From the extreme hardness of the trap rock, the workings on the Bombay line seem to be much more difficult and tardy than those on the Sœmmering, in the Austrian Alps;—the latter is now open. Excursion trains at almost nominal charges had been tried, but were scarcely ever resorted to by the natives, who never travelled except on business,—who took no pleasure in the beauties of nature, and who bestowed their leisure in gaming or sleep. The Bhore Ghaut works, though only three hours' journey from the Presidency, had been visited but by few. They abound in the most beautiful mineral specimens in the world. Collections of them were to be met with in London, but not in Bombay! An attempt had at one time been made by the native directors to exclude low caste men from the carriages,—but they had been overruled. Men of all castes now travelled cordially together; and railways would thus prove to be the means of breaking down one of the most powerful institutions for retarding civilisation.

* Abstract of a Lecture delivered before the Asiatic Society

CONVERSION OF STEEL.

AT the meeting of the Society of Arts, on the 27th ult., Mr. Christopher Binks read a paper "On some Combinations and Phenomena that occur among the Elements engaged in the Manufacture of Iron, and in the Conversion of Iron into Steel." He remarked that the generally received theory of the formation and composition of steel was not perfectly satisfactory. Carbon had been generally considered the only element essential to the conversion of iron into steel, and other matters that analyses might have detected in it, in minute quantities, had been looked upon as foreign and accidental only. In this light the small portions of nitrogen and manganese sometimes detected had not been regarded. In attempting to throw any new light upon this subject some suggestive facts might be discovered among the ordinary processes employed by the steel makers. The very old practice of using ferro-cyanide of potassium as an agent of conversion was worth consideration. This compound contained nitrogen and potassium as well as carbon. Mr. Binks then proceeded to give the details of a series of experiments made by exposing commercial malleable iron to the action of various substances at a high temperature, and, as far as these trials extend, there has always been a co-operation of both carbon and nitrogen whenever steel has been produced. though it still remains to be determined whether this is absolutely necessary to its formation. It was also remarkable that various nitrogenous matters, such as horn and leather shavings, animal charcoal and other substances, were commonly used either in the manufacture or in the tempering of steel.

Mr. Binks then gave an account of some analyses made by himself, which proved that the best kinds of steel contain about one-fifth per cent. of nitrogen, the general results of his experiments tending to show:—That the substances whose application to pure iron convert it into steel all contain nitrogen and carbon, or that nitrogen has access to the iron during the operation. That neither carbon nor nitrogen, used separately, converts iron into steel, but that it is essential that both nitrogen and carbon should be present. That nitrogen, as well as carbon, exists substantially in steel after its conversion, and that this is the real cause of the distinctive physical properties of steel and iron, in which latter these elements do not exist. That presumptively, but not demonstratively, the form of combination is not that of cyanogen (though that compound plays so important a part in conversion), but is apparently that of a triple alloy of iron, carbon, and nitrogen.

With regard to improvements in the present system of manufacture, Mr. Binks was of opinion that the more extensive use of cyanogen compounds was highly important, and he drew particular attention to the fact that these compounds might be economically formed in the ordinary operations of the blast furnace, and, at the same time, might subserve the purpose of purifying the metal and converting it into steel.

NOTES OF THE MONTH.

The vast floating landing-stage recently made by order of the corporation of Liverpool is all but completed. It will be 1002 feet long and 82 feet wide; communication with the shore will be obtained by four cast-iron bridges, each 113 feet long and 13 ft. 6 in. wide, constructed with tubular girders, similar to those employed in the Britannia-bridge. The engineer is Sir Wm. Cubitt, and the contractors for the entire work Messrs. Cochrane, of Dudley. The cost is put at 140,000*l*. The sub-contractors are Messrs. T. Vernon and Son, Liverpool, and Messrs. Fairbairn, Manchester.

The heat-resisting qualities of an equipment, consisting of helmet, shield, gloves, coats, and boots, in fact, a complete suit made of "amianthus," a filamentous mineral worked in wire gauze, has been tested in Paris. Firemen dressed in such suits have walked through circles of flame and on burning materials, and withstood heat of a degree of intensity unbearable to those within five yards of its exterior. Three remained two minutes forty-four seconds in the flames—their pulses rose from 72, 82, and 88, to 124, 138, 152 respectively. They said they had experienced no peculiar painful sensation, save that of excessive heat.

A resolution, commendatory of the Suez Canal project, has been passed by the directors of the Manchester Commercial Association, and transmitted to M. F. de Lesseps, by the secretary, Mr. Fleming. The promoters of the scheme rely principally on the steam mercantile navy, which they show by statistics increases in comparative importance each year. They add that the unfavourable notions hitherto entertained respecting the navigation of the Red Sea, have been removed by the experience of the Peninsular and Oriental Steam Company.

Mr. W. T. Henley, of St. John-street road, calls in question the feasibility of Mr. Allen's plan of employing a small cable without an exterior wire covering for submarine telegraphs. Mr. Henley instances the case of the first rope laid between Dover and Calais, that between Holyhead and Kingstown, and that between Scotland and Ireland. Two of these were cut up and appropriated by fishermen, and none remained sound beyond the first three or four days.

A scheme is under consideration for the formation of a bridge, based or moored on pontoons, across the Hooghly, at Calcutta, to the terminus of the railway at Howrah. The cost of such a structure has been estimated at from 125,000*l*. to 150,000*l*. A more solid and permanent railway bridge, at an expense of 500,000*l*, has been mooted; but it is considered a great object to have some sort of communication, at once to supersede the present inconvenient mode of crossing; and besides, borings have shown that there was no foundation for a massive structure in the bed of the river, nothing having been found but a light and loose soil and quicksands, even to the depth of 37 feet from the surface of the river bed. Objections, such as the bore wave, hurricanes, &c. have been considered, but are not thought to be at all vital. The bridge would be so made as to open for the passage of vessels, and to fall or rise at the river banks, so as to suit the tides. The roadway would be 26 to 30 feet broad, or sufficient for three carriages abreast, with a footpath on either side. Plans and a report have already been prepared by Captain Dicey, first assistant master attendant, at Calcutta, and approved by Captain T. E. Rogers, superintendent of marine there.

The fire-proof building erected to receive Mr. Sheepshanks' munificent gift, being on the point of completion, that gentleman has handed over the whole of his pictures and drawings to the Department of Art; and we understand that they will be exhibited to the public early in June, when the Museum of Art at South Kensington will open.

Mr. Samuel Angell and Mr. George Pownall, both Fellows of the Institute of Architects, have been appointed assessors to aid the judges in selecting the designs for the Government Offices.

The exhibition of designs for the new Public Offices will be closed on Saturday, June 6th. The models for the monument proposed to be erected to the memory of the late Duke of Wellington in St. Paul's, will be received on or before the 1st of June, from artists residing within the United Kingdom; and on or before the 25th of June, from other artists. Westminster Hall will be opened to the public for the exhibition of these models early in July, and those designs for public offices which shall have been selected by the judges to receive the premiums, will be exhibited at the same time.

OBITUARY.

April 1, at Rio Janeiro, of yellow-fever, James Harris, C.E., son of the late James Harris, of Wittersham, Kent, aged 34.

April 5, at Rio Janeiro, of yellow-fever, Thomas Edward Clinger, C.E., aged 35 years.

On the 15th ult., Mr. Daniel Rowlinson Hill, borough architect, of Birmingham. Among his principal works are the borough gaol and lunatic asylum at Birmingham. He had lately distinguished himself in the erection of prisons. The Surrey gaol was his work; he was also engaged to erect the county prison at Lewes; and, at the time of his death, he and his partner, Mr. W. Martin, were employed in designing or executing several of these important buildings in various parts of England. The Birmingham Architectural Society, at its annual meeting since held, resolved—"That, in consequence of the death of the respected member and first president of the society, Mr. Hill, all the business of the meeting should be postponed, and the members should manifest their respect by attending the funeral."

COMPETITIONS.

The Committee for the erection of a Testimonial Building to Herbert Minton, Esq., and for Public Baths for Stoke-upon-Trent, are desirous of receiving Designs for the same, including Plans, Elevations, Specifications, and Estimate. The cost not to exceed 2500*l*. The approved design will become the property of the Committee. Should the successful architect agree to superintend the execution of his design, the premium will merge in the usual commission for the necessary drawings and superintendence. The drawings to be forwarded by the 22nd instant, to Mr. William Dean, High-street, Stoke-upon-Trent. Premium of 40*l*. for the best design.

Models or Designs are required for a Monument to be placed over the grave of the late Joseph Brotherton, Esq., M.P. Premium, 20 guineas. Information of David Chadwick, Town Hall, Salford; William Martin, Town Hall, Manchester; William Foyster, Piccadilly, Manchester, Honorary Secretaries. Models or designs to be sent in by the 1st July.

The Council of the Borough of Brighton are desirous of obtaining Designs and Plans for appropriating the northern buildings comprised in the Pavilion Estate. 200*l*. will be paid for the best, and 50*l*. for the second-best designs. Designs to be sent in by the 10th July next, to Mr. Charles Sharood, Town Clerk, Brighton.

Plans and estimates are wanted for alterations and additions required to the County Gaol, Kilmainham, Ireland, in order to carry out the separate system. Premiums, 25*l*., 15*l*. and 10*l*.

Designs are invited for a Monument to be erected at Sheffield, to such natives of the town as perished in the war with Russia. The monument is proposed to be of an architectural character, embodying incidents of the late war, and on which spaces must be arranged so that the name of every man commemorated may be legibly inscribed. The style, size, and material of the monument to be left entirely to the competitors. The cost of the whole complete not to exceed 1200*l*. For the best or selected design a premium of 30 guineas will be accorded, and for the second best 20 guineas. Such designs to become the property of the Committee. The premium for the best design will be given in addition to the usual commission. All designs must be on the scale of one quarter of an inch to a foot, and must consist of plans, elevations, and specifications, and be sent in or on before the 15th August next, addressed to the Town Clerk, Sheffield. The designs will be afterwards publicly exhibited.

The Metropolitan Board of Works have given notice that they wish to receive designs from Architects, Engineers, and others, showing the best mode of laying out the surface and subsoil of an intended new street in Southwark, as an example of a first-class street, and of an intended new street between Cranbourn Street, Leicester Square, and King Street, Covent Garden, as an example of a second-class street, and showing any improved means of facilitating the traffic and the better disposition of the private vaults, sewers, drains, gas and water pipes, telegraph wires, &c., with such underground or surface arrangements as may be adapted to those and other useful purposes.—Premiums for first-class street, 100, 50, and 10 Guineas; for second-class street, 50, 25, and 5 Guineas.—The width of the first-class street will be 70 feet from front to front of the houses, and the level of the invert of the sewer at the junction of Stamford Street and Blackfriars Road, will be 1·40 above Ordnance datum; the invert at Wellington Street, London Bridge, 0·75 above Ordnance datum, and the area of the sewer 14 superficial feet.—The lowest level of the crown of the road is to be 12·55 above Ordnance datum; length of street, 1130 yards. The width of the second-class street, will be 50 feet from front to the front of the houses, and the level of the invert of the sewer, in St. Martin's Lane, 50·69 above Ordnance datum; the invert of the sewer in King Street, 57·32, above Ordnance datum, and the area of the sewer, 8 superficial feet. The lowest level of the crown of the road is to be 67·9 above ordnance datum; length of street, 135 yards. It is an essential condition of a first-class street, that it should contain facilities for the supply of gas, water, telegraph, and sewer communications to the houses on each side of the street, and also leading mains for an entire surrounding district. A second-class street must contain facilities for the supply of gas, water, telegraph, and sewer communications to the houses on each side of the street, without provisions for the surrounding district.—The designs to be on double elephant drawing paper, drawn to a scale of half an inch to a foot, and must comprise a plan, a longitudinal section of a portion of the street taken down the centre, longitudinal section near the line of the houses, and also a transverse section, with such descriptive details as can be shown on one sheet of double elephant paper; the drawings to be in line, and shaded (if and where necessary) in Indian ink, or sepia only. The plans must embrace service connections, of gas and water pipes, &c., and surface paving for foot and road ways; provision must also be made for surface drainage, comprising gullies, channels, &c. Every design must be accompanied by an estimate of the cost per lineal yard for each class of street. It is proposed that the designs shall be publicly exhibited after the decision.—Robert Stephenson, M.P.F.R.S.; Thomas Hawksley, C.E.; Thomas H. Wyatt, F.R.I.B.A., A.C.E.; and George Lowe, F.R.S., C.E. will be associated with a committee consisting of John Thwaites, Chairman of the Metropolitan Board of Works, and Alderman Cubitt, M.P., and Alexander Wright, members of the Board, assisted by the Engineer and Superintending Architect of the Board, for the purpose of deciding upon the merits of the designs. Further information may be obtained on application to the Superintending Architect, at the Office of the Metropolitan Board of Works, Greek Street, Soho Square. The Designs to be sent in by the 1st day of July next, to E. H. Woolrych, Clerk of the Board.

NEW PATENTS.

PROVISIONAL PROTECTIONS GRANTED UNDER THE PATENT LAWS AMENDMENT ACT.

Dated February 12.

412. T. Turner, Grosvenor-street, Commercial-road East, and H. Boyens, George-street, Commercial-road East—Improvements in apparatus for steering ships and vessels, and in apparatus for communicating or signalling between the deck and engine-room of steam vessels

Dated March 6.

656. J. King, St Swithin's-lane—Improvements in the manufacture of boots and shoes. (Communication)

Dated March 9.

680. J. A. Cumine, Belfast, and C. Hunter, Islandreagh—Improvements in electro-magnetic engines and batteries

Dated March 17.

744. C. Askew and J. Askew, Charles-street, Hampstead-road, and H. Myers, Upper Charlotte-street—Improvements in hydraulic and refrigerating apparatus for the purpose of raising sunken vessels, anchors, and all other submerged bodies, with light and other certain apparatus used for the same purposes
747. Sir F. C. Knowles, Lovell Hill, Berks—Improvements in the manufacture of cast steel

Dated March 20.

779. H. Hall, Spotland, Rochdale—An addition to throstles for doffing the bobbins.
780. E. Gripper, Winchester-wharf, Bankside—The treatment of the fruit or vegetable "algorabas," and in the application of the same as food for cattle
781. C. Weiss and H. Lister, Huddersfield—Improvements in the means, machinery, or apparatus employed in the finishing of mohair and other textile fabrics
783. J. Parker, East Markham, near Tuxford, Nottingham—Improvements in apparatus for separating corn and other grain and seeds from dust, chaff, and other matters
785. J. P. Jourda, New York—Raising sunken vessels

Dated March 25.

830. G. D. Early and J. W. Edmonds, Camberwell—Method of producing glass designs, figures, and patterns

Dated March 26.

847. D. Tomasini, Great Coram-street—Improvements in the construction of easy-chairs and chamber commodes
848. J. J. C. Benoise, Rue Jerusalem, Brussels—A new method of applying marks on paper for postal purposes.
849. A. F. Butler, Ceylon—Improvements in machinery for pulping coffee
850. J. L. Clark, Adelaide-road, Haverstock-hill—Improvements in lighting coal-mines
851. J. J. Palmer, New York, United States—Improvements in the construction of steam boilers.
852. J. Morris, Albert-square, Clapham-road—Improvments in connecting the rails of railways
853. G. White, Port Glasgow, Renfrew—Improvements in weaving
854. F. Rualem, Rue de Paris, Belleville, France—Improvements in railway-breaks. (Communication)

Dated March 27.

855. E. Von Löwenstein, New-street, Bishopgate-street—Improvements in the construction of ovens for the manufacture of coke
856. A. Delon, South-street, Finsbury—Improved mould for the manufacture of buttons
857. E. Hochstetter, Paris—The employment for motive purposes of sulphuret of carbon, an agent not hitherto so used. (Communication from A. Seyferth, Langens-alza, Prussia)
858. E. A. Spurr, Newton-road, Bayswater—Improvements in fire-places, chimney, and stove-grates
859. G Sugden and J. Briggs, Bradford—Improved machinery for weaving checks or figured fabrics
861. C. Martin, Castle-street, Reading—Improvements in working signal apparatus on railways
862. J. Ward, Glasgow—Improvements in the manufacture or production of manures or fertilising agents
863. W. Ross, Glasgow—Improvements in apparatus for regulating the passage of fluids.

Dated March 28.

864. D. Thomson, Pimlico—Improvements in rotary pumps
866. F. Josea, St. Helen's Colliery, near Bishop's Auckland—Improvements in furnaces and ovens for the prevention of smoke and for economy of fuel
867. E. B. Beaumont, Woodhall, Barnsley—Improvements in lamps and apparatus used in coal mines
868. R. Russel, Manchester—Improvements in railway turntables
869. H. B. Girard, Paris—Improvements in insulating telegraphic wires or conductors, and in apparatus for stretching such wires
870. L. E. Deplanque, Rue de l'Echiquier, Paris—An improved composition for sharpening and setting fine-edged cutting instruments
871. J. J. Russell, Wednesbury—Improvements in the manufacture of metal tubes
872. J. Thursfield, Congleton, Chester—An improved water-ram for raising water

Dated March 30.

873. A. Neild, and N. B. Sutcliffe, Ashton-under-line—Improvements in treating or cleansing certain descriptions of cotton waste
875. D. Jack, Glasgow—Improvements in washing or cleansing textile fabrics and materials
876. J. Scott, Glasgow—Improvements in bottles, and their stoppering or closing details
877. W. Childs, jun., Brighton—Improvements in the construction of expansible boxes, cases, and receptacles
878. J. J. Cudworth, Ashford, Kent—Improvements in locomotive boiler furnaces
879. J. H. Johnson, Lincoln's-inn-fields—Improvements in warming and ventilating apartments. (Communication from D. Leasure, Newcastle, Pennsylvania, United States)
880. R. H. Thomas, Kidsgrove, Stafford—Improved machinery for converting plastic substances into spherical forms or balls
881. A. Granger, High Holborn—An improved manufacture of safety envelope

Dated March 31.

882. J. E. D'Arcet, Paris—Improvements in distilling and rectifying tar, resins, oils, turpentine, bitumen, and other matters, and in the apparatus for the same
884. H. Francis, West Strand—Improvements in machinery for ploughing and working land
885. J. C. Evans, South Lambeth—Improvements in railway rolling stock
886. G. Hamilton, Blackland Mill, Paisley—Improvements in the treatment or finishing of woven fabrics
887. J. S. Goode, Aston, near Birmingham—An improvement or improvements in depositing metallic alloys by electricity
888. F. C. Hills, Deptford—Improvement in manufacturing gas, and in apparatus connected therewith
889. G. Lauder and T. Ireland, Dumferline—Improvements in the manufacture of brine to be used in the manufacture of salt
890. J. Wright, Hemel Hempstead—An improved method of bleaching straw plait and straw. (Communication)
891. J. Graham, Ann-street, Commercial-road East—An improved steering apparatus
892. W. Glover, Manchester—Improvements in looms for weaving
893. A. H. A. Durant, Conservative Club, St. James's—Certain improvements in omnibusses

Dated April 1.

894. R. A. Wright, Batignolles, near Paris, and L. J. Fouché, Paris—A new apparatus destined to produce chemical decompositions by means of superheated steam and water
896. W. S. Burton, Oxford-street—A new or improved manufacture of rollers or cylinders for printing fabrics
900. J. Leslie, Glasgow—Improvements in the treatment of wash waters containing soap, oils, saponified or saponifiable matters, for the obtainment of products therefrom. (Communication)
902. W. Smith, Glasgow—Improvements in the manufacture or production of ornamental fabrics
904. R. Wardell, Stanwick, York—Improvements in reaping machines
906. H. Smith, Stamford—Improvements in chaff-cutting machines
908. J. Crossley, St. Helen's, Lancashire—Improvements in machinery for smoothing glass
910. R. Martin, Cambridge-road, King's-cross, and J. W. Sutton, Lamb's Conduit-street—Improvements in the means of giving alarm in dwelling-houses and other buildings in cases of robbery, fire, or other emergencies

Dated April 2.

912. F. A. Laurecisque, South-street, Finsbury—An improved system of constructing dissected maps or charts
914. R. Husband, Manchester—Improvements in the manufacture of hats and other coverings for the head, and in the instruments employed in the said manufacture
916. D. Morrison, Bordersley Works, Birmingham, and S. Lilley, Birmingham—An improvement or improvements in locks
918. R. Otway, Lambeth—An improvement in scythes
920. R. A. Brooman, Fleet-street—A steam windlass and boiler for the same, together with certain modifications to enable the windlass to be worked by hand. (Communication)

Dated April 3.

922. W. Hardman and J. Dugdale, Farnworth, near Manchester—Improvements in machinery for preparing cotton, flax, wool, or other fibrous materials
924. W. Holland, Birmingham—A new or improved manufacture of runner notches and top notches for umbrellas and parasols
926. W. H. Taplin, London—Improvements in the construction of fire-places and stoves
928. J. Smith, Bradford—Improvements in machinery or apparatus used in the manufacture of brushes for flour-dressing machines
930. A. Paget, Loughborough, Leicester—Improvements in machinery or apparatus for the manufacture of looped fabrics, and in the manner of constructing the same
932. T. Whitehead, Leeds—Improvements in spinning flax, tow, and hemp
934. J. H. Johnson, Lincoln's inn-fields—Improvements in the treatment of floss silk. (Communication from E. Royer and F. Rouse, Paris)

Dated April 4.

936. J. F. Toussaint, Brussels—A method for facilitating the examination and discovery of fissures, flaws, or deteriorations in the inserted or hidden parts of axles or other like pieces of machinery subject to decay and rupture
938. G. Spencer, Cannon-street West—Improvements in machines used for facilitating the discharge of coals, minerals, earths, and other similar materials, from waggons used on railways, tramways, and common roads
940. E. Adler, New York, and R. P. Abernethy, Cincinatti, Ohio, United States—Improvements in machines for cleaning knives and other similar articles
942. C. Renshaw, Dukenfield—Improvements in self-acting differential valves
944. J. Milnes and W. Mowbray, Bradford—Improvements in lubricating the pistons and valves of steam-engines
946. J. Mead and G. Mead, Bethnal-green—Improvements in metallic and other packing boxes or cases
948. J. H. Johnson, Lincoln's-inn fields—Improvements in the manufacture of hard india-rubber. (Communication from A. Morey, Paris)
952. J. P. Harvey, Spalding, Lincoln—Improved machinery for crushing land or clods
954. W. Perks, jun., Birmingham—A new or improved manufacture of crown and sheet glass
956. J. J. Rippon, Oakenshaw Print Works, near Accrington—An improvement or improvements in rollers or cylinders for printing fabrics

Dated April 6.

960. C. Burrell, Thetford—Improvements in portable steam-engines suitable for agricultural purposes
966. C. Goodyear, Leicester-square—Improvements in the manufacture of waterproof boots and shoes, applicable also in part to boots and shoes of other kinds, and to other outer coverings for the feet
968. J. M. Siblet, South-street, Finsbury—An improved pulp for the manufacture of paper

Dated April 7.

970. E. Rogers, Abercarn, Monmouth—Improved methods of applying fuel for heating purposes
972. J. G. Hunt, Cincinnati, Ohio, United States—Improvements in fences and gates
974. G. Pearson, Oldham, and E. Jessop, Manchester—Improvements in sewing machines
976. J. Robinson, Glossop, Derby—Improved apparatus for driving or giving motion to power looms, which said improvement is also applicable to driving other machinery
978. C. Cochrane, Ormesby Iron Works, Middlebro'-on-Tees—Improvement in the heating of the blast for blast furnaces

Dated April 8.

982. B. Taylor, Cranbrook, Kent—Improved arrangement of combined bed and utensil for the use of invalids
984. R. K. Bowley, Charing-cross—Improvements in boots and other similar coverings for the feet
986. M. Billing, Birmingham—Improvement or improvements in the manufacture of metallic cornice ends
988. A. Francis, Encomb-terrace, Wandsworth-road—Improvements in fastening shutters and doors
990. C. T. Bright, Harrow Weald, Middlesex—Improvements in laying down submarine telegraph cables, and in apparatuses to be employed therein
992. J. W. Rogers, Peat House, Roberts Town, Kildare—Improved means of, and apparatus for, collecting for use the excrement of towns and villages, and for facilitating the drainage of houses generally

994. A. V. Newton, Chancery-lane—Improvements in hand bullet moulds. (Communication)

Dated April 9.

996. E. Brooks, Birmingham—Improvements in the manufacture of fire-arms
998. W. Oxley and H. Strath, Manchester—Improvements in lubricators
1000. T. Rolfe, Regent-street—Improvements in pianofortes
1002. H. Thompson and H. Walmesley, Great Harwood, near Blackburn—Improvement in looms for weaving
1004. C. F. Bielefeld, Wellington-street, Strand—Improvements in preparing the surfaces of slabs or sheets made of fibrous and cementing materials
1006. G. E. Taylor, Oatlands Mill, Leeds—Improvement in raising and shearing cloths
1008. R. Turnbull, Harwich, Essex—Improvements in slips or ways for heaving up and moving ships, and in cradles for the same
1010. J. Leach, Over Darwen—Improvements in looms for weaving
1012. J. C. Haddan, Cannon-row, Westminster—Improvements in the manufacture of, and in the means of, and apparatus for, discharging projectiles

Dated April 11.

1016. W. Smith, Salisbury-street, Adelphi—A universal Jacquard apparatus. (Communication from C. Anciot, Rouen, France)
1018. C. Smith, Holloway, Middlesex—An apparatus to be used in connection with certain domestic utensils
1020. H. F. Courenq, Essex-street, Strand—Improvements in machinery for ruling paper
1024. R. A. Brooman, Fleet-street—Improvements in the distillation and rectification of spirits, in apparatuses employed therein, and in the preparation of the substances to be distilled. (Communication)
1026. W. G. Wiles, Lady's Well Brewery, Cork—Improvements in brewing
1028. T. N. Pengelly, Gloucester-street, Commercial-road-east, and G. Porter, Mary Ann-terrace, Abbey-street, Bethnal-green-road—Improvements in the application of steam to lifting or hoisting coals and other goods from ships' holds
1030. T. R. Winder, Dover—Improved mode of constructing submarine works
1032. H. Adcock, City-road—Improvements in steam-boilers

Dated April 13.

1034. T. J. Searle, Portland Wharf, Shadwell—Improvements in fastenings for window sashes
1036. T. Richardson and E. J. J. Browell, Laboratory, Neville Hall, Newcastle-on-Tyne—Improvements in treating old or waste railway wood sleepers and bearers, and in preparing or preserving wood for railway sleepers and bearers, and other works
1038. C. Goodyear, Leicester-square—Improvements in the manufacture of life-preserving apparel, and other buoyant pliant articles
1040. A. E. Schmersahl, Miles Platting, Lancaster—Improvements in treating bones for the purpose of obtaining gelatine, size, or glue, and in obtaining certain useful products from such treatment
1042. R. A. Brooman, Fleet-street—A method of, and apparatus for, disinfecting alcohol, or for separating essential oils therefrom. (Communication from H. Breton)
1044. T. G. Potter, New Oxford-street—Apparatus for day and night advertising

Dated April 14.

1048. R. Hazard, Thanet-place, Strand—Improved heat extractor
1050. C. J. M. Lavigne—Improvements in machinery or apparatus for swinging, seesawing, revolving, and for performing other exercises or amusements in the air
1052. T. Harrison, Nebthwait Mills, Lancaster—New or improved machinery for the manufacture of wooden pill-boxes, match-boxes, and other such like articles.
1054. B. O'Neale Stratford, Earl of Aldborough—Improvements in aerial navigation, and in the apparatus connected therewith, parts of which are applicable to locomotion generally
1056. J. H. Johnson, Lincoln's-inn-fields—Improvements in apparatus for generating and super-heating steam. (Communication from A. Prouvost, Lille, France)
1058. J. H. Johnson, Lincoln's-inn-fields—Improvements in fire-arms. (Communication from F. Schepers, Liege, Belgium)
1060. W. E. Newton, Chancery-lane—Improved means of lighting gas for illuminating and other purposes. (Communication)

Dated April 15.

1062. R. Knowles, Manchester—Improvements in power looms for weaving
1064. L. Barnett, New-street, Bishopsgate—Improvements in the making and cutting out of garments
1066. C. Goodyear, jun., Leicester-square—An improved manufacture of paper-knife
1068. J. Payne, Kirkcudbright—Improvements in scythes
1070. J. Safran, Wellclose-square—Improvements in locking or fastening combinations of drawers in chests, tables, nests, or otherwise

Dated April 16.

1072. J. Sudbury and A. W. Lissell, Halstead, Essex—Improved gas regulator
1074. T. and F. Sugden, Oldham—Improvements in sewing machines
1076. W. Weild, Manchester—Improved arrangements for printing, dyeing, colouring, or staining and otherwise preparing yarns or threads for various manufacturing purposes
1079. I. Sherwood and J. B. Wayne, Birmingham—Improvements in certain apparatus to be attached to vehicles for the purpose of acting as a check upon the drivers or conductors of such vehicles, by indicating the number of passengers carried and the distance each has travelled.
1080. J. Warburton, Addingham, near Otley, York—Improvements in preparing and combing wool and other fibres
1081. J. Hands, Epsom—Improvements in kilns, and in furnaces and flues for withdrawing air and vapours from drying and other chambers
1082. J. Warburton, Addingham, near Otley, York—Improvements in carding machinery
1083. S. Newington, Ridgway, Ticehurst, Sussex—Improvements in structures for growing grapes and other fruits
1084. J. Warburton, Addingham, near Otley, York—Improvements in preparing and combing wool and other fibres
1085. W. Smith, Salisbury-street, Adelphi—A smoke-consuming furnace. (Communication from Messrs. Sebille, Bartholomey, and Mariotte, Paris)
1086. P. A. le Comte de Fontainemoreau, South-street, Finsbury—Improved truck apparatus for moving and transporting stones and other heavy bodies. (Communication)
1087. G. Schaub, Birmingham—A new or improved manufacture of types for printing

Dated April 17.

1088. E. Oldfield, Adelphi Ironworks, Salford—Improvements in self-acting mules for spinning and doubling. (Partly a communication)
1089. S. Messenger and T. Fletcher, Birmingham—Improvements in gas-burners
1090. J. M. L. Caillaud, Marshgate-lane, Stratford—Improvements in removing the fur from the skins of rabbits, and in preparing rabbit, calf, and other skins for tanning
1091. G. Arthur, Linares, Spain—Improvements in the manufacture or production of bricks, tiles, and other articles of earthenware

Dated April 18.

1092. J. Smith, Kidderminster—Improvements in the manufacture of carpets
1093. H. Duhamel, jun., Clichy-la-Garenne, near Paris—Improvements in the fabrication of glass
1094. T. Harris, Shiffnall, Shropshire—Improvement in the mode of constructing and applying horse-shoes
1095. J. Wylie, Edinburgh—Improvements in piano-fortes
1096. D. H. Brandon, Bedford-row—Improvements in fastenings for shutters, windows, doors, &c. (Communication)
1097. G. Davis, Searle-street, Lincoln's-inn—Improvements in the method of laying underground telegraphic wires. (Communication from M. S. Goddier and H. E. Goddier, Paris)
1099. H. D. Deane, Pigott-street, East India-road, Limehouse—Improvements in the floats or paddle boards of paddle wheels
1100. G. Jahn, Bedford-row—Improvements in revolver fire-arms
1101. H. Heald, Sabden, Whalley, Lancaster—Improved method of packing pickers employed in looms
1102. C. R. Barnes, New York, United States—Improvements in means for hulling and cleaning rice, and other grains having a hull or husk
1103. C. B. Normand, Havre, France—Improvements in generating motive power by the employment of heated air, steam, and gases

Dated April 20.

1105. T. Sanderson, Lothian-road, Edinburgh—Improvements in wheeled carriages
1106. R. F. Sturges, Birmingham—A new or improved manufacture of metallic pens
1107. J. C. Martin, Firn Cottage, Charlewood-road, Putney—Improvement in the manufacture of paper
1109. W. Thompson, Dalkeith-gardens, Midlothian—Improvements in stoves or heating apparatus
1110 R. Tindall, jun., Fraserburgh, Aberdeen—Improvements in harpoon guns and ammunition
1111. J. S. Jarvis, Wood-street—An improvement in the manufacture of stocks or ties for the neck
1112. J. Underwood, Gloucester-road—An improved method of printing, and of preparing materials employed therein
1113. W. Clay, Liverpool—Improvements in the manufacture of iron and steel
1114. W. E. Newton, Chancery lane—Improvements in meters for measuring the flow of gas, water, or other fluids. (Communication)
1115. T. G. Treeby, Westbourne-terrace-villas, Paddington—Improvements in syphons and parts connected therewith

Dated April 21.

1116. H. Wimball, Aldermaston, Berks—Improvements in pug mills
1117. B. A. Fournier, High Holborn—Preventing on railways those accidents that occur through one locomotive running into another
1118. W. Crighton, Manchester, and P. Foxcroft, Pendleton—Improvements in machinery or apparatus for preparing cotton, wool, or other fibrous substances to be spun
1119. A. F. Sherman, Roxbury, Norfolk, Massachusetts—Improvements in machinery for the manufacture of ropes, strands for ropes, and for other purposes
1120. W. Gossage, Widnes, Lancaster—Improvements in the manufacture of certain kinds of soap
1121. A. V. Newton, Chancery-lane—Improvements in rules and other measuring instruments. (Communication from M. Siegrist, Dornach, France)
1122. E. Marten, Pratts-row, Phipps Bridge, Mitcham—Improvements in apparatus for regulating the pressure and supply of gas
1123. J. Chanter and D. Annan, Bow—Improvements in furnaces when moveable firebars are used
1124. H. Smart, Queen's-terrace, Bayswater—Improvements in organs
1125. D. Colladon, Paris—Improvements in means and machinery for boring and cutting stone, earth, and other like substances, and for ventilating the places where such machinery is employed

Dated April 22.

1127. W. Steel, Glasgow—Improvements in discharging ashes from steam-boats
1128. T. Burton, Padiham, and S. Lord, Burnley, Lancaster—Improved self-acting, steam-pipe regulator, which is also applicable to drying cylinders, and other similar purposes
1129. J. Higgin and J. Lightfoot, Manchester—An improved compound and improvements in the method of applying the same for the purpose of stiffening fibrous or textile materials, the same being applicable to the fixing of colouring matters or pigments
1130. W. Williams, Liverpool—An improved propeller for propelling ships, boats, and other vessels
1131. W. Ogden and H. Firth, Bacup, Lancaster—Improvements in fans or blowing apparatus
1132. W. Kendall, Blawith, Ulverstone—Improvements in the manufacture of boxes and similar articles, and in the machinery or apparatus to be employed therein
1133. J. H. Johnson, Lincoln's-inn-fields—Improvements in sewing-machines. (Communication)
1134. R. Taylor, R. Worswick, and J. Lovat, Ipswich—Improvements in railway chairs, and in the mode of securing the ends of rails therein
1135. G. Cavanna, Genoa—Improvements in obtaining motive power
1136. R. B. Grantham, Great Scotland-yard, and J. Grantham and H. Sharp, Liverpool—Improvements in graving docks
1137. C. E. Osmont, Rue Neuve Coquenard, Paris—Improvements in penholders
1138. W. Robertson, Manchester—Improvements in machines for preparing to be spun cotton and other fibrous materials
1139. W. Rutt, Sutton-place, Homerton—Improvements in microscopes

Dated April 23.

1141. G. Welch, Birmingham—Improvements in metallic pens and penholders
1143. M. Dunnett, Glasgow—Improvements in embroidering or sewing, and in machinery or apparatus connected therewith
1144. J. Morison, Paisley—Improvements in portable shower and sponge baths
1145. D. Milnes, Bradford—Improved manufacture of woven goods or fabrics
1146. G. Scarr and J. Pollard, Burnley—Improvements in power looms for weaving
1147. J. Taylor, Cullen, Banff—Improvements in apparatus for producing fire and light
1148. J. Garnett, Wells-street, Oxford-street—Improvements in the construction of corsets
1149. J. Richard, near Melun, France—Improved agricultural machine for cleaning grains
1150. R. Bodmer, Thavies-inn, Holborn—Improvements in safety valves for steam boilers. (Communication)
1151. G. Wright, Sheffield—Improved apparatus for heating
1152. A. D. Bishop, Woolwich—Improvement in the construction of windlasses
1153. W. C. Cambridge, Bristol—Improvements in chain harrows
1154. A. la Paras, Gloucester-place, Portman-square, and J. Mazel, King-street, Portman-square—Improvements in preparing paints and varnishes. (Communication from Carpentras and Mazel, Paris)
1155. A. P. Rochette, Brighouse, York—Improvement in currying leather
1157. A. P. Rochette, Brighouse, York—Improvements in currying leather

Dated April 24.

1158. R. F. Swift and R. Swift, Wenlock-road, City-road, and J. Cormes, Balmes-road Hackney—Improved machinery for washing, wringing and mangling clothes or fabrics
1159. E. Manico, Bucklersbury—Improvements in obtaining foundations for marine or other structures
1160. W. Clark, Chancery-lane—Improvements in machinery or apparatus for embroidering. (Communication)
1161. J. B. Bellon, Moorgate-street Chambers—Improvements in mordants for use in dyeing processes
1162. T. Craddock, Tachbrook-street, Pimlico—Improvements in the steam-engine and the steam-boiler
1163. J. Caddick and T. Hemmings, Garndyn's Ironworks, and D. Caddick, the Ebbw Vale Ironworks, near Newport, Monmouth—Improvements in puddling and balling furnaces for heating and melting iron or steel

Dated April 25.

1164. M. Smith, Heywood, Lancaster—Improvements in looms for weaving
1165. S. Walmsley, Stockport—Improvements in machinery for preparing and spinning cotton and other fibrous materials
1166. S. Tonks, J. Breeden and W. Breeden, Birmingham—A new or improved gas burner. (Communication)
1167. S. Sunderland and R. Dean, Burnley—Improvements in looms
1168. E. W. Otway, West Bromwich—Improved apparatus employed in descending and ascending pits or shafts, and raising minerals and other bodies therefrom
1169. W. White, Adelaide-street, South Shields—Improvements in making moulds or matrices employed in casting metals
1170. T. Mann, Aldbrough, near Boroughbridge, York—Improvements in horse powers
1171. J. Simpson and E. Rimmer, Manchester—Improvements in Venetian blinds
1172. W. E. Newton, Chancery-lane—The application of certain substances not hitherto used for food, as a source of nutrition and support to the respiratory organs of animals (Communication from H. W. Adams, Brooklyn, New York, United States)
1174. W. Cory, jun., Gordon-Place, Gordon-square—An improvement in the manufacture of coke
1175. J. Burrow, Ashford Parsonage, Bakewell—Improvements in coating wrought-iron
1176. W. Pickstone, Radcliffe-bridge, near Manchester—An improvement in preparing or manufacturing dyeing matter peculiarly applicable to cotton and other vegetable fibres, and useful when dyeing and printing other fibres and fabrics. (Communication)
1177. J. Belshaw, Nottingham—Improvements in manufacturing knit fabrics
1178. A. P. Oldershaw, Doctors' Commons—An improvement in apparatus for skidding the wheels of carriages

Dated April 27.

1179. A. V. F. Larchier, Paris—Improvements in the manufacture of gas. (Communication from M. Lavezzari, Beaurain Chateau, France)
1180. C. Cowper, Southampton-buildings, Chancery-lane—Improvements in electro-plating and depositing metals. (Communication from H. Landois and L. Daniel, Paris)
1181. P. de Keyser, Cannon-street West—An apparatus for preventing horses slipping. (Communication)
1182. W. Thompson and H. Woods, Newcastle-on-Tyne—Improvements in lowering weights by means of cranes, winches, or similar apparatus
1183. E. F. Barnes, New York, United States—Improvements in telegraphic instruments, and called an 'Embossing Telegraph'
1184. P. A. le Comte de Fontainemoreau, South-street Finsbury—Improvements in obtaining motive power. (Communication)
1185. J. Macintosh, Euston-place, Euston-square—An improvement in the manufacture of air-beds, cushions, and other like inflated and fluid-tight apparatus or bags
1186. A. Eddington, Springfield, near Chelmsford—Improvements in machinery for ploughing, tilling and draining land.
1187, T. D. Rotch, Surbiton, Surrey—New and useful improvements in gas generators. (Communication from A. A. Hayes, Massachusetts, United States)
1188. W. Levesley, Sheffield—Improvements in manufacturing the blanks of forks, scissors, cutlery, chisels, and other tools, which improvements are applicable to the manufacture of springs for pocket knives, and other like articles, now prepared by the forging process
1189. J. Billiard, Red Lion-square—Improvements in the arrangements and construction of furnaces and other fireplaces, (Communication)

Dated April 28.

1190. H. Hochstaetter, Darmstadt—Improvements in the manufacture of matches
1191. J. Withnall, Manchester—Improvements in the manufacture of rollers or cylinders to be employed for printing calico and other surfaces
1192. W. Ager, Rohrsburg, Pennsylvania, United States—Improved mode of hulling and cleaning rice
1193. J. Barker, Blackfriars-road, Surrey—An improved propeller for ships and vessels
1194. K. L. Sutherland(Junior United Service Club, St. James's—An improved safety candle lantern
1195. W. A. Gilbee, South-street, Finsbury—An improved mode of reefing and reducing top-sails. (Communication from Isaac Boss, New York, U.S.)
1196. D. Grundy, Tyldesley, Lancaster—Improvements in the manufacture of boots, shoes, and clogs
1197. W. Jones, Pendleton, and T. Edwards, Eccles, Lancaster—An improved lubricator.
1198. J. Ramsbottom, Accrington, and J. Bailey, Salford, Lancaster—Improvements in regulating the flow and pressure of liquids and fluids
1199. G. Newton, Upper Thames-street — Improvements in copying and other presses

Dated April 29.

1202. C. Pascall, Norwood—Improvements in tile-making machinery
1203. J. Aitken, Essex-street, Islington—Improvements in furnaces for melting the materials of glass, iron, and other metals, and for boiling water and other substances
1204. A. P. How, Mark-lane—An improved cork holder for bottles and other vessels
1205. W. J. Curtis, Crown-court, Old Broad-street — Improvements in apparatus to facilitate passengers ascending to and descending from the roofs of omnibuses
1206. A. A. Revel-Busquet, South-street, Finsbury — Improvements in artificial flowers
1207. F. Menusier, South-street, Finsbury—An improved bee-hive
1208. J. Bottomley, C. Hodson, and W. Fielden, Rochdale—Improvements in mules for spinning
1209. G. Bartholomew, Linlithgow, North Britain—Improvements in tanners' and curriers' knives
1210. J. H. Johnson Lincoln's-inn-fields—Improvements in apparatus for distilling, applicable also to the extraction of oils, coloring matters, and essences, and to the purification of gums. (Communication from P. E. Lemettais and M. Boniere, Rouen, France)

Dated April 30.

1212. F. Walton, Haughton Dale Mills, near Manchester—Improvements in the ma facture of wire cards for metallic brushes, and for carding fibrous substances, a the machinery employed therein
1214. L. H. Spooner, Munlochy, Ross, North Britain—A new or improved manufac of paper and paper pulp
1215. B. Barcroft, Radcliffe Hall, near Manchester—Improvements in dyeing printing
1216. T. Baldwin, Bury, Lancaster—Improvements in indicators for regist pressure
1217. J. McDowall, Walkinshaw Foundry, Johnstone, Renfrew—Improvements in st hammers
1218. S. Mortimer, Halifax—Improvements in 'screw gill-boxes' used in the prepar of wool and other fibrous substances
1219. W. E. Newton, Chancery-lane—Improved machinery for moulding and pre bricks. (Communication)
1220. C. Cammell, Sheffield—Improvements in the manufacture of axles or axle-t for railway carriages, and shafts for various purposes
1221. G. Powers, Wellclose-square—An improved scuttle for ships
1222. T. F. Hale, Bristol—An improved tap or cock
1223. S. R. Lewis, Catherine-street—Improvements in trousers
1225. J. Collins, Birmingham—Improvements in furnaces and flues, and in kil drying chambers
1226. J. Anderson, Glasgow—Improvements in the treatment, application, and u maize or Indian corn

Dated May 1.

1227. J. Avery, Essex-street, Strand—An improved washing or fulling machine. (C munication from J. L. Boucher)
1229. E. Hawkes, Birmingham—New or improved machinery for the manufactu pipes for smoking
1231. J. H. Johnson, Lincoln's-inn-fields—Improvements in apparatus for preve collisions at sea. (Communication from Messieurs T. and F. Pitel, B France)
1233. R. Leake and M. Sykes, Barnsley—Improvements in consuming smoke generating heat in furnaces of steam engine or other boilers, also heating the water of the said boilers, therefore economising fuel to a great extent

Dated May 2.

1235. E. Tucker, Belfast—Improvements in the manufacture of starch.
1239. C. Chatel, Essex-street, Strand—Improvements in the manufacture of bli screens, reflectors, and other articles of a similar nature
1241. J. Davy, and W. Bentley, Bradford, York—Improvements in looms for we fibrous substances
1243. A. L. Cauville, Paris—Improvements in the manufacture of shoes and boots
1245. J. Marland, Lawrence, Massachusetts, United States—Improvements i tubes used in spinning
1247. J. P. Booth, Cork—An improved manufacture of stuffing for beds, cou cushions, and other seats
1249. T. J. Cooke, Wolverhampton—Improvements in the manufacture of k roses, and escutcheons used for doors, drawers, shutters, and other similar purp

Dated May 4.

1253. T. B. Moseley, Upper Charlotte-street, Fitzroy-square—An improved pneu holder, adapted for photographic and other purposes
1255. W. E. Wiley, Great Hampton-street, Birmingham—Improvements in ever-poi pencils
1257. S. Desborough, Noble-street—An improvement in the manufacture of the flaps of envelopes and letter paper
1259. J. Travis, Mercaston, Derby—Improvements in apparatus used in the man ture of cheese
1261. J. Turner. Leicester—Improvements in the manufacture of elastic fabrics, for the application of such fabrics to the manufacture of boots and shoes
1263. B. J. Heywood, Leicester-square—An improved construction of self-closing v and means for rendering the same applicable for supplying or discharging air, wa and other fluids

Dated May 5.

1265. J. T. Pitman, Gracechurch-street—An Improvemrnt in the construction of c combs. (Communication)
1267. T. Keddy, Birmingham—New or improved machinery for cutting sugar and o substances
1269. W. B. Paul, Langport, Somerset—Improvements in signalling upon railways
1271. J. Easterbrook and R. F. Drury, Sheffield—Improvements in machinery or t for drilling and boring
1273. L. Bissell, New York, United States—Improvements in trucks for locomo engines

Dated May 6.

1275 G. K. Geyelin, Lothbury—Making oscillating spring laths for beds, couches, other purposes
1277. W. Hood, Edgbaston, Warwick—An improved charcoal filter for rectifying cleansing spirits, and which is also applicable for filtering water and other fluids
1279. A. Kinder, Worcester—Improvements in cutting irregular forms, and in the chinery or apparatus employed therein or connected therewith
1281. M. Semple, Stonehouse, Plymouth—An improved pipe tube or stem

Dated May 7.

1287. E. Ziegler, Heilbronn, Wurtemburg—A substitute for animal charcoal, appli also as a colouring matter
1289. C. W. Ramié, Camberwell—Improvements in the mode of attaching kno spindles
1291. D. Morrison, Bordesley Works, Birmingham—A new or improved manufac of rollers or cylinders for printing fabrics
1295. J. Stenhouse, Upper Barnsbury-street, Islington—Improvements in the ma facture of various kinds of glue or gelatine
1297. G. B. Price, Bedford—Improvements in apparatus for affixing stamps and la to letters and documents
1299. J. Hedgely, Westbourne-street, Eaton-square—Improvements in lamps for r way carriages

Dated May 8.

1303. C. E. Darby, Brymbo Ironworks, near Wrexham—Improvements in collec the inflammable gases generated in blast furnaces

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PATENTS APPLIED FOR WITH COMPLETE SPECIFICATION.

1224. G. T. Bousfield, Loughborough-road, Brixton — Improvemennts in colla boats and pontoons. (Communication from N. Thompson, jun., Brooklyn, New Y United States).—April 30
1266. R. W. Sievier, Rue du Cerf, Brussels—An improvement in the mode of trea saccharine juices in the manufacture of sugar.—May 5
1357. G. W. Morse, Louisiana, United States — Improved breech-loading fire-a May 13
1400. C. F. Vasserot, Essex-street, Strand — A typographical numbering appa (Communication from A. Trouillet, Paris).—May 19

NEW CONGREGATIONAL CHURCH, CHESHUNT, HERTS.

(*With an Engraving, Plate* XVIII.)

THIS building was commenced on the 12th of May, and the foundation-stone was laid by J. H. Puget, Esq., on the 23rd inst. The site is a parallelogram in form, about 100 feet deep, and 55 feet wide, fronting Crossbrook-street. The main building is so placed as to leave a fore-court, and is 60 feet 9 inches by 40 feet, and will accommodate about 400 persons on the ground-floor, and 120 Sunday-school children in a gallery at the western end, so arranged as not to intercept the view of the large window, and approached by a separate doorway and stone staircase in the tower. The roof is of deal, stained and varnished, open to the ridge, and ceiled on the back of the rafters; the ornamental arched trusses, forming five bays in the length of the building, in the centre of each of which are single-light pointed stone windows, except in one bay in the south side, where a stone arched recess is provided for the organ. The seats are of deal, stained and varnished, with raking backs and low doors. The pulpit is of the same material with a stone base, and stands on a raised dais, surrounded by an ornamental communion railing.

Behind the pulpit is a recess, opening to the chapel by a stone arch supported on columns with foliated capitals; within this is a richly carved screen, forming a passage between the minister's vestry and committee-room, which are situated on either side of the recess, and have direct communication with the chapel by doors in front of the screen. Above the screen is seen a small trefoil window; and over the stone arch, a handsome wheel window occupies the centre of the eastern gable of the chapel.

The school-room forms the boundary in the rear, and is 38 feet 3 inches by 19 feet 6 inches, with entrance lobby. Between the school-room and chapel there is also an infants' room, superintendent's room, and lavatory; and heating room under the lobby.

The style adopted is Gothic, of the early decorated or geometrical period; and the front has tower and spire 85 feet high, with deeply-recessed and moulded doorway, and large three-light traceried window. The materials are good stock bricks and Bath stone. The contract is taken at about 1800*l*., which includes the value of the old materials.

The architects are Messrs. Lauder and Bedells, of Great James street, Bedford-row; the builders, Dove Brothers, of Islington.

UNIVERSITY OF LONDON.

PRACTICAL measures are at length occupying the attention of the Universities. Oxford has laid before the world a scheme for opening an examination for all who may present themselves, and for awarding subordinate degrees. Cambridge is engaged in a like undertaking. London, the national University of the empire, is about to receive a new charter, which is devised on a most liberal basis. It is proposed that this new charter shall throw open the examinations for all degrees and all branches to whomsoever offers, without the requirement of any collegiate attendance.

An agitation has hence arisen which divides the University, but which as yet, it is to be regretted, has very little moved the public, to whom the University of London belongs, and who have the chief interest in it. To the liberal measure of reform, University College, King's College, and we believe most of the colleges of the Universities throughout these islands, are opposed, because they fear the abolition of certificates will deprive their possessors of various fees. This is as it may be, but it is too early in the day for these colleges to set up a vested interest in the purses of fathers of families. So far as the colleges really deserve support they will receive it, as University College and King's College did before there were degrees; and with regard to New College, Owen's College, and the colleges at Birmingham, Manchester, and elsewhere, they are nearly all endowed by the various dissenting bodies to which they belong, irrespective of any connection with the University. The opposition of the colleges rests therefore on a most flimsy basis; and it is questionable whether they will suffer any diminution of revenue from the impulse given to education, but on the contrary will receive an accession. University College, which bids fair to attain the highest place in the ranks of illiberality and intolerance vacated by the colleges at Oxford and Cambridge, has signalised itself by passing a vote in opposition to the new charter, with only a minority of two; but of this minority, Grote, the historian, formed one. The leader of the majority was Mr. Jacob Waley, one of the Jewish graduates, who devotes his new liberty to maintain exclusiveness.

Mr. Waley, as a graduate, is likewise a leader in another body of oppositionists. This is the association of Graduates of the University, which, being composed of members of the colleges, is ambitious of retaining a certain odour of semi-aristocratic respectability or entire snobbishness, and therefore objects to the University being thrown open. A strong minority however, it is fair to say, has declared itself; but Mr. Foster and Dr. Barnes, the two secretaries, the leaders of the liberal party, are dispossessed of their truncheons, and Mr. Waley is the official champion of the majority.

The *Lancet*, which has taken up this question very ably, says: "It is satisfactory to know that the senate, who have on so many occasions felt the injustice of which the prohibitive terms of the charter compelled them to be the instruments, have almost unanimously resolved to free the University from restrictions that have more than anything else retarded its development and impaired its public usefulness. The voices of such men as Lords Granville, Burlington, Stanley, Sir Edward Ryan, Faraday, Arnott, Billing, Grote, Warburton, speak with authority. In this course they have, as might be expected, encountered the opposition of some of the colleges, which as we have shown derive a dishonest profit from this monopoly. The opposition is also strengthened by a body of the graduates, mostly newly fledged, just fluttering their academical feathers in the sun, and vainly imagining themselves the true typical collegiate graduates. On the other hand, the Senate is supported by a considerable array of the older graduates, whom experience, the more liberal views acquired by a wider intercourse with society, and a truer insight into the interest and mission of their University, have led to perceive that this is not a college or a graduates' question, but one which concerns the University and the country.

"Professor Foster, Dr. Barnes, Dr. Gull, Dr. Storrar, all active members of the Graduates' Committee, have announced their adhesion to the principle of opening the University. We earnestly trust that at this crisis the senate and the Home Secretary will not regard the clamour of numbers, but their own deliberate convictions and the voice of the older graduates. We append a memorial in support of the liberation of the University, which has already received many signatures:—

"The Memorial of the undersigned Graduates of the University of London, and others,

"Showeth—That the undersigned beg respectfully to express the great satisfaction with which they have learned that the senate propose to insert in the charter now under consideration a provision to admit candidates to examination for degrees in arts, without the exaction of a certicate from an affiliated institution.

"That the undersigned believe that the restrictions hitherto in force have impeded the growth of the University, discouraged free education, and operated with especial injustice, by excluding many deserving persons whom religious opinions, residence abroad, limited means, or other circumstances, have prevented from joining an affiliated institution.

"That the undersigned, further believing that the opening of the University will, by giving free scope to the principle of competition, impart a healthy stimulus to both collegiate and extra-collegiate education; and that it will, by widening the basis of the University, materially increase its public usefulness—

"Therefore earnestly pray that the new charter, abandoning the existing prohibitive system, may be allowed to pass."

The *Lancet* further says, with great truth, as the experience of our readers will confirm, that there "are many circumstances which may preclude an earnest student from entering a college. His religious opinions may not allow him to enter the particular theological college within his reach. His health may be too feeble to enable him to encounter the physical turmoil of college life. His means may be too limited. But he may even reside abroad, and actually have gone through a long course of study in a foreign university—he may have enjoyed a far better academical training than nine-tenths of the London affiliated colleges can impart, yet notwithstanding he cannot be admitted to examination."

This memorial will we trust receive the signatures of many of our professional readers. It lies at the residence of Dr. Barnes, 13, Devonshire-square.

The supplemental charter of the University of London, granted five years ago, embodied more than Oxford and Cambridge have now conceded. The National University was then empowered to grant certificates in chemistry, and the sciences allied to architecture, engineering, and the practical arts. The senate was, however, so badgered by the graduates, that it was obliged to postpone a measure so unpalatable, as placing chemists, architects, engineers, naturalists, and persons of that kind, alongside of bachelors of arts and bachelors of laws, whose scholastic dignity feared the contact of practical men. As these said graduates are likely to be constituted the Convocation of the University in the place of the senate, it is desirable professional men in particular should devote a little more attention to the proceedings, and exercise a salutary vigilance over a body which has shown no liberal appreciation of public interests.

As practical men we are no believers in the examination system as a panacea, and do not recognise it as a practical test of the highest class; but we think that the whole public have a right to require of the National University a free system of examinations and certificates for whomsoever chooses to test his proficiency in the various faculties, whether he offers himself in chemistry, mathematics, Latin, or any branch of education. This the new charter proposes to effect.

The assertion, that a University degree is not a testimonial of simple examination, but of the student having undergone a regulated course of collegiate discipline, it may simply be affirmed that it is a piece of humbug imposed on the public. Most of the colleges under the University of London have no system of domestic collegiate discipline, but supply a course of professional lectures and examinations. With regard to the collegiate system of Oxford, Cambridge, and Dublin, it is unfortunately known that its theoretical efficacy is not realised, and that the majority of the students manage to evade its beneficial influence. As a general principle, we may avail ourselves of the well-known fact, that everywhere a system of cramming or coaching at the last moment constitutes the efficient educational process and preparation for a degree. There is, therefore, no reason why anyone who is ready to pass his examination should not go up for it and take his degree, even if he have not pretended to go through a college at any of the Universities.

We certainly think it desirable that the collegiate system should be upheld, and that collegiate discipline in its various modes should be encouraged, rather than detracted from; but besides the natural desire of parents who have the means to afford every requisite of education, colleges have such advantages in their endowment and in their social privileges, that they will always command a preference. Still, when the private tutor can train a pupil for a degree, let him do so, and compete with his better established rivals; but above all, let not the young man whom the accidents of fortune and position have deprived of the means and opportunity of attending a college, be deprived of the fruits of his solitary study, not less arduous perhaps in its discipline, because achieved by self-sacrifice and exertion under difficulties. Let, too, the self-taught student, the architect's or engineer's pupil, who has worked himself into a competent knowledge of mathematics or natural philosophy, have the University certificate, which will afford a testimonial of his attainments.

We consider that one result of throwing open the Universities will be, that instead of candidates being restricted to the curriculum of the bachelor of arts, and thereby diminished to the few who can pass the whole of the subjects (many candidates otherwise competent being likewise rejected on partial grounds), certificates will be given for the single subject, and thereby the examinations be more numerously attended, and become of greater importance. It is not possible to create engineers and architects at colleges, nor can colleges ever give more than a restricted class of information for these professions; but so far as the knowledge possessed is of a scholastic character, the student should be entitled to obtain a certificate for it.

The sum of 30,000*l.* is to be expended upon the erection of a joint lunatic asylum for the counties of Carmarthen, Cardigan, and Pembroke, to be built in the vicinity of Carmarthen, where 46 acres have been purchased in proximity to the monument to Lieut.-General Picton. It is intended to hold 216 persons.

IRON BUILDING, MANCHESTER.

An iron building has been put up recently near the Art Treasures Exhibition, Manchester, which has excited some attention, in consequence of the rapidity with which it was done. It has been built at a cost of about 400*l.*, by Messrs. E. T. Bellhouse and Co., for Mr. Ogden, of Long Millgate, Manchester, for the purpose of receiving a valuable collection of paintings, antiquities, and curiosities, which that gentleman wishes to bring under the notice of the visitors to the Art Treasures Exhibition. The building consists of a cellar and upper room, and is 65 feet long and 32 feet wide: the cellar is 8 feet high, and the walls thereof are of brick: the upper room is 15 feet high to the eaves, and the roof is raised so as to give sloping and perpendicular glazed lights; thus leaving the whole of the wall space free for pictures and other objects. The shell of the upper portion of the building, above the floor, is composed of corrugated iron sheets, attached to pilasters and roof principals. The interior of all the wall is lined with boarding, upon which are paper and maroon-coloured calico cloth.

Thirteen working days only elapsed between laying the first brick and the completion of the building; and this short time includes the manufacture of the materials, as well as the complete erection of the same. The building is of very creditable external appearance.

MESSRS. SARL & SON'S NEW PREMISES, CORNHILL.

Wrought-iron Tubular Girder.

These premises form a conspicuous feature opposite to the Bank of England and the Royal Exchange. The building is of Bath stone, in the Venetian style; its height is 96 feet from the pavement, and the width about 40 feet. The ground-story is 25 feet high from the floor-line of shop. Around the shop are coupled Doric and Composite columns and pilasters supporting a handsome gallery, with imposts and arched recesses on three sides of the ground-floor, filled in with plate-glass. The gallery has deep recesses, corresponding with the ground-floor, fitted to receive separate ebony cabinets for jewellery and plate.

The whole of the front of the building above the shop-level, 70 feet high, is carried on a wrought-iron tubular girder of 32 feet span, the weight of stone and brickwork which it carries being about 400 tons. The frieze of the shop-cornice is supported by a wrought-iron apron-piece bolted to the girder, and having Clarke's revolving shutters fixed behind the apron-piece.

The shop-front is composed of two circular-headed sashes, in bronze, with arched lobby 6 feet wide, with a large clock recessed over the doors.

The whole of the designs are by Mr. John Barnett, of Verulam-buildings, Gray's-inn, who is superintending their execution.

List of Ironwork used in Girder.

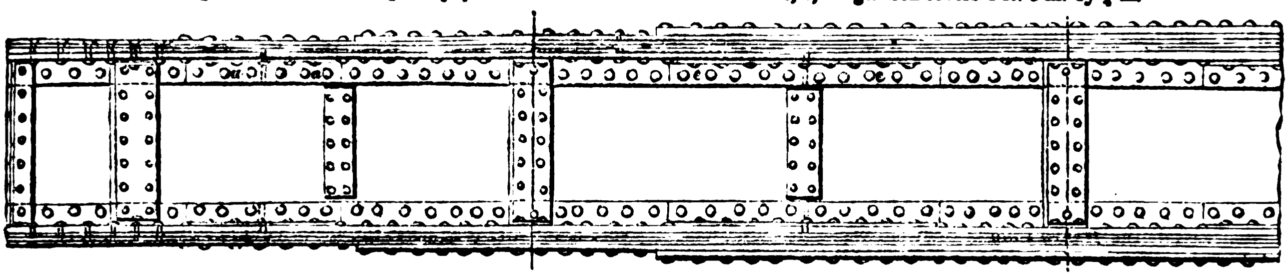
Number of Pieces.	Size. in.	in.	Length. ft.	in.	
2	15 ×	$\frac{1}{4}$	13	6	External covering plates
2	15 ×	$\frac{1}{4}$	13	6	Internal ditto
4	15 ×	$\frac{1}{4}$	11	3	Ditto ditto
4	18 ×	$\frac{1}{2}$	12	0	Plate I.
2	12 ×	$\frac{1}{2}$	15	0	Ditto
4	12 ×	$\frac{1}{2}$	4	6	Ditto
4	12 ×	$\frac{1}{2}$	15	0	Plate II.
2	18 ×	$\frac{1}{2}$	6	0	Ditto
4	18 ×	$\frac{1}{2}$	12	0	Ditto
4	30 ×	$\frac{1}{2}$	3	0	Ditto
6	18 ×	$\frac{1}{2}$	12	0	Plate III.
2	12 ×	$\frac{1}{2}$	15	0	Ditto
4	12 ×	$\frac{1}{2}$	10	6	Ditto
8	3 × 2 ×	$\frac{1}{2}$	9	0	Vertical side plates
12	6 × 6 ×	1	9	0	Angle-irons
8	6 × 6 ×	1	4	6	Ditto
4	5 × 5 ×	$\frac{1}{2}$	2	11	Angle-iron at ends
10	14 ×	$\frac{1}{2}$	2	11	Bent plates
8	5 ×	$\frac{1}{2}$	2	2	Stiffening plates
6	8 ×	$\frac{1}{2}$	3	0	Inside covering plates
8	5 × 5 ×	$\frac{3}{4}$	4	3	Angle-iron covers
8	5 × 5 ×	$\frac{3}{4}$	2	6½	Ditto
8	5 ×	$\frac{1}{2}$	4	3	Inside ditto
8	5 ×	$\frac{1}{2}$	2	6½	Ditto
1000		1			Rivets
200		$\frac{3}{4}$			Ditto
120					C I washers as per drawing.

WROUGHT-IRON TUBULAR GIRDER, MESSRS. SARL & SON'S NEW PREMISES, CORNHILL.

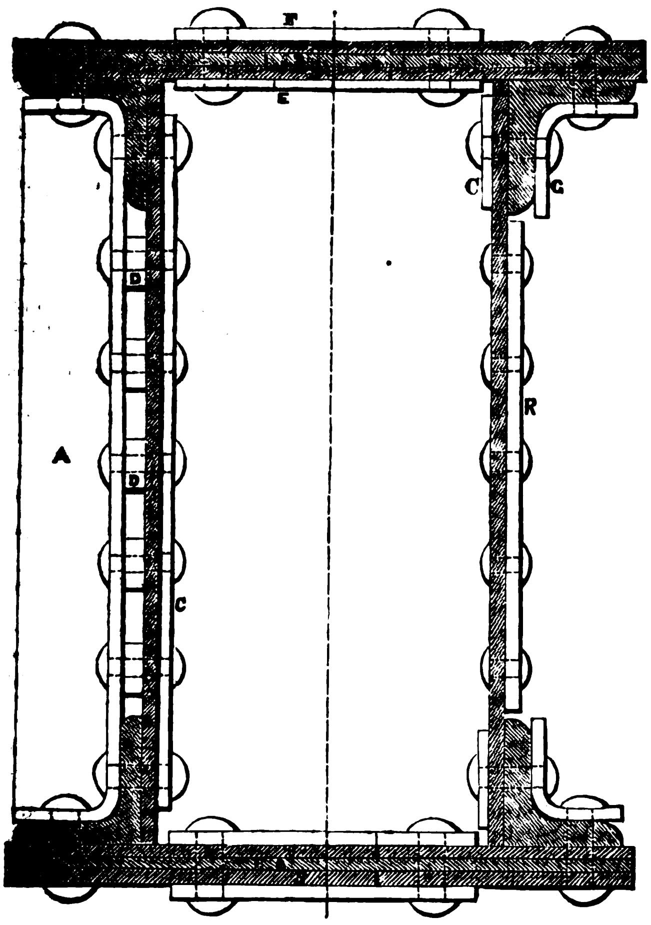
JOHN BARNETT, Esq., *Architect.*

SIDE ELEVATION.

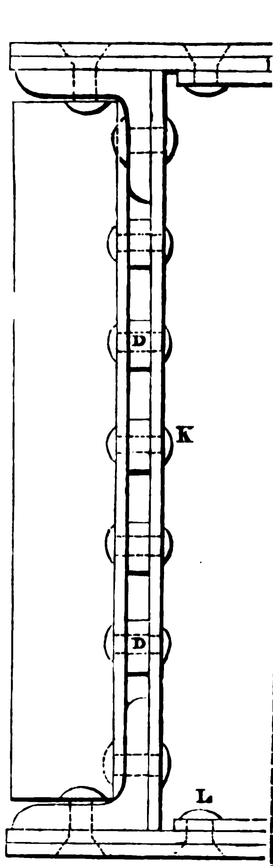
a, *a*, Angle-iron covers 2 ft. 6$\frac{1}{4}$ in. by $\frac{3}{8}$ in. *c*, *c*, Angle-iron covers 4 ft. 8 in. by $\frac{3}{8}$ in.



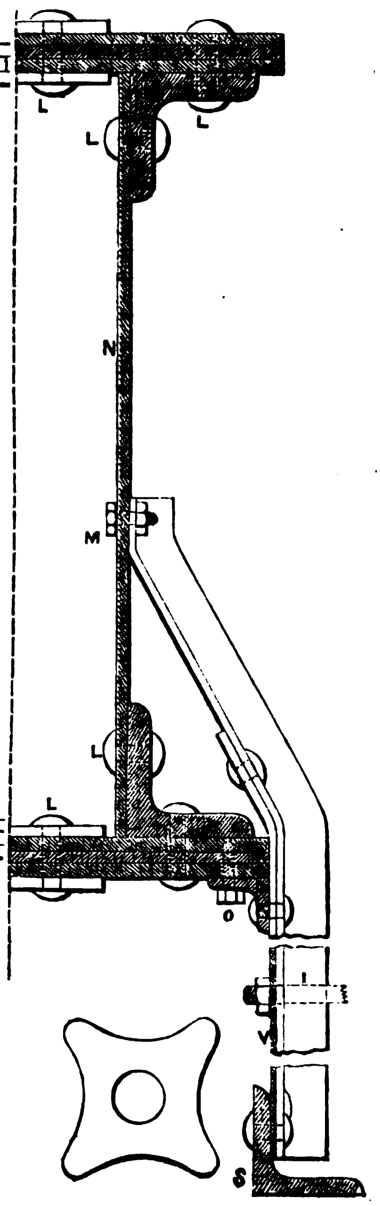
HALF SECTIONS, showing Bent Plates, Angle-iron Joint Covers, Stiffening Plates, &c.



END ELEVATION.



HALF SECTION, showing mode of attaching Stirrup Irons.



References to Engravings.

A ......Bent plate
C ......Joint covers 5 in. by $\frac{3}{8}$ in.
c ......Inside covering plate 3 in. by 8 in. by $\frac{1}{2}$ in.
D ......Cast-iron washers
E ......Internal covering plate
F ......External covering plate
G ......Covers 10 in. by $\frac{3}{4}$ in.
I ......$\frac{3}{4}$ in. bolt through stone
K ......$\frac{3}{4}$ in. rivets
L ......1 in. rivets
M......$\frac{3}{4}$ in. bolt
N ......Side plate 9 ft. by 38 in. by $\frac{1}{2}$ in.
O ......$\frac{3}{4}$ in. tap screw
P ......Angle-iron 2$\frac{1}{2}$ in. by 2$\frac{1}{2}$ in. by $\frac{5}{16}$ in.
R ......Stiffening plate 2ft. 1$\frac{1}{2}$ in. by 5 in. by $\frac{1}{2}$ in.
S ......Angle-iron 5 in. by 5 in. by $\frac{5}{8}$ in.
W......Angle-iron 6 in. by 6 in. by 1 in.

REVIEWS.

Villas and Cottages; a Series of Designs by CALVERT VAUX, Architect, Newburgh on the Hudson, U.S. London: Low. 1857.

Three months ago there came into our hands for review an American work on "Parish Churches," by Mr. Coleman Hart; we have now before us a volume from the same quarter, but another source, on "Villas and Cottages," practically considered. The author, Mr. Calvert Vaux, is, we believe, an Englishman; and he was already beginning to distinguish himself in his profession, when, as a young man, he became introduced to the late Mr. Downing, of New York, with whom he eventually entered into a partnership, severed only by death. Mr. Downing was a man of considerable architectural taste, as his executed works and literary productions testify; and his practice was large and increasing, when his career was suddenly cut off by his loss in that ill-fated vessel, the *Henry Clay*.

A large proportion of the subject matter of the present volume is based on projects designed and carried out, either by Mr. Downing or by him and his partner conjointly, so that there is a tone of reality infused which adds immensely to the weight of what otherwise might go for mere opinion; and, besides this, the views of the authors are clearly interpreted on general points by the host of illustrations with which the volume abounds. These latter appear to be a comparatively new feature in the architectural bookmaking of our sister-land, since we find that till within the last few years it has not been an easy matter to place before the public the necessary illustrations in a form that would be available; and, as mere verbal descriptions are seldom thoroughly intelligible, this difficulty has probably retarded the diffusion of popular architectural information. Although Americans are said to be always reading and incessantly building, the one habit has scarcely so much influence on the other as might naturally be expected, when we consider the practical character and universally recurring interest of the subject. Of the general *status* of architecture in America, let the author speak for himself:—

"Over the length and breadth of this country are scattered cities and villages by thousands, and public and private edifices innumerable; and yet we may fairly say, There are the buildings, but where is the architecture? There is the matter, but where is the manner? There is the opportunity, but where is the agreeable result? Is it in the churches? —a few really creditable specimens may be pointed out, but the large majority are unquestionably deficient in truthful dignity and artistic beauty. Is it in the public buildings?—several fine works of art may at once occur to the mind, and although a floating doubt somewhat questions the Americanism of their expression, still, as they are nobly conceived, and do not shrink from the ordeal of the artist's pencil, it is granted that they are successful. Then comes the question of the great majority again.

"Does the secret of beauty lie in the private buildings, the stores, the warehouses, the mansions, the villas, the hotels, the streets, or the cottages? There are probably as magnificent hotels and stores in the large cities of America as any where in the world. Architecture, within the last ten years, has managed to get a genuine foothold in this department of building; it has begun to *pay*, and that is an excellent sign, and one that offers food for reflection and solid encouragement; yet it is the few and not the many, even here, that speak of refinement, and a love of grace, which is as averse to meretricious display as it is to ungainly awkwardness. Among the private residences a great number are excellent; but still the mass are unsatisfactory in form, proportion, colour, and light and shade. What is the reason of all this? Why is there comparatively so little beauty in American buildings? Some will say America is a dollar-loving country, without taste for the arts; others, that expense is the obstacle, and that the republican simplicity of America cannot afford the luxury of good architecture. The latter of these solutions is clearly incorrect, for it is knowledge, and not money, that is the chief source of every pleasurable emotion that may be caused by a building. Indeed a simple, well-planned structure costs less to execute, for the accommodation obtained, than an ill-planned one; and the fact of its being agreeable and effective, or otherwise, does not depend on any ornament that may be superadded to the useful and necessary forms of which it is composed, but on the arrangement of those forms themselves, so that they may balance each other and suggest the pleasant ideas of harmonious proportion, fitness, and agreeable variety to the eye, and through the eye to the mind. All this is simply a matter of *study before* building, not of additional *cost in* building. The other solution of the problem, that Americans do not appreciate the beautiful, and do not care for it or value it, is a more specious but equally erroneous one.

"The truth is, not that America is a dollar-worshipping country, with a natural incapacity to enjoy the arts, but a dollar-making country, with restricted opportunities for popular, artistic education, *as yet;* but when this want is freely ministered to, in the spirit that it may be, and it is hoped will be, ere long, there is every reason to conjecture that correct architectural taste may be as generally diffused throughout the United States as we at present find the idea of a republican form of government."

The study of what has been done by other nations, though useful as a help, can never lead to a direct result in a country like America, where the climate, the institutions, and the habits of the people, have a distinctive character that requires special adaptations. Thus, the Greek mode, though completely beautiful when contemplated from a proper point of view, is characterised by an enervating repose that is not heartily sympathised with either by the American atmosphere or the spirit of this locomotive age. Everywhere there is a cry, and a sensible one too, for verandahs and visible chimneys; so that the pure classic outline in due course suffers grievous mutilation. The mention of verandahs might suggest the borrowing of ideas from Moorish or Chinese styles, but neither of these phases of architectural taste is of comprehensive value. They are both wanting in compactness and completeness of plan; and in artistic design they depend too much for their effect on delicate and elaborate ornamentation. The free Italian, and the later modifications of the Gothic, are the most useful types to analyse; but the flat-terrace roofs of the first have to be avoided on account of the snow, and the latter has to be conformed to the use of verandahs before it can be acceptable. Books have hitherto done but little, yet any genuine step in advance will be responded to at once by the sympathetic perceptive faculties of individuals who may notice it; and the result, so far as it bears on their requirements, will be ever imprinted on the memory.

"One especial disadvantage that rural art labours under in America is, that the plans of country towns and villages are so formal and unpicturesque. They generally consist of square blocks of houses, each facing the other with conventional regularity; and this arrangement is so discordant with the varied outlines characterising American scenery, that Dame Nature refuses, at the outset, to have anything to do with them, and they never seem afterward to get any better acquainted with her. Except, perhaps, in a very large city, there is no advantage gained by this intense monotony of arrangement, and it is much to be regretted that in the many new villages that are being erected, the same dull, uninteresting method is still predominant.

"The great charm in the forms of natural landscape lies in its well-balanced irregularity. This is also the secret of success in every picturesque village, and in every picturesque garden, country-house, or cottage. The roads should wind in graceful, easy curves, and be laid out in accordance with the formation of the ground and the natural features of interest. A single existing tree ought often to be the all-sufficient reason for slightly diverting the line of a road, so as to take advantage of its shade, instead of cutting it down and grubbing up its roots."

Besides all this, it should be remembered that in country-houses the design has to be adapted to the locality, not the locality to the dwelling; it is, moreover, undesirable, and generally impracticable, to make the natural subservient to the artificial. Woods, fields, mountains, and rivers, *will* be more important than the houses that are built among them, and every attempt to force individual buildings into prominent notice is an evidence either of a vulgar desire for notoriety at any sacrifice, or of an ill-educated eye or taste. There must, of necessity, be a degree of monotony in the varieties of any class of buildings under the same circumstances, and arising out of probably the same materials; to obviate this, Mr. Vaux suggests intermixing the natural colours of the materials with the free use of *paint* on the suitable portions.

"Every rural building requires four tints to make it a pleasant object in the way of colour; and this variety costs but little more than monotonous repetition, while it adds much to the completeness of the effect. The main walls should be of some agreeable shade of colour; the roof-trimmings, verandahs, and other wood-work being either of a different colour or of a different shade of the same colour, so that a contrast, but not a harsh one, may be established. The third colour, not widely different from the other wood-work, should be applied to the solid parts of the Venetian blinds, and the moveable slats should be painted of the fourth tint. This last should be by far the darkest used on the premises, for the effect of a glass window or opening in a wall is always dark when seen from a distance; and if this natural fact is not remembered, and the shutters are painted the same colour as the rest of the house, a blank, uninteresting effect will be produced, for when the blinds are closed, which is generally the case, the house, except to a person very near it, will appear to be without any windows at all. This error is often fallen into, and requires to be carefully guarded against."

It will be judged from the foregoing extracts what kind of "villas" are most in favour; but we may as well add, that a considerable variety of effect is frequently given by slight modifications of a certain plan, such as the addition or omission of a conservatory, the adding of a porch or recessing the entrance, the carrying up of one portion of the building an extra story, and numerous contrivances which varying circumstances will dictate, and which an average amount of skill only is required to turn to proper account.

It would not appear that America is very productive of good building-stone, and Caen stone has been imported into New York, and used to some extent. "It seems, however, a little unnatural for a continent like this to seek building materials in Europe, and there can be little doubt but that a strict geological examination will, after a time, supply us with many new varieties of building-stone." A capital freestone, of a pleasant, soft tint, has lately come into use, brought from the Dorchester quarries, Westmoreland county, New Brunwick.

Our author strongly opposes the use of "compo," which, he says, "has exercised a most pernicious effect upon architecture." Compo fronts now swarm in town and country. Cheap materials cheaply run up, and smeared over with Portland or Roman cement, impose for a year or two, perhaps, upon the passer-by; but the day of reckoning soon comes, and the peeling, spotty, cracking complexion that the false stone assumes, proclaims the whole affair a worthless sham and contemptible failure. Fortunately, the use of external cement has made no great progress in America at present, and it is to be hoped that the more genuine modes of construction will continue to be preferred.

For covering walls of porous brick or inferior stone, cement is available enough; and those who are constantly engaged in its manufacture and use, speak highly of it as a material for general external work, even without painting. Still, we should always prefer good plain brickwork. But as circumstances will arise in which it is desirable to try the experiment of cementing, we subjoin the directions furnished by experienced parties on the subject. There can, however, be no doubt but that the success of the work depends quite as much on the way in which it is done as on the materials used:—

"'First, saturate the surface to be operated upon with water used abundantly (a force-pump and hose is the best method.) Secondly, make a wash of liquid cement, as for inside brick walls, applying it with a brush, so that all small cavities may be entirely filled. Then spread on the finishing coat about a quarter of an inch in thickness, and made in proportions of two of sand to one of cement. During the operation of putting on this second coat, the first coat of liquid cement should be kept quite damp by frequent sprinkling. After the cement is upon the wall, it is important that it should be sprinkled with water, so as to keep it damp for a week or two.

"'In making the mortar care should be taken to have none but clean, sharp sand, free from loam and quicksand. If taken from the sea-shore it should be very thoroughly washed with fresh water before using. All the cement required is just so much as will be sufficient to coat each particle of sand. The sand and cement should be thoroughly mixed before water is applied, and water should be applied to only so much as will be used immediately.'"

One of the most interesting sections of this book is that which examines in detail the various portions and features of detail that occur in country residences, and from these pages many useful hints may be gleaned. (Even in the backward condition of rural architecture in our own country, how much is due of the good that exists to the persevering endeavours of the ill-requited Loudon, especially in his 'Cyclopædia,' and his 'Architectural Magazine!'—works not of ephemeral but lasting value.) The first part of the design that appeals to the attention of the visitor, is the *porch*, which admits of much character and expression. The due relative proportion with the rest of the building is insisted on, and the effect of the non-observance of this point is argued. Several varieties of entrances are depicted, such as recessed doors merely, hooded doors, and the bold projecting porch of stone or wood, perhaps in connection with a conservatory or verandah. Another plan, rarely adopted in England, but susceptible of pleasing effects, is a recessed entrance, whose arched head shall be further hooded by a balcony attached to a window over, and whose architectural features shall blend in unison. Porches may be fitted up with permanent or moveable seats, but these should be of wood, in preference to anything else: they may be floored with wood,—with stone or marble in various tints,—or with plain or encaustic tiles.

The *hall*, it is recommended, should on entering appear to some extent symmetrical; that is as regards the arrangement of its doors and windows, and several methods are suggested for obtaining pleasing results.

The *library* is an apartment in general demand in most country houses. It need not be of large dimensions under any circumstances, but should be so arranged that, even when occupied by only one or two persons, it may have a cheerful domestic look. It may be adapted to its special purpose in many ways. One that most readily suggests itself is by recessed bookcases, with dwarf closet for papers and magazines. To preserve symmetry, Mr. Vaux upholds what is a very frequent custom, the use of imitation bookcases, *i. e.*, doors made up of book-backs corresponding with surrounding volumes. This, as a veritable sham, is unworthy of honest architecture, and we are ashamed to find that the practice has been countenanced in that noble new Reading-room just added to our British Museum.

In the *dining-room* we are shown an arrangement (very convenient) for a sideboard in a recess, with a door to a private closet on one side, and one to a pantry or service-room on the other. Another arrangement shows one end of the room opening by glass doors into a conservatory. In this case the glass might be frosted or slightly cut, to relieve monotony.

For the *drawing-room* few strictly architectural features are wanted. A bay-window is a very desirable addition to such a room, as it breaks up the monotony of outline, and gives a more free and open effect.

In the planning of the upper floors, some useful hints are dropped, as well as respecting the management of staircases, bath-rooms, the positions of windows, and the construction of chimneys, roofs, gutters, and ventilators. High-pitched roofs are invariably recommended, but their forms are varied, some being plain hips, others curved outwards or inwards, and some with an ogee outline. We have often wondered why more play of form is not observable in English roofs. The expense additionally is inconsiderable, compared with the agreeable variety of effect. The author states that he is in the habit of employing, in practice, high-pitched roofs, with a flat on the top. The acute angle of the roof precludes the possibility of any large surface being exposed to the vertical rays of the sun; and the flat on the top has a space between it and the attic, which acts as a satisfactory shield from the heat. This space can be floored, and fitted with a staircase, and used as a lumber garret, if thought worth while; and such a plan of arranging the roofs, so as to increase the value of the attic-rooms without loss of exterior effect, has been generally approved: the flat is not noticeable from below, as the ridge lines alone are apparent.

As an appendix to the general subject, illustrations and descriptions are furnished of thirty-two designs, all more or less meritorious, and which have been executed under the immediate superintendence of the author. There can be no question but that his views are, in the main, correct, and consequently that his book may be perused with interest and profit by all to whom the subject commends itself.

A Treatise on the Integral Calculus and its applications, with numerous examples. By T. TODHUNTER, M.A., Fellow of St. John's College, Cambridge. Macmillan. 1857. Crown 8vo pp. 268.

This is, we believe, the fourth of Mr. Todhunter's contributions to the list of mathematical class-books for the use of Cambridge students. His preceding treatises on the Differential Calculus—Analytical Statics—and Plane Co-ordinate Geometry, have met, and this work probably will meet, with the success due to scientific honesty which abhors imperfect demonstrations and will not "shirk" mathematical difficulties. The study of an author who assumes to teach more than he knows—knows certainly and clearly—is always unsatisfactory; and no redundancy of illustration, no deceitful evasion of difficulties, no diplomatic generality of language where the subject is not thoroughly mastered by the author, will enable him to produce a good students' book. We know that the elements of nearly all the exact sciences involve certain theorems of which the demonstrations are difficult or imperfect, and though in modern times many of the objections to them have been removed, some still remain. The author does not deal fairly with his readers who keeps these objections out of sight. Among the theorems the demonstrations of which have been the stumbling-blocks of students, and have exercised the ingenuity of the most accomplished mathematicians, are the celebrated 12th axiom of Euclid—the binomial theorem and the theory of $\sqrt{-1}$ in algebra—the parallelogram of forces and the principle of virtual velocities in statics—the "three laws" of motion and D'Alembert's theorem in dynamics—Taylor's theorem, the rectification of curves, and the complanation of surfaces in the Differential and Integral Calculus.

The latter two subjects are considered in the present work. The rectification of a curve consists in finding a *right* line equal in *length* to the curve, and it is ordinarily assumed—or but imperfectly demonstrated—that the required length is the limit which the sum of the chords drawn from point to point in the curve has, when the distances between the points are indefinitely diminished. Mr. Todhunter assumes this proposition, and refers respecting it (Art. 121) to his Differential Calculus, De Morgan's Differential and Integral Calculus, and Homersham Cox's Integral Calculus. In Mr. Todhunter's former work, the assumption is stated to be dependent on an axiom which is "difficult and will not be necessarily true" in all cases. Another way of getting over the difficulty has been to simply *define* the length of the curve to be the limit just mentioned. But this is a mere evasion. What is meant by *length*? If the length of a curve were a mere artificial conception, a writer might define it arbitrarily; but knowing it to be a reality—a quantity which all curves necessarily possess, we have left our task incomplete until we strictly deduce our theorems respecting it from what is certainly known about length. Now, in measuring lengths of *straight* lines there is no difficulty, because the idea of superposition of such lines suggests immediately the method of measuring them. We ascertain a straight line to be 12 feet in length by superposing on it a foot "rule" twelve times. But in the case of curves the method is inapplicable, for the straight edge of our "rule" cannot accurately be superposed on any portion of the curve, however small. If, then, the length of a curve cannot be thus obtained by resort to the axiom which is tacitly assumed in measuring straight lines, it is clear that we must resort to some other. The axiom, that a straight line is shorter than any curve joining its extremities, *i.e.* possesses less of the quantity called *length*, recommends itself just as clearly to the mind as the last-mentioned axiom, and is, we believe, a sufficient basis of the theory of rectification of curves. In the same way, the complanation of curved surfaces may be based on the axiom that a plane possesses less of the quantity called *area* than any curved surface having the same boundary. We do not despair of seeing these subjects thoroughly elucidated in a future edition of this work. Mr. Todhunter has the bent of mind which peculiarly qualifies him for this investigation.

At the end of his Differential Calculus was given a short account of *single* integration. The present work treats of that subject more fully, and of course investigates the principles of multiple integration and its geometrical applications. There are also chapters on elliptic and definite integrals. The chapter on the change of the variables of a multiple integrals is an excellent example of Mr. Todhunter's talent of explaining abstruse things perspicuously, and we especially admire the geometrical illustrations of this subject.

The Grammar of Ornament. By OWEN JONES. London: Day and Son, Lithographers. 1856.

It is true that various efforts have been made to illustrate Decorative Art, but all previous attempts in this department have failed to grapple with the subject in the comprehensive manner in which it has now been accomplished by Mr. Jones and his artistic assistants. In the preface the author observes: "All that I have proposed to myself, in forming the collection which I have ventured to call the 'Grammar of Ornament,' has been to select a few of the most prominent types in certain styles closely connected with each other, and in which certain general laws appeared to reign independently of the individual peculiarities of each. I have ventured to hope that in thus bringing into immediate juxtaposition the many forms of beauty which every style presents, I might aid in arresting that unfortunate tendency of our time to be content with copying, whilst the fashion lasts, the forms peculiar to any bygone age, without attempting to ascertain, generally completely ignoring, the peculiar circumstances which rendered an ornament beautiful, because it was appropriate, and which as expressive of other wants, when thus transplanted, as entirely fails." In furtherance of his peculiar views the author lays down thirteen propositions, containing what he considers the general principles in the arrangement of form in architecture and the decorative arts, viz.:

1. The decorative arts arise from and should properly be attendant upon architecture.

2. Architecture is the material expression of the wants, the faculties, and the sentiments of the age in which it is created.

3. As architecture, so all works of the decorative arts should possess fitness, proportion, and harmony, the result of which is repose.

4. True beauty results from that repose which the mind feels when the eye, the intellect, and the affections are satisfied, from the absence of any want.

5. Construction should be decorated. Decoration should never be purposely constructed.

6. Beauty of form is produced by lines growing out one from the other in gradual undulations.

7. The general forms being first cared for, these should be subdivided and ornamented by general lines; the interstices should then be filled up with ornament, which may again be subdivided and enriched for closer inspection.

8. All ornament should be based upon geometric construction.

9. As in every perfect work of architecture, a true proportion will be found to reign between all the members which compose it, so throughout the decorative arts every assemblage of forms should be arranged on certain definite proportions.

10. Harmony of form consists in the proper balancing and contrast of the straight, the inclined, and the curved.

11. In surface decoration all lines should grow out of a parent stem. Every ornament, however distant, should be traced to its branch and root.

12. All junctions of curved lines with curved, or of curved lines with straight, should be tangential to each other.

13. Flowers or other natural objects should not be used as ornament, but conventional representations founded upon them, sufficiently suggestive to convey the intended image to the mind without destroying the unity of the object they decorate.

Twenty-four propositions are also enforced in reference to colour as applied to ornament, which are well worthy of consideration.

In the strictly historical portion of the work the author divides the subject into twenty chapters, in the following order of chronological arrangement, viz.: Chapter 1, under the head of Ornament of Savage Tribes, comprising three plates;—2. Egyptian ornament, eight plates;—3. Assyrian and Persian, three plates;—4. Greek ornament, eight plates;—5. Pompeian ornament, three plates;—6. Roman, two plates;—7. Byzantine, three plates;—8. Arabian, five plates;—9. Turkish, three plates;—10. Moresque ornament, from the Alhambra, five plates;—11. Persian ornament, five plates;—12. Indian, seven plates;—13. Hindoo, three plates;—14. Chinese, four plates;—15. Celtic, three plates; 16. Mediæval (including illuminated MSS.), eight plates;—17. Renaissance, nine plates;—18. Elizabethan, three plates;—19. Italian, five plates;—and, 20. Ten plates of leaves and flowers from nature.

Taking the classification of the author historically, we may remark—without however impugning the accuracy of placing what are termed the "savage tribes" first on the list—that, viewing the Mosaic account of the creation as a standard, the original inhabitants of the earth are scarcely to be described as mere savages, but were endowed with a considerable amount of intelligence, ranging much above the brute. At the same time, we admit that the South Sea or any other savages who roam amidst their primeval forests may be taken as examples of sections of the olden world, who displayed an inherent feeling and love of ornament so admirably illustrated in the work before us. Some of the specimens as copied from the productions of the South Sea Islanders are really astonishing, not only for the ingenuity of their design, but also from the elaborated results produced by such simple materials and tools.

In the Egyptian section we have a highly important series of plates from the works of an ancient people, who claim to have been the great pioneers of architectural and decorative art, and who laid the basis of the succeeding developments accomplished by the Greeks up to the period of the Phidian age, when the art arrived at its perfection. The great beauty of some of the conventional forms of Egyptian ornament is unquestionable; and it is curious to observe in some of them the origin of the Corinthian capital, the Greek fret, and the Vitruvian scroll.

Contrary to some authors, who place the Nineveh and Persian styles prior to the Egyptian, we quite agree with Mr. Jones in classing them after, it being evident that the examples from Assyrian and Persian art exhibit a much more advanced state of manipulation than the Egyptian. Further, we have no doubt that the antiquities brought to light by Mr. Layard and others, and now deposited in the British Museum, are not vestiges of either the ancient Nineveh or Babylon of the scriptures, but remnants of the Persian palaces of Cyrus, Cambyses, Darius, and Xerxes. We fear therefore that the only conception we have of the two great cities of the old world will still have to be conveyed through the gorgeous combinations of the most eminent architectural painter of the age, "the prince of perspective and the lord of space," who gives us Babylon and Nineveh in all their supposed glory and magnificence, eclipsing immeasurably everything of the kind in ancient or modern times. We gladly accord to Martin the full benefit of a sweeping and unlimited poetic license in the miraculous creations of his fancy, for the sake of feasting our eyes on the wonderful productions of his fertile imagination, but as to whether his works give anything like a fac-simile of the real cities as they appeared in the days of Nimrod and Semiramis, we shall not take upon us to determine. In some of the Assyrian examples of ornament it is curious to observe the true forms of the modern guilloche and so-called winding foliage adopted in friezes; also in some instances, panels filled in with enrichment nearly as much elaborated as works of Roman production; which serves, to a very great extent, to prove the fact that the data fixed for the execution of these Assyrian specimens is erroneous.

In the examples of Greek art, from its earliest development to its most refined forms, we could have wished that a few specimens of capitals and bases had also been given, which would have rendered the collection more interesting to the student, as exemplifying the way in which the Greeks had improved so admirably upon the originals set before them by the ancient Egyptians, in these important members of architectural design.

The few gorgeous examples of Roman works are beyond all praise, and afford a fund of employment and study in free-hand drawing, more particularly in foliage.

The next style illustrated is the Byzantine, and we freely confess that we have no sympathy with most of the forms of which it is composed, further than its admitted appropriateness for mosaics and the decoration of plain surfaces. This style is distinguished by its clumsy proportions, its stumpy columns, and the heaviness of its arches. Most of the figures introduced into it are ill-drawn, and its ornaments rudely conceived, roughly executed, and possess neither refinement nor delicacy of finish.

The specimens of Arabian ornament, drawn from originals executed in black and white marble and tiles in the mosques and private houses of Cairo, are truly wonderful. The materials for these samples were kindly furnished to the author by Mr. James W. Wild, who passed a considerable time in the study of the interior decoration of Arabian houses; they may therefore be considered as faithful transcripts of Cairean ornament, and afford valuable hints to our manufacturers.

The three plates of Turkish ornament are extremely curious, some of them elaborate in design and coloured with an extraordinary degree of taste; omitting, however, like the Arabian and Alhambran, the representation of the human or animal form.

In the plates of Moresque ornament from the Alhambra, as a matter of course, the author is entirely at home, and the whole series is executed with exquisite finish.

The same degree of praise may also be awarded to the five plates of Persian ornament; and succeeding these are the examples of Indian decorative art, Nos. 5 and 6 of which are from specimens in veneered marbles of highly elaborate design, the parti-colouring of which is at once gorgeous and very judiciously managed.

The next three plates are illustrative of Hindoo art: then follow four plates of Chinese ornament, many individual examples of which offer good hints in design, and show that the fret enrichment was not unknown at an early period to this mysterious race of people.

The three plates of Celtic are historically interesting, but somewhat rude and uncouth.

The plates of mediæval ornament include specimens of stained glass and illuminated manuscripts. The glass comprises some beautiful designs from the churches of Cologne, the cathedrals of Troyes, Bruges, Angers, Soissons, York, Canterbury, and Strasburg, the abbey of St. Denis, and Southwell church, Nottinghamshire. We could have wished to have seen a few more examples of capitals, bosses, &c., in this inexhaustible style, in order to elucidate its various historic periods of Norman, Early English, Decorated, and Perpendicular, the peculiar ornaments of each having their distinguishing characteristics. There are, however, five good specimens from mediæval carvings of capitals, bosses, and spandrils, in woodcuts in the body of the work.

In the Renaissance section, the author acknowledges the valuable assistance of Mr. M. Digby Wyatt, who has written a most admirable essay in the work, on this style, and also one on that of the Italian, which are illustrated with numerous wood-cuts, and as a whole form interesting adjuncts. The Renaissance style is profusely represented in eight plates drawn by a master-hand; they include examples from the works of Ghiberti, Sansovino, and the later artists of this period, which admirably denote the characteristics of the style, and afford a wide field for careful study.

Three plates are devoted to Elizabethan art, accompanied by an ably written essay by Mr. B. Waring. This style, although comprising in its numerous ramifications several ingenious combinations, is distinguished by gross and vulgar conceptions, bad drawing, and, in many instances, rude execution.

The Italian style is depicted in five plates, most of them taken, we regret to see, from painted frescoes. We should have preferred copies from the stucco work of some of the Italian palazzi, as executed by a few of the best artists of Italy.

The work is appropriately concluded by a series of ten plates comprising a varied assemblage of leaves and flowers from nature, as applicable to the purposes of ornamentation.

We trust hereafter to see a supplementary volume by Mr. Jones, in which he will enunciate what ought to be the *true* style or styles to be adopted in England, as made up from the great storehouse here spread before us. We mean a style that may be adapted externally to our climate, and internally to our requirements and peculiar notions; made thoroughly distinctive in order that we may eventually have a style of decorative art that shall with propriety be called *national*, and our own. Not directly, slavishly, and degradingly copied from any existing examples, be they mediæval, Renaissance, or Italian; but partaking of the spirit of progress which distinguishes the age in which we live, and that may stamp our own time and country with something like originality of conception, at present unknown amongst us.

Great credit is due to Messrs. Day and Son for the admirable getting up of the work, which is one of the most beautiful specimens of lithographic printing in colours we have seen.

THE ROYAL ALBERT BRIDGE, SALTASH.

The construction of the suspension bridge to cross the Tamar at Saltash, thus joining the counties of Devon and Cornwall, is being carried out with great energy by the Cornwall Railway Company, under the direction of Mr. Brunel. About four hundred men are employed on the works, which are so far advanced that in about two months one of the stupendous tubes forming an arc of a circle, with the railway attached by immense chains, will be ready for removal to the columns erected to receive the enormous burden—one in the centre of the river, where the water is 80 feet deep, and the other on the Saltash shore, just at the verge of low water. The four iron pontoons to be used in the transport of the tube are nearly ready; these will each support a weight equal to 280 tons. Two will be placed under each end, and by this means the tube and railway—the latter being suspended 70 feet from the centre—will be floated across the river.

A large portion of the materials for the second tube is also ready. The construction has been commenced at both ends, and as soon as the first is removed the entire strength of the establishment will be called into requisition, in order that the work may be expedited with all speed, the opening of the railway depending on the completion of this bridge—the works on the line generally being in an advanced state. It is expected that the line will be finished and opened for traffic in August 1858.

COTTAGES AND CLOCK TOWER, LITTLE ELLINGHAM HALL.

(*With an Engraving, Plate* XIX.)

The building shown in our engraving forms part of a series erected by Mr. John Tingey, the present occupier of Little Ellingham Hall, from the designs and under the superintendence of Mr. D. Cubitt Nichol, of 17, Heathcote-street, Mecklenburg-square; consisting of a range of farm buildings, 222 feet by 141 feet, containing boxes for fattening thirty-six bullocks, and yards for about eighty more, with root houses; stables for twenty cart horses and five nag horses; horse boxes; coach house; carpenter's and smith's shop; implement shed; barn and granary, with twelve-horse power steam engine for thrashing and grinding, &c. Forming one of the largest ranges of farm building ever erected by a tenant farmer in England;—a house for his principal clerk, with office adjoining;—Clock Tower and Cottages, and a house (not yet finished) as a residence for himself.

The cottages are intended for a groom and gardener. The clock is a very valuable one, and has been made a feature in the the general design, being erected in connection with two cottages proposed to be built.

The architect was not allowed to make any alteration in the bell chamber, which has been merely re-erected. The buildings are entirely constructed of brick, no stone being used except for steps to doors; all the bricks and tiles were burnt on the estate.

SECTIONAL FLOATING DOCK, PHILADELPHIA, U.S.

This dock consists of nine rectangular tanks, each 105 feet long, from 30 to 32 feet broad, and 11 feet deep. At each end of every tank there are three pumps with piston-rods from 40 to 50 feet long, extending upwards to a platform 28 feet broad and 29 feet long, supported by a framework attached to the end of the tank. When the tanks are laid side by side, either with or without an interval between them as the greater or less length of the ship may require, these platforms make a continuous stage, which will be about 8 feet above the surface of the water when the tanks are sunk to receive the ship, and about 40 feet when the ship is suspended. Two of these tanks have a high-pressure engine on each of their platforms, making in all four engines of an aggregate power of 64 horses. These engines work a shaft running along on each line of platform, to which all the piston-rods of the pumps are attached. They are also employed either to lift or to force into the water a rectangular air-vessel sliding up and down within each of the frames on which the platforms are erected. When a vessel is to be docked, the tanks are moored side by side, making up a length of from 282 feet to 330 feet, as is required. They are then braced together, and the several parts of the shafting are connected with each other and with the engines. The tanks are allowed to fill and to sink until the blocks laid on their upper surfaces are about 2 feet lower than the bottom of the keel of the ship to be docked. They are prevented from sinking lower than this by the air-vessels spoken of, which are allowed to move up a line of cogs on the framing as the tanks descend, until the required depth is reached, when the cogs are pauled. The frames then rest on the air-vessels, which, floating on the surface of the water with an immersion of between 5 feet and 6 feet, sustain the weight of the whole apparatus. After the vessel is hauled over the blocks the tanks are raised until the blocks touch the keel, by connecting the cogged-wheels by which the air-vessels move up and down with the shafting; the engine then turns these round and, bringing a pressure on the air-vessels, raises the tanks. Bilge blocks are then dragged under the bilge of the ship by men stationed on the platforms, and graduated shores are set against the side of the ship, from the side frames, to keep her upright before she is properly shored. The pumps are set to work, and the tanks, being gradually freed from water, rise; and, if the ship does not weigh more than 5800 tons, lift her entirely out of the water. She is then shored from the tops of the tanks.

If it should be required to raise or depress either end of one of the tanks before they are braced together, it may be done by connecting the gearing on one of the end air-vessels with the shaft, and forcing it into the water, or by allowing it to rise up the cogs, as the case may be. The chief use of this gearing will, however, be to regulate the descent and ascent of the tanks. It will be observed that the dock is capable of division into two separate docks, each having a pair of engines. It is said to be capable of raising the heaviest ships in two hours. It is easily repaired, as one section may be raised by two others for that purpose. The shafting which conveys the power of the engines from one section to another runs into a hollow sliding shaft, and may be slid in or out, as may be required by the proximity of the sections when united by the connecting beams. Between all the sections there is an universal joint in the shaft, to provide for any deflection there may be in the line of shafting extending along and over the platforms.

The cost of the dock, with the engines complete, is said by Mr. Stuart, engineer-in-chief of the United States Navy, to have been 76,000*l.*

A shallow basin is used in connection with the dock, into which it may be floated. From this basin a sliding way leads to covered slips, up which the ship may be hauled by hydraulic machinery on a cradle prepared on the top of the tanks previous to her being docked.

THE NAUTILUS DIVING MACHINE.

Some very interesting experiments with this machine (of which a full description, with diagrams, will be found at page 104 of the present volume of this *Journal*) took place on the 9th ult., at the Victoria Docks, London. A large number of engineers and scientific men were present.

Various parties from time to time descended in 25 feet of water, all returning highly gratified with the sensations experienced. Most critical examinations were made by the various experienced engineers and practical men who were present, all of whom expressed themselves most favourably, not only as to the principles involved, but as to their mechanical adaptation. It was clearly demonstrated, not only that several persons could remain in it under water for a considerable time, but that even if the tube communicating with the reservoir at the surface should accidently become disconnected, no danger would ensue to those in the machine, as they were able, by means of the compressed air within the bell itself, to expel a portion of the water, and thus to rise to the surface. The Nautilus has been for some time in use at the Victoria Docks, in relaying the sills of the dock-gate.

At the close of the experiments a *déjeuner* was provided for the company present, Mr. G. P. Bidder occupying the chair. Mr. Robert Stephenson, in proposing "Success to the Nautilus Company," said this was a machine of which almost every civil engineer had felt the want; and whilst the use of the old diving bell was confined to certain conditions not always to be obtained, this was universally applicable and ready for use in the most difficult cases. The engine and condensing-pump, which he had inspected, were scarcely inferior in ingenuity and completeness to the diving apparatus itself. He expressed his conviction, from a personal examination of the capabilities of the machine, that he had never witnessed one so perfectly adapted to the purposes for which it had been designed.

The following is the report of the resident engineer:—

"Victoria Docks, June 8th, 1857.

"The work performed by the 'Nautilus,' under my superintendence, in replacing the roller-path of the outer gates at this dock, has been, for the week ending the 6th instant, forty-three hours, or four days and three hours. In this time two sections have been cut around (concrete), the connecting bolts cut off, the old paths taken up, and two new ones replaced. One entire tide of eight hours was lost, in replacing some wedges which were disturbed by the opening of the dock gates. The last section was placed in twenty minutes after being lowered down. During the time the dock has been undergoing this operation, the gates have been regularly opened every tide, no delay whatever having been experienced. I have yet five other sections to put down. Last summer, in putting down a new and removing one old section, by the aid of my men in submarine armour, I was occupied three weeks and four days, during all of which time the gates were of necessity open, and the locking was done from the tidal basin. The efficiency of the 'Nautilus' in this operation is demonstrated by its performing the work of three weeks and four days, in two days one and a half hours, there being no more men employed in the one case than in the other. I have been down in the 'Nautilus' very often; and I am satisfied that very nearly the same amount of work can be done under as above water in laying masonry, &c."

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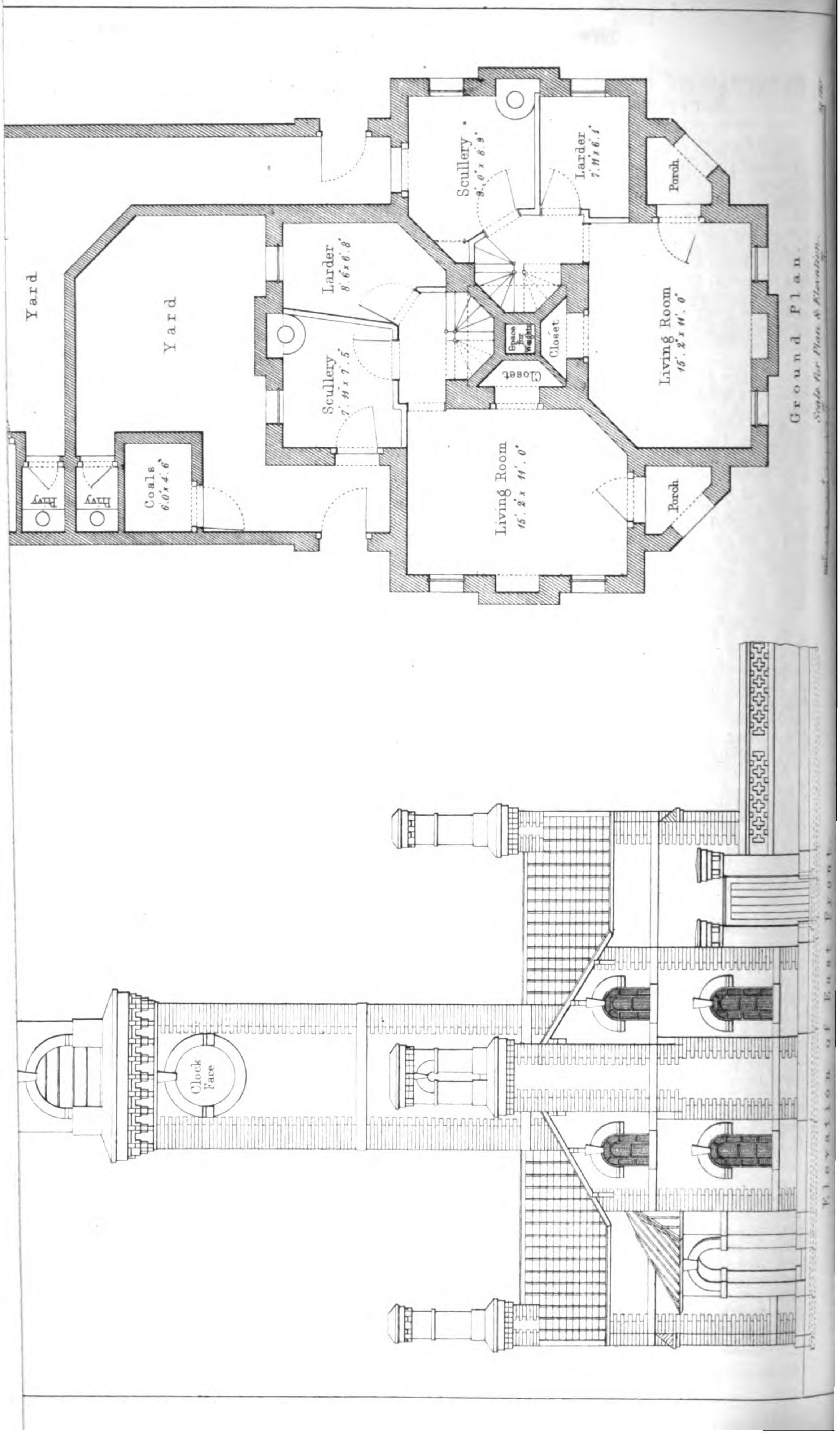


Ground Plan.
Scale for Plan & Elevation.
Elevation of East Front.

PRE-RAPHAELITE DEFINITION OF ARCHITECTURE. COPYISM.—COMPETITIONS.*—

By Samuel Huggins.

One of the most remarkable phenomena in the world of art is the onward progress of a recently-formed school of artists, upheld by at least one writer of eminence, known as that of the Pre-Raphaelite Brethren, whose peculiar doctrines are put forth as the expression of radical principles which are not only to operate upon architecture and painting and the other arts, but to pervade the whole of our intellectual, social, and moral life; though from all I have heard or seen it has had but little of a moral influence upon their own. This has already affected painting and sculpture, and in some measure architecture, and to be consistent should be carried into every department of fine and useful art. By this school, which has been very justly considered a revolutionary one, all our definitions of poetry and art, as laid down and acted upon by the greatest poets and artists, are reversed. With them poetry is but higher knowledge, and reality the only genuine romance for full-grown persons; and the proper aim of art is not creation, but literal imitation; so that those faculties that have all along been considered essential to the artist—invention, idealisation, imagination—are, if not ignored, at least kept in subordimation, and employed only so far as they can contribute to the literal matter-of-fact rendering of nature.

Painting is required to abandon her time-honoured office of elevating and refining the mind by dint of a truthful rendering of the beautiful and poetic in nature, and to betake herself to the work of the preacher and moralist. Sculpture is to follow in the same path, as she best can; and even architecture, through the medium of sculptured subjects, which are to be henceforth her all in-all, has tasks assigned her such as neither Greek nor Barbarian ever dreamt of.

Ruskin makes sculpture the vital essence of our art, and sneers at the old definition which refers us to proportion and form as the source of its charms. He defines architecture—"The art of designing sculpture for a particular place, and putting it there on the best principles of building;" which is not a whit more sensible than to call naval architecture or shipbuilding the art of designing the figure-head of a vessel and fastening it properly on. With him nothing is entitled to the name of architecture but what bears sculptural subjects of high significance, in which features all virtue and power of the work would lie—like Samson's strength in his hair: a warrior would be inspired by it with bravery and fortitude, while the youth should gather consolation under its shadow for unrequited love—conditions, you are aware, indirectly laid down in his Edinburgh lectures, in which he rebukes the genius of our Whitehall banqueting-house for being without such influence. I cannot say whether the charms of proportion and form would go to the extent of consoling me for the unkindness of a mistress, or of awakening in my breast any extraordinary bravery; but I know that a piece of noble architecture, by its general effect, to which the graces of proportion and form were almost the sole contributors, has always had a wonderfully pleasing and harmonising effect upon my mind. It does not speak to or reason with me as a poem or essay would, but it soothes and elevates me just as music does. And this is the legitimate effect of architecture, and the effect which, judging by the way in which it is always spoken of, it has always had upon minds susceptible of such impressions. Such is the effect it must have had upon the mind that called it frozen melody, a music that has ceased to vibrate. Such is the effect it must have had upon Coleridge, when he called a Gothic church a petrified religion; on Madame de Stael, when she called Milan cathedral a beautiful image of grief. Byron speaks of the *eloquent* proportions of St. Peter's church, at Rome—

> "Which unroll
> In mighty graduations, part by part,
> The glory which at once upon thee did not dart."

The genius of architecture, like that of poetry, delights in various kinds of effects. A poem may abound in comparisons, pictures, and pathetic allusions, or, without being destitute of merit, it may be devoid of all these; and so may a building be severe and exclusive, and yet be instinct with some of the very highest qualities and utterances of art. Masonic architecture, by proportion and form and colour alone, will blend and harmonise with the surrounding works of the Supreme Architect, and fully express to us the idea of their peculiar purpose; and it affords scope for the exercise and expansion of all the faculties of the architect, and the employment of all his sympathies with the varied beauties of nature, which may all exert an influence upon a design, though they may not literally find a place in it. Architecture may embrace in its niches and panels, or on its brackets, the personages and events of history, or it may not: it may find abundant work for the imagination in conventionalised and imaginary foliage, and in the beauties of geometrical form—than which latter nothing can be better fitted for introduction into architecture, or appeals more forcibly to our sense of the beautiful, the poetic, the romantic. There is nothing within the range of the eye, or even the imagination, but what might be laid under contribution by the architect; but architecture is independent of any direct imitation of living forms, and the style of a people who were prohibited from using any natural object—the Saracenic, which is form and proportion alone—is not only a true style, but perhaps the most beautiful ever practised. And there are buildings nearer home universally admired for their beauty, some as gems of art, that are all but void of sculpture, and in which what they do possess certainly constitutes but a small portion of their charms.

With what is exclusively architectural sculpture, and forms an integral portion of the substantial fabric, such as modillions, carved keystones, sculptured mouldings, scrolled foliage, of the Greeks and Romans; the corbels, dripstone-terminations, bosses, water-tables, and so forth, of the Gothic; the capitals and bases of all styles—features which are each capable of infinite modification and design, while at the same time they can be executed by common workmen—you may produce architecture perfect both as to decoration, composition, and skyline; and in a domestic building the chimneys may be so arranged, formed, and decorated as to supersede any other embellishment in the way of finial. The window alone, reflecting the hues of earth and sky, and of every object of art around, basking in the glories of rising and setting sun, may be a perfect, ever-changing picture of inconceivable beauty. You may produce a higher and a grander whole by adding to the architectural elements I have enumerated the contributions of high-art sculpture, which may be viewed as dress, as a jewelled robe thrown over the limbs of beauty; and it is not the shame of architecture that it should be dependent for its most vivid manifestations upon the chisel of the artist-sculptor, but its glory that it will embrace its highest productions. With sculpture it becomes more phonetic, and may have more direct and immediate influence of a moral and intellectual nature; but without it, it may raise emotions of the sublime which, as Mr. Fergusson justly remarks, are the highest that sculpture itself could excite.

Masonic architecture may be so designed—as is the Parthenon, the order of which, the Doric, is more dependent than the others on sculpture—as to render the sculpture essential, and it may be so designed that the architecture becomes the mere framework of the sculpture; but it is not an inevitable necessity in any order that the architecture should be subordinated, or stand as incomplete without sculpture.

Architecture is the art of idealising the great physical exigence of shelter, and enclosing space by forms that shall possess fitness, durability, and delight. It is the art of constructing the beautiful, of transfixing the melody, of petrifying the poem—not by the bright utterances of historic or poetic sculpture, or by these alone, but by its arcuated and columnar perspectives, its mysterious recesses, its fretted vaults, its majestic domes. It is the creator of the eurithmical mass, the symmetrical and harmonious utility, the gorgeous palace, the cloud-capped tower, the solemn temple. It is, in a word, the tent, the cave, the hut, the wigwam, exalted from the lowly vale of material necessity to the ethereal regions of art and beauty.

The popularity of its author could alone render necessary any notice of such a theory, if theory it can be called, as the one we have been considering. It is, I take it, nothing more than an expression of the very peculiar feeling of an individual whose eloquence as a writer gives to his views an importance to which logically they have no claim. Let me warn the young architect of the danger of being led captive by mere eloquent words, and remind him of the necessity of looking for and carefully weighing the arguments of every author he reads. Read, says Lord Bacon, not to contradict and confute, nor to believe and take for granted, nor to find talk and discourse, but to weigh and consider. Nor act, I would add, upon any man's opinion, until by due consideration of it you have made it your own.

* Abstract of the Annual Address to the Liverpool Architectural Society.

Remember that neither styles nor works are to be tested by individual feeling, but must be brought to the immutable standard of reason; without the full exercise of which in yourselves, whatever of poetic feeling or imagination you may possess, you are in constant danger of falling into the most mischievous and ruinous absurdities.

Seek all external light, but consult your own intuitions, which, like the promptings of a simple and uncorrupted heart, are to be trusted rather than the mere dicta of others. I remember ideas that occurred to me when I was a very young student, respecting the architectural doings around me, which at the time I scarce ventured to express to my nearest friends, so altogether opposed were they to the teachings and practice of the day, but which are now seriously entertained by all thinking members of the profession.

I have given you what I conceive the true definition of architecture—a definition which frees it from all the trammels of styles and schools, models and canons, ancient and modern, and places it alongside the free muse of Cowper and Wordsworth. My views as regards its relation to the past, what constitutes true originality in architecture, and what is likely to be its course and direction in future, will bring us to another phenomenon of the day,—I allude to the disparaging views taken of the architecture of the last three centuries by some of the ablest and in many respects most judicious writers of the day; with which I cannot entirely coincide.

Nobody views with more contempt than I do anything like copyism. But I cannot think that the art is to be called false that merely makes a free and enlightened use of the elements of other styles; and that to hold an original relation to architecture it is necessary that we should, like the spider, weave all from our own entrails, and create even the elementary language of the art itself. None but artistic giants could, by the ignoring of all that has been done, and commencing absolutely anew—guided alone by present requirements and circumstances—create works such as would satisfy the tastes of the day, cultivated as it is by the study and contemplation of the best works of antiquity.

To me it appears most rational to take the elements of the purest and most intellectual style we can find as our starting-point, which I need not say is the style of architecture originated by the Egyptians and Greeks, and practised and enlarged by ancient Romans and modern Italians. This being the progenitor of all styles, it is most natural that it should be made the basis, the outline, the framework or nucleus, of our future architecture. Nor is there any style so much adapted for growth, expansion, and progress, or that has so great a power of digestion and absorption of new detail and decorative element that time and circumstances may bring to it from other styles and from every possible source.

The styles of the past are not so many insulated architectural systems—they are one great living and breathing fabric of architecture. The differences between them are superficial—their resemblances are profound. The true artist discovers what is simple, permanent, and self-existent, and traces in each style of the past the germs of future expansion; and true progress, I consider, lies in the direction of extracting what is still vital from all styles, and bringing it to one broad system, taken as a framework; and which can be scarcely confined within less than the extreme range at present indulged in. The multifarious and growing requirements of modern life render the confinement of future architecture within the limits of any one style of the past impossible; and there is I trust taste sufficient to render anything barbarous unsatisfactory. There will always be purposes for which a chaste Classic or a florid Gothic will be appropriate. The central productions of the style will be a union of the two systems, breathed on by the spirit of the beautiful that beams from the works of the Saracenic creations, in which, I believe, many of the problems of the day, more especially such as relate to colour and polychromatic embellishment, and mural decoration by geometrical form and device, will be found all but worked out and solved for us. There is much of intimate relationship—real architectural and philosophical affinity—between Classic and Gothic. How should it be otherwise? And a progeny of beauty yet undreamt of will result from their union, belonging to or forming a style or system the most comprehensive, the most responsive to nature and humanity, that has yet been evolved. This does not apply merely to our own country. If architecture becomes practised on true principles in different countries, then increase of international communication must operate to the production of a general resemblance, till we shall have something like a universal system of architecture, with but slight local modifications.

In the early ages of the world styles of architecture grew up but little affected by each other, which may be said, I think, of the Egyptian, Assyrian, and Indian styles; but as means of communication between nations increased, the influence of one architecture upon another became apparent. There will doubtless be a greater intercourse in future between different countries than ever existed before; and we may naturally look for a corresponding increase of general uniformity in their architecture. And as it is impossible to say to what extent international communication will not be carried, so we cannot set bounds to the unity that will spring up in the architecture of civilised lands. It is not impossible that mankind will some day speak one language, or but different dialects of one language; nor need we despair of having but one architectural style, modified in each country by climate alone.

The number and amount of the premiums in the great Government competition should augur good to architecture, as being not only in themselves calculated to give an impulse to the study of the art, but by their example to shame committees from the insulting offers which, though not responded to, I should think, by any deserving the name of architect, are yet calculated to degrade the entire profession in the eyes of the public. But while as an architect I cannot but feel beholden to the Government for thus coming to the rescue, I question whether if the evil alluded to were remedied there would not still remain abuses sufficient to prevent any balance of good accruing to architecture. In proper hands I know no means so potent to give new life and vigour to the art, as public competition. Rightly conducted, no noble patronage, no royal charter could do half so much for us. Some of the greatest achievements of art, you are aware, both in this country and on the continent, are amongst its fruits; and it is to me a matter of astonishment that any one should be seriously opposed to the system in the abstract. Carried on, however as at present, the resulting evils, I fear, far outweigh the advantages. By far the greatest of these arises from the undue relative importance that, by the usual and obvious principle of decision, becomes attached to the mere manipulation and getting up of drawings, to which if a competitor is to have any chance of success he really must pay more attention than to the design itself.

I believe that in nine-tenths of the competitions of the day, if the best design that had ever been conceived in this world, surpassing in every excellence the master works of all Greek, Mediæval, or Italian genius, were submitted, in line or geometrical shading only, the author disdaining to descend to the trickery of colossal perspectives, accidental shadows, and atmospheric effects, it would not have the least chance of being chosen. So certain, generally speaking, is the success of the largest and most dashing set of drawings, that there is some little danger of architecture getting out of the hands of the architect altogether, into those of the second or third rate water-colour artist, who, if he acquired a little knowledge of the orders of columns and the disorders of buttresses, just sufficient to enable him to steal decently, would stand on a better footing than the architect himself.

One would suppose that the incompetency in committees that could bear such fruit as this, and which I believe is working much mischief to architecture, and degrading the system far more than dishonesty itself, the "schoolmaster," who has been so much abroad of late years, would soon remove. Surely, the faintest glimmer of intelligence would suffice to tell any one that the executed work can be none the better for the brilliant sky that bends over it, and the fine ladies and gentlemen who gaze admiringly on it in the picture—a part of it which I suppose the wildest and blindest contractor would hardly undertake to execute.

The design for a royal palace or town hall might be fully rendered by a merely architectural draughtsman, on a few penny sheets of paper, the cost of which is all the expense the designer should be compelled, or, indeed, allowed, to go to. Nay, if the tribunal were composed of men possessed of one spark of common sense and another of common honesty, an idea sent in by a working joiner, drawn on the back of a piece of sandpaper, would be as certain of receiving fair consideration as would a glazed and gold-framed picture.

TIMBER-BENDING MACHINE.

The Timber-Bending Company, York-road, Lambeth, *Patentees*

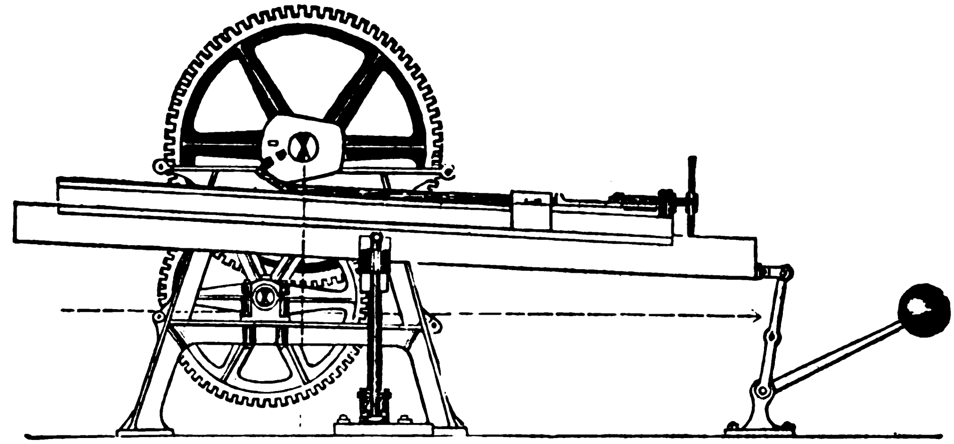


Fig. 1.

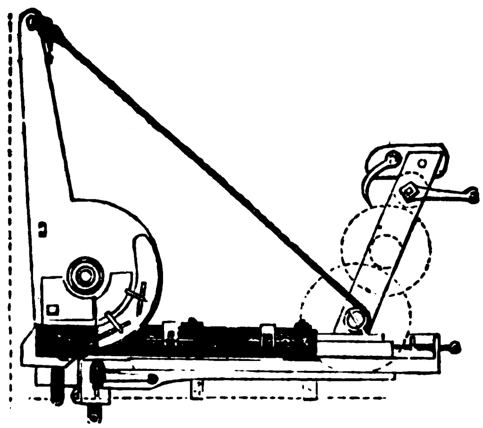


Fig. 2.

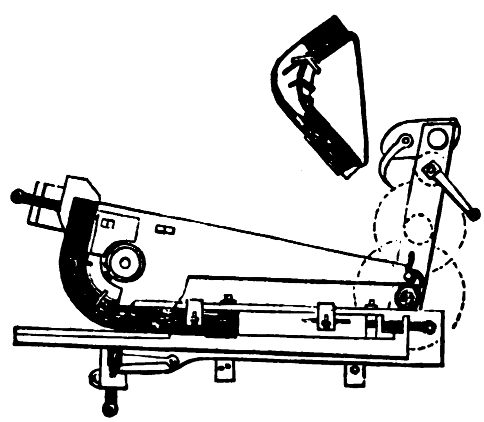


Fig. 3

This invention consists in so conducting the process that the piece of timber is subjected to pressure on all its sides during the bending, in place of being simply bent over a form, as has heretofore been the practice. By this means the wood is prevented from swelling or bursting, as it is liable to do when bent without such support. The apparatus employed for large timber consists of a lever, which turns on a centre or axis; to the lever is attached a trough, of the curve to which the wood is to be bent, one side of the trough being moveable, so that it may be pressed firmly against the surface of the wood by wedges. Underneath the lever is a travelling table, the distance of which from the curved form can be adjusted by a screw. The piece of timber is laid on a flexible band of metal, placed on this table, and clamped down thereon, so that it is pressed upon all sides; one end of the timber is then clamped to the forepart of the curved trough on the lever, the other end of the timber buts against a block, acted on by a screw. When this is all arranged, the lever is drawn down, during which operation the timber passes into the curved trough; when this is done, the two ends of the wood are connected together by a tie, which takes hold of the ends of the flexible band before mentioned, the wood being still confined by the curved trough; the flexible band and the tie are removed from the machine, and are so held until it is set. The time occupied in bending a piece of timber, say 15 feet long, and 12 inches by 9 inches in section, is about twenty minutes. For bending small timber a much simpler machine is employed, and the pressure is confined to the ends of the piece during the bending process.

Fig. 1 is a side elevation of a small machine to be worked by manual labour, and suitable for bending small articles. The mouldblock shown fitted on the machine is for forming chair bottoms, but any other block or mould can be substituted. Fig. 2 is a plan view (to a small scale) of a machine suitable for bending ships' timbers, and such like articles of about 16 feet long by 16 inches square. Fig. 3 is another view of the same machine, after the timber has been bent into the form shown by detached view.

REBUILDING OF NEWGATE GAOL.

The Court of Aldermen having determined on the rebuilding of Newgate Gaol on the cellular system, the plans prepared for that purpose by Mr. Bunning, their architect, have been adopted, and the works commenced by the demolition of the present north wing of the prison, containing wards in which several prisoners were usually congregated together, and also the condemned cells. The portion of the intended buildings now in progress will consist of five stories above the basement, and contain 130 separate cells, with access thereto on each story above the ground floor by means of galleries on either side of a central corridor. The basement story will contain punishment cells, baths, and store-rooms. Airing yards will be attached to the building, and adequate accomodation provided for the officers in charge of the prisoners. The system of the cells and the system of ventilation will be similar to that which has been successfully adopted at the City Prison, Holloway, which was also erected from Mr. Bunning's designs. The building will be entirely fire-proof, and instead of the prisoners being, as now, taken from the van in view of the public, the plan for the new building is so arranged that the van will be driven into the gaol, and the gates closed on the prisoners before they alight. In the rebuilding of the gaol, the governor's house and the external walls will be retained, so that the architectural appearance of the present structure will not be interfered with. The amount of the contract for the works now in progress is 12,550*l.*, and the contractors are Messrs. Browne and Robinson, of College-hill, City.

ON THE SUPPLY OF WATER TO GEELONG.

By John Millar, C.E., Engineer-in-Chief to the Geelong Water Commission.*

Three modes of supply have heretofore been proposed by others prior to my connection with the Commission.

First, in 1852, Mr. Henry's—A pumping and very partial gravitation scheme combined. A crude and undigested plan, upon a very low scale.

Second, in 1853, Mr. Taylor's—A pumping scheme.

Third, Mr. Darbyshire's—A modification embracing both the foregoing plans, being a combined pumping and gravitation scheme, from the river Barwon, at Buckley's Falls, at an altitude of 54 feet above mean tide level, from whence the water was to be raised by pumping to an additional altitude of 170 feet; thus supplying Geelong proper, a population of 30,000, at a limited consumption of but 10 gallons per head per diem. On the engineering merits of the scheme it will not be necessary for me to make any observations, as a fatal objection occurs at the very outset of its consideration, namely, in the quality of the water it is proposed to afford.

Subsequently, and very lately, a fourth proposition has been mooted, namely, an extension of the Yan Yean to Geelong. It requires but the enumeration of a very few counter-reasons to set so futile a scheme on one side.

To those not quite conversant with the Yan Yean scheme, I may briefly say that it is the name of the reservoir which is intended to supply Melbourne with water. It is an extensive natural basin, comparatively shallow, covering about 1300 acres, into which the waters of the river Plenty are directed, and is situated 598 feet above the level of Hobson's Bay.

The water, if brought in an unbroken line into the city (assuming the pipes to stand the pressure) would command the highest houses. It is however imperative on that commission to filter their water from its vegetable and other impurities, and it is their intention to construct such filters adjacent to the line of mains at Darebin Creek, about midway, say 300 feet above datum; therefore the pressure in relation to the height of the highest houses in Melbourne or elsewhere must be reckoned only from the altitude of the filter-beds.

The length of pipe main carrying the water to Melbourne is is about 20 miles; and the idea is to continue a sub-main (branching to Williamstown), along the Geelong and Melbourne Company's Railway to Geelong, the distance being an additional 50 miles, to be fed by the re-erection of the old Collingwood cast-iron tank at North Melbourne, from whence Williamstown and Geelong would be permitted to get a night supply, thereby introducing and perpetuating (on the supposition of there being water to spare) the exploded intermitting supply.

Besides, in alluding to it at all (which, of necessity, I am called on to do) as the only work of the kind as yet approaching completion in the colony, there are certain geographical and physical considerations, which I should notice, were it not that by so doing I would run this paper to a greater length than I had contemplated. Seeing however that attempts have been made to foist this water on the district to which I have the honour to be engineer; and having proved the great difference of exceeding purity between our own and the water in the Yan Yean reservoir, I therefore object, on principle, to its introduction to Geelong.

One among other errors which might have been obviated by the appliance of engineering forethought and skill—namely, the shallow embankment, causing the back water for a considerable acreage from its perimeter to be so shallow in its depth, as must inevitably cause increased loss from evaporation, absorption, and the moisture entering vegetable life; consequently rendering the water apt to vegetate, and become highly impure. What a splendid opportunity was here lost, and which presents itself to a comprehensive mind, in the possibility of having the finest artificial inland lake in the world, impounding water enough and to spare, the annual value of which as a motive power alone, or for irrigating purposes, would have been equivalent to the interest of the entire expenditure, large as it has been.

In addition to the first outlay in any attempt to supply Geelong, there would be an annual charge by the Melbourne Commission for the water itself.

* Abstract of a Paper read before the Philosophical Institute of Victoria.

From my earliest connection with the commission I have advocated the adoption of the gravitation principle; and in all my subsequent and consecutive reports I have invariably urged on their attention the advantages arising from, and the necessity of providing the supply from a reservoir placed at such altitude as would give a sufficient command above the level of Geelong proper and its suburban districts, as would enable us to have a high-pressure supply to all, and on such a scale as would be ample for the rapidly increasing population, and of such a nature as in all future time could be supplemented without loss or deterioration to the then existing works;—being, all things considered, the cheapest and best: the annual cost of the maintenance of such a system being a mere bagatelle as compared with the numerous advantages gained by its adoption.

It is an admitted axiom, that water collected in reservoirs from the rainfall over an extensive catch-water district, is not only purer than river water, but infinitely superior to well water, artesian or others, all of which are liable, more or less, to much mineral impregnation.

Taking the foregoing as a truism—and who can doubt it?—as regards the old country, how much more is it applicable to this country and to this particular locality, the subject of the present paper, where the rivers are either originally unfit for such uses, or are being rendered so. The Moorabool—saline, brackish, nauseous. The Yarowee, originally one of the purest, least saline, and most wholesome river waters in the colony, has become totally unfit for domestic purposes—quite turbid from the uses made of it by the mining population; running as it does through one of the most populous and successful gold mining districts at Ballarat, it has become so charged with finely comminuted particles of clay held in suspension, of an unusually persistent character, from the gold-washing and puddling operations —and which I find do not subside even on its reaching the Barwon river, with which it intermixes on its course to the ocean border; and at a distance probably not much short of 100 miles, taking into account its many tortuous and capricious meanderings through the bush, it is still foul with extraneous matter, next to impossible to arrest even by the finest filtering media.

Finding the Barwon above its confluence with the Yarowee apparently pure to the eye, almost transparent, but palpably not so to the palate, being highly charged with saline matter, impregnated, no doubt, by having its course over or intermixing with the numerous saliferous spring which there abound.

Whilst on the subject of saliferous springs, I trust it will not be considered out of place or an unpardonable digression on my part to make a few remarks thereon *en passant*, seeing that, as is well known to every settler, they abound in this colony, leaving the toil-worn traveller no alternative but to partake of them, however nauseous the draught, which but turns out to him a Tantalus cup; and instead of the expected pure water, he of necessity has to partake so far of Epsom salts and damper for breakfast, or damper and Epsom salts for dinner; so *vice versâ*.

I doubt not but that it may have come under the observation of many that most of the large as well as smaller salt lagoons are cup-like in formation, which I believe to be caused by a gradual sinking of the outer crust of the earth as the saliferous springs bring the brine to the surface, and which have found their way thither by "faults in the flag," caused possibly by slight shocks of earthquake in time past.

To make this theory more readily understood to those who may not have had any experience in mining, more particularly salt mining, I shall further explain what I mean by the "flag." It is a term generally used by the miners of Europe for a very hard earthy matter of about 2 feet thick, at some 60 or 100 yards from the surface of the earth, under which the upper strata of rock-salt is generally found, varying in thickness from 10 to 15 yards. Brine is made by the passing of water (percolating from a higher level) over this bed, and which, becoming saturated with the rock, escapes to the surface by simple pressure; rising through the faults or fissures which may have been formed as before explained, or by other exciting causes. This, when evaporated by our dry atmosphere in these lagoons accounts for the crust of salt found in and around them in such quantities.

As the bed of the rock salt is dissolved by the motion of water over it, it becomes brine, and on making its way to the surface, leaving a vacuum, the outer crust will naturally sink, and follow the wasting away of the rock; accordingly we find these lagoons formed, and, I doubt not, increasing in depth, but so imperceptibly as scarcely to excite a passing notice. It is a well-known fact, that such has taken place in the mother country, at Northwich, and other salt neighbourhoods; where land formerly elevated is now submerged many feet under water. No doubt this sinking in the old country will and does take place much more rapidly, which is easily accounted for, when I state that it is no unusual thing at many of these places to pump up an average of a thousand million gallons of salt brine per year.

I should mention, that generally under this first or upper bed of rock salt (that is between the first and second beds,) is to be found a stratum of ten yards or so in thickness, containing no particle of salt, but quite impermeable to water; it is therefore quite natural to expect that the brine from the upper layer will find its way to the surface, just as it does with us.

To return:—Being foiled by the impurities of the sources of supply which offered themselves in the neighbourhood of the town, I turned my attention to the source of the Barwon itself, to the elevated districts—the high and densely-timbered ranges, which, as an outlying belt, intercepts and condenses the rain-bearing clouds from abrupt contact with the saturated volume of air, highly charged with humidity from the Southern Ocean, carried landward by the prevailing winds; and, as far as I have been enabled to judge from the geological structure of the country, its general configuration, its wild and precipitous glens, its systems of deeply-indented ravines, abrupt hills, deep creeks, elevated ranges, and extensive gullies, all tend to the belief—in the absence of any well-founded meteorological data, or even statistical information to go on—that the local and visible effects have been produced by the copious outpourings amounting to torrents of rain, which must have been supplied from the condensing vapours precipitated on its surface; a surface proving the humidity of the climate, clothed with all but perpetual verdure, even in the summer season, when the low lands or plains are literally scorched up, and not a blade of grass to be seen. These circumstances constitute it as one of the best rain gathering districts probably in the colony, the aggregate volume of which, I doubt not, will ultimately keep the reservoir, where I have decided on, after much and diligent search in the valley of the Wormbete, well supplied, after making all due allowance for evaporation, leakage, absorption, decomposition, or other waste.

On the occasion on which I laid before the commission my report of this district, and a recommendation of the site for the reservoir, I had the honour of their approval sufficient to warrant me in taking a feature survey of the valley, and its numerous creeks, dying out, or rather taking their rise in the high timbered ranges, abutting against the east and west saddle separating them from the Retreat Creek of the Wormbete forest, and comprising at least ten thousand imperial acres of gathering ground within the water-shed marginal line, the surface of which I found to be like the general surface of the colony, hard and impermeable; so much so, that the body of the waters falling on its entire extent quickly drain off, from its peculiar conformation, suddenly swelling the numerous creeks and gullies to an enormous size, thus causing rapid but temporary floods after the rain, which, from the formation before alluded to, runs off in four or five days, gorging the Barwon, and causing it to overflow its banks, inundating the surrounding flats, swamps, and lagoons north of the reservoir, again to find its way into mid-air by evaporation.

Traversing these creeks, and finding that the majority of them and other minor gullies were the natural channels of the available rainfall of this favourably circumstanced gathering ground, such as I have attempted to describe and represent by my finished map, which I have the honour to exhibit this evening, centred themselves by an almost arterial system in the valley of the Wormbete, near Hopkins's pre-emptive purchase. I at once determined on that as the best and most advisable site for the reservoir, provided a more careful inspection and mature study warranted it. John Macadam, Esq., M.D., verified, in almost every particular, my original assertions, that the sources which I had recommended, namely, the Wormbete and Retreat Creeks, yielded as pure, if not the purest, water in the colony of Victoria, and quite equal to the majority of the purest known waters in the mother country.

Subsequent and more mature consideration has but affirmed me in my first resolve, seeing that all that was required in this naturally formed valley of the Wormbete, is the construction of such works as may enable me to arrest and impound the whole of the flood-waters of the hilly country, on their onward passage to the sea, by the channel of the Barwon.

Besides, having discovered the possibility of otherwise increasing the quantity very considerably by intercepting the Retreat Creek and its tributaties, taking its rise and course south of the great dividing range of the Wormbete Forest, having its embouchure into the Barwon some miles distant, higher up the stream, by drifting a short tunnel through the dividing range at a suitable level into an already formed natural channel, I shall be enabled to convey this additional supply into the Wormbete reservoir by way of Western Creek. By securing this additional quantity, I make assurance doubly sure, considering that in our variable climate, it is but prudent to put beyond hazard, or even doubt, the question of supply, by embracing all available sources within compass.

Every attention has also been paid to the principal point in reservoir construction, *i. e.* the natural impermeability of the bottom, and which I have thoroughly ascertained by numerous trial pits, which I ordered the chain and staff bearers to sink to an average depth, whilst my assistants were otherwise employed in camp duties, plotting their field-work.

Care has also been taken in selecting the site for embankment within certain limits of deviation, the foundation of which must either be solid or capable of being made so, having good natural abutments on either side of the valley, at the shortest possible span, the height sufficient to impound forty feet of water at centre of embankment; considering, as I do, that the great value of a reservoir, more particularly in these latitudes, depends principally on its greatest cubical contents with the least possible superficial evaporating surface.

To make this a certainty, and the more palpable to the ready understanding of the commission, and that such may not be altogether depending on the mere assertion of my verbal opinion, I have had an accurate surface survey, longitudinal and numerous transverse sections, taken at every five chains across the valley, showing its converging sides, and giving, at same time, the area of each cross section, and the means of plotting accurate contour lines on the map, describing the tortuous perimeter of the water levels at the three several depths, of forty, thirty, and twenty feet at embankment, thereby enabling me to come to as close an approximation as may be of the separate cubical quantities of water retained by each proposition.

Acreable Extent and Capacity in Gallons of Wormbete Reservoir.

Contour.	Imperial Acres.	Gallons.
40	252	1,661,318,850
30	184	950,677,092
20	124	583,400,687

The first or forty-feet contour level is about half the annual rainfall, and which would be equivalent to two and a half years' consumption of double the present population, at the Melbourne standard modicum of twenty-five gallons per diem—even after taking into account the probable maximum waste arising from absorption, decomposition, leakage, and evaporation, on the one hand, and of no rainfall whatever for the above period on the other.

This, be it remembered, is without taking into account any portion of the evaporation returned to the reservoir during the two and a half years' assumed drought, in the shape of dew precipitated on the surface of the quiescent waters of the reservoir, which of itself alone would yield nearly another month's supply.

In the absence of all meteorological observations to be depended on in times past for this locality, I must perforce draw my conclusions from facts founded on those of the nearest adjoining districts, where a known careful register of the quantities of rain falling has been kept for a series of years, as indicated by the pluviometer. I grant, however, it is difficult to calculate the rainfall in any given district, even to an approximation by data resting on observations taken elsewhere; yet at the same time, in the absence of such valuable and necessary local information, I must say that in proper hands the other will approximate nearer the truth than by quoting authorities from another hemisphere; it being exceedingly doubtful, in the present state of meteorological science in the colony, how far it would be safe to rely on such analogy, besides affording no guide in estimating the proportion of rainfall in so favourably circumstanced a locality as that of Wormbete Forest. Besides, I prefer dealing with facts, when to be had; and whilst on this subject I will here record one fact not generally known either in the colony or the mother country—a fact regarding the great amount of difference existing between the rainfall of Melbourne and that of several cities of Europe.

Melbourne exceeds London by upwards of 33 per cent. From a mean of five consecutive years, commencing with 1847 and ending 1851, both inclusive, it was as high as 32·63 inches; while London was but 24·04 inches, taken from a mean of twenty years anterior to 1846; showing a difference of 8·59 inches, or in other words, an extra 125,000,000 gallons of rain per square mile, leaving a large balance in favour of colonial accounts, and which but require the appliances of skill to turn to some profitable use.

Simultaneous observations upon the quantity discharged by the outlets of this now ascertained area of surface drainage, and a comparison of the quantity of rainfall will afford something like data of the greatest importance. This, together with a careful study of the configuration of the surface of that district, with its attendant or exciting causes, enable me to approximate pretty near the truth of what proportion of rain can be considered available; no doubt, however, this must be modified by the local circumstances of the Wormbete district, meteorological, hydrographical, and physical; evaporation, rainfall, general configuration, soil, &c., not only within the bounds of the catch-water district, but the surrounding country generally; as well as other varied circumstances, such as the prevailing winds, and other counter-agents bearing on the results. All must be taken into account and properly considered, with such accurate information as I may have been enabled to collect and record, so as ultimately to give me a perfect basis from which to deduce a calculation that can be depended upon in its resultant facts; not forgetting to take into account that the water-shed commences at a high level, something like twelve to fifteen hundred feet above the sea board, falling with rapid but regular gradients towards the valley, ensuring a rapid conduction of the water falling on its surface to the reservoir, thereby diminishing the likelihood of extensive evaporation and mineral impregnation.

Touching the vexed question of evaporation in these colonies, I may here state, that the hitherto theoretical opinions formerly held by several parties in Victoria, have been considerably toned down by practical experience. It should not, however, be forgotten, that evaporation is more or less modified by several attendant causes acting on the atmosphere, such as temperature, moisture, force and direction of the wind, all tending to that uncertain condition, which, ever varying the evaporation, precludes the possibility of having any fixed rule, excepting an average founded on actual observation in the locality, and extending over a considerable space of time.

My opinion, founded on actual observation on large bodies of deep and almost quiescent water, such as reservoirs in a still state, enables me confidently to pronounce it as considerably under fifty-two inches per annum; and very probably the opinion held by Colonel Cotton, from more extended observations in the colony as regards time, are still more in conformity with the fact. His opinion was forty-five inches.

As a general principle, I have advised that the consumption of Geelong be apportioned as follows, looking on the standard modicum, twenty-five gallons allowed in Melbourne, as no criterion for colonial guidance, having the likelihood of a most abundant and unlimited supply. In my calculation, I allow sixty gallons per head per diem, for the summer consumption, to supply the ordinary domestic wants, &c., &c., as hereafter enumerated, for a population numbering fifty thousand souls. For the winter half-year, when consumption necessarily (for public purposes) is very much diminished, I allow forty gallons; being a mean of fifty gallons per head per diem.

SUPPLY.

	Inches.
Assumed Rainfall taken at	36·00
Evaporation	27·00
25 per cent rainfall	9·00

	Gallons.
6666 imperial acres, or two-thirds of water-shed, allowing 9 inches or 25 per cent. as available rainfall	1,356,758,310
3334 imperial acres, or two-thirds of water-shed, in the immediate vicinity of the reservoir, or 50 per cent. as available rainfall	1,357,165,378
252 imperial acres surface level of 40 feet contour. Rainfall .... 36·00, Dew .... 4·00 } 40·0 inches ...	227,958,192
10,252 acres, giving available gallons of water per annum	2,941,881,880

Cubical Capacity of Reservoir:

	Cubic feet.	Gallons.
Wormbete Valley Proper...	207,976,236	
Western Inlet	53,541,047	
North-east Inlet	5,147,058	
	266,664,342 or	1,661,318,850

Evaporation:

Acreage at 40 feet level of surface 252	Mean, 218 to 4166 feet.	
Ditto at 30 feet ... 184		246,462,969
		1,414,855,881

DEMAND.

Consumption of 50,000 population, at an average of 50 gallons per head per diem, for all purposes, for twelve months ...	912,500,000
Showing a balance of five hundred millions of gallons, as provision against occasional droughts	502,355,881
Consumption for an additional six months	456,250,000
Balance of forty-six million gallons for evaporation and contingencies, after supply for eighteen months	46,105,881

In calculating the supply, I take the water-shed, being a surface catch-water basin, assumed to be at a most moderate estimate *ten thousand* acres in extent, the drainage of which either flows with the Barwon, by way of the Wormbete Valley, or other tributaries, which can be diverted thither and embanked.

The working out of the last table shows a balance of water still on hand from the *once filling* of the reservoir, and after supplying a 50,000 population for eighteen months, and without receiving during that period any additions to its quantity. It will be observed that a present population of 25,000 could be supplied from the same quantity for two and a-half years; or, by reducing the allowance per head to the Melbourne standard of 25 gallons, for five years.

This, let it be observed, is without infringing on but half the rainfall, the whole of which, being 2,942,881,880 gallons, were it impounded, there would be a sufficiency after deducting for yearly evaporation, for nearly double the above periods; say three, five, and eight years respectively. Quite sufficient to lull all anxieties respecting the probabilities of a water famine, even if three or four consecutive years of drought should ever unhappily again occur, as it has in the memory of many of the early settlers. It leaves a very ample margin to meet contingencies of any nature or kind, and more particularly all cavil.

It may be, that superficial observers, or persons who have not made hydraulic questions their study, may at first sight, imagine that I have either set down the available rainfall at a high figure, or from imaginary data. In contravention of such idea, I append a table of actual rainfall at Yan Yean reservoir, and quantities ascertained both by careful gaugings at mouth of inlet tunnel, and checked by water-gauge staff permanently fixed at the outlet tower of the reservoir. I wish to show the several facts deducible therefrom.

The following tables are compiled from the most accurate and authentic data, and checked from means within my own control. The quantities of water, 35, 70, and 100 per cent. respectively, may seem to be excessive for the registered rainfall, but I know that nearly as much water escaped by the bye-wash, *i.e.* the river Plenty; this reservoir having no bye-wash proper, it is therefore a misnomer, as at present applied by the authorities in connection with the scheme; it is simply an outlet overflow, constructed on a portion (or rather at the termination) of the embankment. [illegible] real bye-wash is the original river Plenty, by which all [illegible] the aqueduct cannot receive pursues its onward course to [illegible] sea.

These tables prove one of two things—either that the [illegible]viometer indicated less than the real fall; or that nearly a[illegible] not quite all, of the rainfall on the 40,000 acres (and the [illegible] acres) found its way towards the reservoir, and would have [illegible] filled it if the two-mile aqueduct had been capacious eno[illegible] convey it. That the whole quantity came down I do no[illegible] moment doubt; and it arose from the fact of the ground [illegible] been thoroughly well saturated prior to the rain now re[illegible] for June and July, 1856, thereby proving that heretof[illegible] theoretical allowance of colonial engineers and others for a[illegible] water is much under the mark.

I would have it therefore inferred that the percentage as allowed by me for Wormbete is no way in excess, but otherwise scanty, seeing that it is a much more favourably circumstanced gathering-ground, all things considered, than the Plenty.

Date.	Rain Gauge.	Quantities calculated at a percentage on Rainfall of Water-shed.		Quantities as gauged at Inlet, and checked by Tower Staff.
1856.			Gallons.	Million Gallons.
June	1·70	40,000 acres drained by Plenty river, 38 per cent.	507,478,356	
		5,500 acres drained by Reservoir, 65 per cent.	137,442,054	
		1,300 acres, surface of Reservoir, 100 per cent.	49,978,929	
			694,899,339	698
July	2·25	40,000 acres, as above, 35 per cent.	712,369,630	
		5,500 acres, as above, 70 per cent.	195,901,571	
		1,300 acres, as above, 100 per cent.	66,148,582	
			974,419,783	974
	3·95			1672

Synopsis, showing Register of Pluviometer in Victoria.

Yan Yean, 600 feet above sea level.	Melbourne, 180 feet above mean sea level.		Geelong, 125 feet above mean sea level.
June and July, 1856.	Mean of Five Years, June and July, ending 1851.	June and July, 1856.	June and July, 1856.
3·95	5·006	5·135	4·46

Acreable Evaporating Surface of various Home and Colonial Reservoirs and natural Lakes, as compared with their Acreable Water-shed in extent.

Lake Corangamite	One-ninth
Lake Colac	One-tenth
Lake Wardyallock	One-eleventh
Rivington Pike (England)	One-twentieth
Wormbete	One-fortieth.

In regard to the purity of the Wormbete Reservoir waters, it should be borne in mind that from the time on which they are condensed on the surface until they are impounded in the reservoir, there are no lagoons to fill—no sedgy marsh lands, no extensive swamps to pass over, absorbing much, discolouring the residue, and creating vegetable poison; no fallow lands or agricultural district, to impregnate more or less by the impurities which they contain, and which may be gathered up by the waters passing over them; no contaminating influences arising from sheep or wool washing establishments; and being far removed from population, there are few floating impurities in the air, and no sewerage matter to deteriorate the surrounding soil—scarcely a human being, all being still, save the occasional ringing note of the solitary woodsman's axe. And it should not be forgotten, that animal matter taken hold of in any shape by the solvent power of pure water, though in minute particles, is held by the first authorities to be prejudicial in regard to health.

It should further be borne in mind (and it is no slight recommendation) that from the very natural configuration of the thousands of acres in this forest, it never can in all time become an agricultural district—must remain as it is, save being denuded of its timber; thereby giving an assurance that coming generations will, equally with the present, enjoy a pure water gathering-ground and pure water, without the intervention of artificial filters, many of which in some of the finest works in the mother country are becoming a nuisance rather than a benefit.

The Retreat yields water of the greatest natural purity, the pellucid stream of which is comparatively free from even vegetable contamination. Notwithstanding the adjacency in such numbers of the tall but graceful and luxuriant tree fern, and other plants of an almost tropical growth, little or no perceptible change has been imparted to the water thereby. It is deliciously cool, strongly reminding me of the bright sparkling waters of the mother country. It is almost as pure as the purest known, and very much better adapted for domestic purposes than most, being less impregnated either with mineral or chemical constituents; not requiring filtration, pure, brilliant, and entirely unexceptionable in colour or taste, betraying no organic taint, and evincing *primâ facie* great purity.

Having shown that more than a sufficiency of water is procurable, it now rests with the commission to order the necessary steps next in progression to be taken, by which so abundant a supply can be made available for the town, by the construction of such works as may be required for collecting, conveying, and distributing that which nature has put within our grasp, namely, the fundamental groundwork for creating a never-ceasing gravitation supply.

Having given much and serious study to the ichnographical features of the town and its suburban districts, with a view to high and constant service, it but remains for me to say, that seeing it is a matter of the greatest importance, and should be kept most prominently in view, the supply being not only ample, but good and unlimited, with an ever-continued pressure constantly on, available at all times day or night, from an altitude sufficient to command the upper story of the highest house in the most elevated district; sufficient to quickly and efficaciously extinguish fires, however extensive, and that without incurring any additional outlay for power, save the fire-plugs or hydrants; protecting the town against the devastating element of fire, a striking proof of the lamentable effects of which we so lately have had in the ravages committed in the Market-square, Geelong, on the night of 26th December last, destroying in so short a space of time 50,000*l.* worth of property; whereas, had these projected works been but complete and in a working state, they would most assuredly have kept the total loss under 500*l.*, a difference of 45,500*l.*—a large amount on this one fire alone, a considerable item in the necessary expenditure.

Thus, I take it, the future protection of the citizens and their property will be better secured from such a scourge by simple pressure, obtained from such an altitude as will render obsolete the primitive mode now obliged to be resorted to as a matter of necessity by an otherwise well-regulated, energetic, and fearless fire brigade, bringing to their aid a comparatively weak and inefficient mechanical power.

Suffice it to say, that by this gravitation we avoid the necessity for the erection of steam-engines or other expensive machinery, in duplicate or otherwise, ever liable to get out of order. We also avoid elevation syphons, with all their paraphernalia, which is rendered unnecessary, besides other expensive appendages too numerous to detail within the limited compass of this paper; nor is it necessary that I should do so, seeing that any or every pumping scheme is superseded by the adaptation of nature's own providing—a gravitation scheme, eligible, safe, simple, and comprehensive.

It may be, that I shall have the honour on a future day to submit, subject to your wishes, a further or supplemental paper, on an extended scheme, the possible formation of a reservoir in the same locality, covering an area of 450 acres depth of water, seventy feet at embankments, and the cubical contents of six hundred and forty-five million feet, or four thousand and eighteen million gallons in quantity. The which is worthy of our consideration in a climate such as this, where the rainfall has been known to be occasionally exceedingly precarious, uncertain, and scanty in amount.

In the experience of the older colonists, we have had two and even three (some say four) consecutive years of drought; if such should unhappily again occur, it may be that the population of Melbourne might be dependent on Geelong for water. Such being the case, by the erection of an embankment, such as I contemplate in my supplemental paper, we would have enough, and to spare, so that Melbourne could be assisted without infringing on the rights of Geelong.

I believe I am warranted in stating, that the value of water for irrigation purposes is by no means as yet sufficiently known in the colony, but it is to be hoped that the day is not far distant that its merits will be appreciated as it deserves. And in connection with this, I will but draw your attention to a few facts connected with such a use in a climate not unlike ours, namely, the innumerable tanks and reservoirs of our conquered provinces of India, which had been constructed under the native princes for the use of the people. Scarce a village is without one; and where the population was dense, requiring greater, such as the present Madras Presidency, they had a reservoir thirty miles in circumference, having an embankment of some twelve miles long, and approaching a depth of fifty feet.

In reference to this subject, I doubt not but when the time arrives for our Government to take the matter up in detail, it can be satisfactorily proved that such works can be made reproductive, and handed down to posterity as the triumph of the infant age of Victoria, and worthy of the times in which we live.

THE PRINCESS'S THEATRE AND OPERA HOUSE, MELBOURNE.

This edifice, known as Astley's Amphitheatre, has been entirely remodelled. It will seat about 2200 persons. All the seats in the dress circle will be chairs, and the utmost care has been taken to render that portion of the house comfortable and commodious. Beneath the dress circle are arranged the boxes—a somewhat novel arrangement; but in this particular instance a very good one. The two tiers of boxes, with the pit and stalls, comprise all the compartments of the theatre, so that there will be no gallery. The entrances to the dress circle and to the boxes are through a building specialiy erected in Parliament-place. The stage has been advanced 19 feet, and so arranged that no part of the house will be without an excellent view of it. The house will be lighted by a number of elegant chandeliers, and a handsome gold ornament in the centre of the ceiling will cover a very efficient ventilating process. The decorations throughout are in white and gold. On either side of the proscenium are two highly-finished figures representing Music and the Drama. The scenery has been painted by Mr. Fry and assistants.

The entrance to the pit and stalls will also be in Parliament-place, and quite removed from the hotel. The latter has been greatly enlarged. The whole façade of the building will be protected by a verandah, extending to the edge of the footway, so as to form a protection to visitors in wet weather, as well as an agreeable promenade.

IMPROVED CONTINUOUS COMPRESSING MACHINE.—Thomas King, Spitalfields, *Patentee.*

FIG. 1

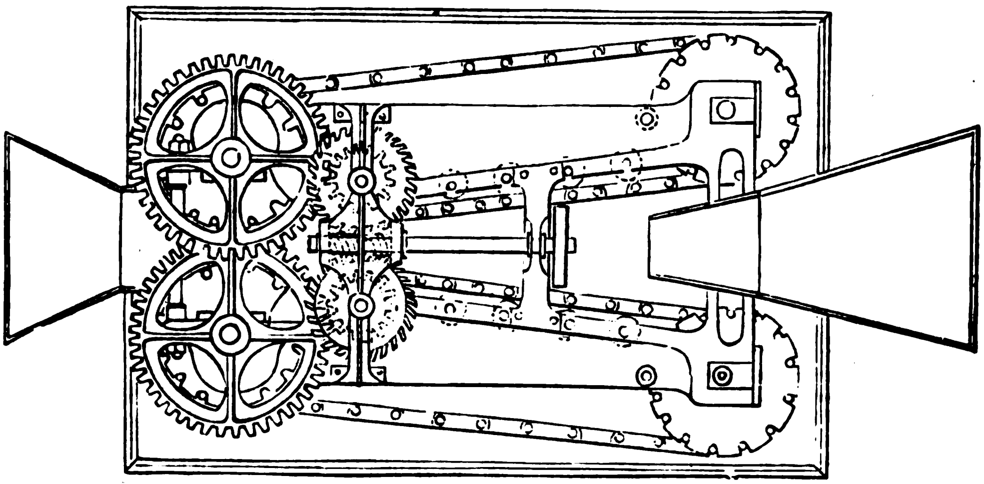
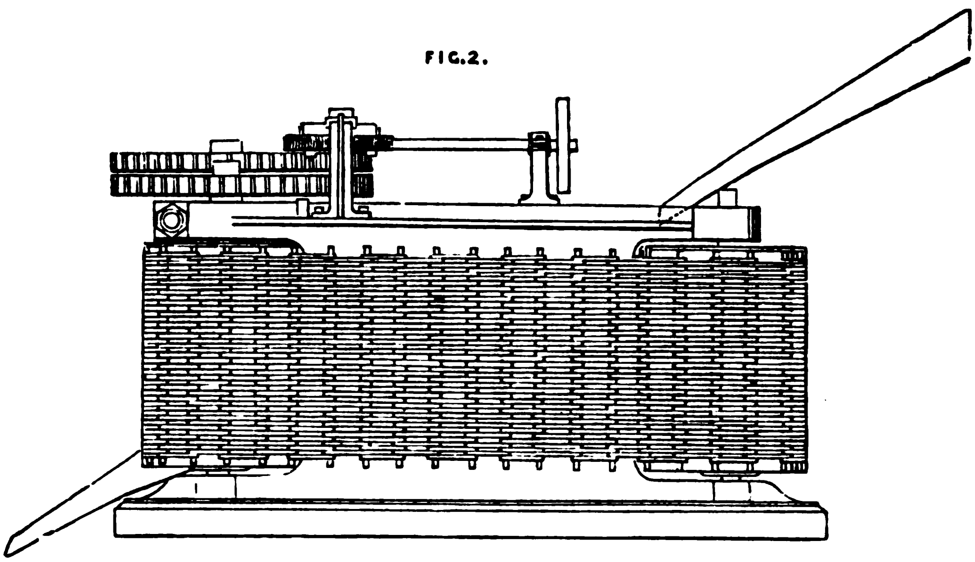


FIG. 2.



This invention consists in arranging two endless perforated bands of articulated bars or links in such a manner, that whilst each works round two drums placed at a distance apart, their faces shall be inclined to each other at an angle in the direction of their length. Thus the space between the faces of the two continuous bands is wedge-like, and any materials placed between them will, when the bands are caused to move from the west end toward the narrow end, be gradually compressed. In this way, tan, hops, &c. may be readily compressed.

Fig. 1 is a plan of a machine with the drums placed vertically, fig. 2 is an elevation of fig. 1.

THE MONOGENESIS OF PHYSICAL FORCES.*

By ALFRED SMEE, F.R.S., F.C.S.

IN our intercourse with nature and natural phenomena, we, each of us, according to the peculiarity of our minds, view the same phenomena in a somewhat different manner; some of us perceive more vividly by our organs of sensation, whilst others with less powers of perception store up facts more accurately. Some generalise simple facts into extensive laws; whilst it is permitted to a few to compare and bring into relation numerous generalisations at first apparently distinct. From this diversity in the powers of the human mind, I have always strongly felt that society is benefitted by each person unfolding the impressions which his own mind receives, as by that means all are made acquainted with the various aspects from which external nature may be viewed.

I have chosen for my theme the "Production of Physical Forces," and this lecture will be a cursory glance of that view of natural phenomena which I published, in the year 1843, in a work entitled 'The Sources of Physical Science,' and which constitutes one of that series of metaphysical works which I have made the business of my life to develope from nature. I venture to hope that you will neither be surprised nor offended in my submitting this view of nature, especially as I have myself practically applied it for a period of fourteen years in the ordinary transactions of life, and I trust not altogether without some advantage to the public.

We live in a material world, but we can neither make nor destroy matter. However many times matter may be combined or acted upon by other matter, it remains the same in amount, and even when it is so changed that it possesses no vestige of its former state, yet it is neither increased nor diminished.

When our great poet in his lofty flight says—

> "Imperial Cæsar, dead and turned to clay,
> Might stop a hole to keep the wind away;"

the change is not more wonderful than the daily transmutations in our manufactories, where offensive offal is converted into beautiful pigments for the dresses of our fairest daughters, and noxious residues are changed into exquisite flavours for sweetmeats.

In every case in which we observe matter, we notice that it possesses a power whereby two portions are drawn together or mutually attracted. From this we deduce a law, "That whatever attracts is matter, and whatever cannot attract is not matter." To my mind, attraction is an inherent property of matter, which it has possessed as long as matter has existed, and will possess till matter ceases to exist, by the fiat of an Immaterial Power.

We know not how far matter is divisible, because we can readily separate it into particles far below what our senses can appreciate; nevertheless, it is convenient to assume that matter is divisible into definite particles which can no longer be divided, and hence called atoms. We know not, moreover, how many kinds of matter there are, or whether there is more than one kind. It by no means follows because we cannot decompose the so-called sixty elements that they are separate bodies. We must remember that it is possible, as every element has a different combining number, that each may be only a number of atoms attracted together so firmly as to resist our powers of separation. These considerations are entirely within the boundary of speculation, and not at present of fact; yet, this view meets all the known facts of the case, and when two theories, equally expressing all the circumstances, are offered for our consideration, it is more consistent with natural science to choose that which involves the fewest hypotheses. One of the most subtle divisions of solid matter is to be found in the black pulverulent state of metals, such as employed for my form of battery. It has been supposed that all matter is black when extensively divided, because the particles are too small to reflect light; but the form of the black particles is unknown to us, because the highest powers of the microscope are insufficient to render them visible to the eye. At the last Bakerian lecture, Professor Faraday made known methods for dividing gold to an extreme amount. He precipitates the metal from its solution by bi-sulphuret of carbon, and obtains a ruby-coloured liquid, in which metallic gold is so minute, that the particles are invisible by any microscopic power. This distinguished philosopher satisfied himself that the ruby glass owes its colour to gold in a metallic state in an infinite division; and by adding gelatine to the ruby solution, he obtained a ruby jelly precisely similar.

Ultimate particles of matter are aggregated or attracted into masses, of which we may observe many varieties. Look at ice: how different is its appearance at different times; and in our electro-metallurgic deposits, where we build up our objects atom by atom, we obtain many very different kinds of aggregation. The copper electrotype from which the Bank of England note is printed is so excellent, that a portion I tried was found capable of being drawn into three-and-a-half miles of wire; whilst, under certain circumstances, copper deposited breaks with a concoidal fracture with the greatest ease.

We are ignorant whether there is any difference in the mode of attraction between the ultimate particles of solid, fluid, and gaseous particles, but, having regard to the entire range of physical knowledge, we may assume that the particles are most firmly attracted in the solid, and more in the fluid than the gaseous state; as by different amounts of attraction we obtain the difference between the solid and gaseous states. I have speculated whether one atom might not by itself have boundless expanse, and fill the firmament—a limitation of extent being due to the attraction between two or more atoms of matter.

Masses of matter aggregated together still have the power of attracting each other into one uniform mass, by adhesion, as when two pieces of lead or glass are brought into contact they mutually adhere, and sometimes greatly to the manufacturer's discomfort.

Liquids and solids in contact have a power of mutual attraction, as in capillary attraction.

Gases and liquids have also this power of attraction, as in the case of muriatic acid gas and water.

I have proved by experiment that attraction is existent between gases and solids. Some years ago I discovered that coke or charcoal might have so much hydrogen firmly attracted to it, that when plunged into solutions of gold, silver, or copper, an extensive deposition of metal takes place; and I have found that it would retain the gas for many days.

Attraction is also exerted between gaseous bodies, according to the law of diffusion so elegantly developed by Graham; and even carbonic acid (a very heavy gas) passes into the atmospheric air.

Lastly, liquids attract each other by a law very similar to that of the diffusion of gases.

Hitherto we have considered the attraction of particles of matter in indefinite quantities, or of the attraction of masses already aggregated; but particles of two or more different kinds of matter may be attracted to produce a totally new substance, having none of the properties of former particles: thus chlorine and sodium form common salt; oxygen and hydrogen, water.

Attracted matter, either in masses or in the most attenuated particles, attracts other masses at any distance, and by this power of gravity everything in the universe is kept in position. To this power the sun, the moon, the earth, the stars in the firmament, and every substance in the world, owes its position.

In the cases of attraction already described the power appears to be exercised promiscuously, but there are cases in which attraction is exerted in definite directions. Crystals are masses of attracted matter of this character, as their particles are attracted unequally in different directions. In consequence of this they yield to mechanical force in some directions, not in others; they expand unequally by heat, they are acted upon unequally by magnetism, and they have very curious properties in relation to light. Not only in crystalline bodies do we observe that attraction is exercised in a definite direction, but we observe a direction in the power of attraction during the magnetic state. A bar of iron, when it suddenly assumes this state, appears to have its former attractions altered, for under favourable circumstances it will sound a distinct musical note. When a magnetic body attracts another body capable of assuming the magnetic state, the second substance also evinces a similar direction in the exercise of the power of attraction. From these views we deduce that the idea of magnetism is derived from certain kinds of matter, under certain circumstances, evincing the power of attraction in a definite direction.

We have considered the mode in which attraction acts to unite particles of matter, and thus construct the various objects of which the material universe is composed. Now let us pause to consider the earth at rest. The quiet which gives the loveliness

* "The Monogenesis of Physical Forces: a Lecture delivered at the London Institution, February 18th, 1857, by ALFRED SMEE, F.R.S., F.C.S., Surgeon to the Bank of England, &c." London: Longman and Co. 1857.

to evening, and soothes the mind after the business of the day, forms but a dim shadow of that awful quiet which would exist were attracted matter not capable of being acted upon, when there would be neither heat to cheer, light to gladden, sound to enliven, or motion to excite.

Nature, however, abhors quiet, and delights in action. In every case where attraction is exerted, it can be destroyed by a new attraction; and thus, whilst attracted matter exhibits cohesion, composition, position, so a new attraction can cause disintegration, decomposition, and motion. Hence we deduce the law, "that a new attraction can destroy a former attraction."

For a study of the effect of a new attraction acting upon attracted matter, the voltaic battery stands forth pre-eminently as an instrument well calculated to exemplify the phenomenon. For a voltaic circuit it is essential to have a fluid-compound built up of two atoms only; this compound is decomposed by any matter either in a solid, fluid, or gaseous state capable of setting up a powerful attraction between itself and one element of the compound: this is the positive pole. The second element is evolved at the negative pole, and the two points may be connected together by matter extending for miles and miles; a fact on which depends the electric clock and telegraph. In a single battery there is but one point at which the new attraction is excited. In the compound battery there are as many points as there are cells in the series. A single voltaic battery may act through a series of similar troughs, provided that in these secondary troughs the tendency to destroy the former attraction is nearly equal to the tendency to maintain it. I place before you an example, in which one battery is reducing gold, silver, copper, tin, lead, iron, zinc, in separate cells, having solutions of the positive poles of those metals. In this case, one grain of zinc in the battery reduces $6\frac{1}{4}$ grains of gold, $3\frac{1}{2}$ of silver, $3\frac{1}{4}$ lead, $1\frac{8}{10}$ tin, 1 copper, $\frac{8}{10}$ of a grain iron, these being the relative weight of one atom of each of these metals.

By the voltaic battery, especially if we employ the platinized silver battery, as is now almost invariably used for heavy work, we obtain results equivalent to the original attraction within a very trifling percentage, a result which must be regarded as a glorious triumph of human skill. On account of this perfection of result I have been enabled to construct an instrument which I call a battery-meter, in which every degree shows that a grain of zinc has entered into combination, and become sulphate of zinc. By this we can tell the amount and thickness of metal reduced in our precipitating trough. This instrument is the first instance in which man has estimated work done by the primary attraction or source of power. In the steam-engine the coals burnt do not point out so accurately the result obtained; and I have elsewhere observed that even in the animal, the most perfect of all machines, the food the soldier eats will not of necessity indicate the number of miles traversed, nor of the enemy killed.

This instrument was designed for the Bank of England. You are all doubtless aware, that, upon my proposition, the entire system of printing the Bank of England notes has been changed, and that they are now printed from surface: a change which has contributed so much to give identity to the note. The original dies are cut in copper, steel, or brass; from these, moulds are made, which again are electrotyped to make the cast for printing. The battery-meter, placed in the battery, shows us the thickness of our deposited metal in the trough; and though our practised eye enables us to dispense with extraneous aids, I can but think this little instrument is a very beautiful practical application of profound physical laws.

The cause of all voltaic phenomena is referable to a new attraction, and when this is opposed by obstacles tension is manifested. Tension, to use a figurative expression, is "a desire for action ungratified," and thus, as soon as the tension is increased, or the obstacles are diminished, action results, and disintegration, decomposition, or motion occurs.

It was from the long-continued and close study of the voltaic battery requisite to enable me to write my treatise on 'Electro-Metallurgy,' that I was led step by step to develope the system of physical philosophy upon which this lecture is based. I could, therefore, tarry and dwell upon this beautiful instrument, did I not remember that on this occasion it will be my endeavour to compress into one lecture a slight sketch of the entire range of physical phenomena.

Passing from the study of the action of a new attraction upon binary fluid compounds, we may next, with advantage, consider its effect upon solid substances, or substances under the attraction of aggregation; and the electrical machine is well adapted for this purpose. In this case, force is applied to a solid body, whereby tension, far exceeding that which is readily obtainable by a voltaic battery, is manifested. Whenever the electrical machine is excited by any force, the origin of that force is due to some new attraction, and hence the new attraction is the primary cause of the electrical tension; and when this is increased sufficiently, or the obstacles decreased, action ensues by a destruction of attractions, such as disintegration, decomposition, or motion, and is frequently accompanied by light, heat, and sound.

From the above views, the mind is led to suppose that electricity is not an immaterial essence, imponderable, or spirit attached to matter, to which the effects are due; but that the phenomena of electricity are entirely owing to the action of a new attraction upon matter aggregated or composed by former attractions.

By frictional electricity we can trace how repulsion is a phenomenon of attraction, and not an inherent power of matter; as by electricity we can readily suspend some of the numerous forces by which any body is held in position, when it moves in the resultant of the others. Two balls suspended close together, when similarly electrified, appear to repel each other; but in reality they are attracted to surrounding objects.

Carry the reasoning one step further, we find that which we term positive or negative electrical phenomena is due to the direction in which the new attraction acts, and this direction is analagous to the polarity of the magnet or the condition of the electrolyte in the voltaic battery.

Passing from the known to the unknown, we may glance at the thunder-cloud, the awful grandeur of which must for ever appal the human mind. From the dense black masses of clouds which usually accompany this grand natural phenomenon, we have seldom an opportunity of observing that which is taking place; yet on one occasion, on Forest-hill, I saw that which probably is the cause of the electric action. It was a damp day in June, and there had been much rain previously—the entire sky being covered as it were with misty clouds, through which the sun was seen in an obscured form. Suddenly, without warning or the slightest apparent reason, clouds aggregated above our heads so rapidly, that within five minutes we were in comparative darkness, when the most terrific flashes of lightning occurred, accompanied with peals of thunder. This was followed almost simultaneously by enormous hailstones, so thick that we could scarce see a few yards before us. We had great difficulty in proceeding to the nearest house, which was scarce a hundred yards, and it was only after incessant ringing that one of the inmates ventured out to open the gate to give us shelter.

In this case there was manifestly an instantaneous and rapid development of new attractions in the aggregation of aqueous vapour into large hailstones; and I believe that aggregation of vapour acting upon the attracted matter of the clouds is the true source of the electric development.

The sublime phenomenon of the thunder-cloud I have watched as it plays over the ocean's bed; I have been in the midst of it at the top of the mountain; I have seen it hovering over the lake, and heard the thunder reverberate from shore to shore of the castle-bearing hills of the Rhine; yet it is worthy of mention that in no place has it been so grand as in this circus during the stillness of night. Here we have a multiple echo, and when the cloud is overhead, the crash is reverberated from side to side with a majesty unequalled by any other natural phenomenon, and which well marks the power which is acting during the electric discharge.

The capacity to produce action is called force, and whenever a new attraction is set up, force results. Force differs from tension in being able to do that which tension is prevented, by a resistance, from accomplishing. Any kind of attraction gives rise to force. The attraction of gravitation, capillary attraction, the attraction of aggregation, or of chemical affinity, will produce force.

When a new attraction is exerted, the force emanating therefrom may be propagated through aeriform bodies, when it is termed pneumatic force; through fluid bodies, when it is called hydrostatic force; through solid bodies, when it is called mechanical force.

I have heard it stated that whenever force is generated it is never annihilated. To such an extraordinary proposition my system not only gives an unqualified denial, but points out the manner in which force comes to an end. However long it may endure, however many bodies it may pass through, its final action is to destroy some pre-existing attraction, and either disintegrate, decompose, or move previously attracted matter.

The resistance of matter under attraction to a new attraction, leads to the production of various phenomena. Under certain circumstances, that which we call heat is evinced. For heat, it is necessary that a resistance to the new attraction should be afforded by the pre-existing attraction. In the voltaic circuit, if any part is contracted heat is manifested, and in this way water may be boiled, or platinum (one of the most infusible of substances) may be made to fuse like wax. Mechanical force causes heat, when applied to solid bodies; and whenever attraction acts with sufficient energy upon attracted matter, heat results. Where we require intense heat we must employ an intense new attraction on an intense aggregation, and hence, every practical man uses light or strong coke according to the intensity of heat he requires. Whilst heat exists, the new attraction is merely attempting to destroy other attractions, and the force may be transferred to any other body—by conduction, that is, through bodies in contact; or by radiation, that is, to bodies at a distance. In every case where heat ceases, either the new attraction ceases to exert itself, or the former attraction is destroyed, and disintegration, decomposition, or motion is the result.

Some difficulty is presented to our knowledge of the actions and reactions which constitute heat; but, upon the whole, I am inclined to think that heat is best described as that action of matter which from a distance influences the nerves of sensation in the skin, or in other words, heat is that which is felt from a distance by the skin.

There is another range of actions and reactions which are not appreciated by the skin, but are alone seen by the eye. This range is termed light; and by the prism we are enabled at once to distinguish that which is seen by the eye, or light, from that which is not seen by the eye. Chemistry indicates that there are actions both more refrangible than the violet ray on the one hand, and less refrangible than the red on the other. For the production of light the new attractions must be of the most powerful kind, so that they may act with great intensity upon matter attracted, and it is preferable to be in a solid state. The inflammation of hydrogen gives little or no light: add solid matter, and a beautiful light is the result. Hydro-carbons give us the most convenient light when they are burnt with such energy that the solid matter is first deposited to be acted upon by the new attraction, and subsequently burnt that it may yield no smoke; if all is burnt at once, so that no solid matter remains in the flame, light will not be produced. An illuminated body may communicate the force which is seeking to act upon the solid matter to other bodies, and finally decomposition, disintegration, or some destruction of attraction takes place.

As the skin feels heat, the eye sees light; so, by the ear, are we made acquainted with the actions and reactions constituting sound. The vibrations constituting sound have been accurately measured by philosophers, and though different people differ in the power of appreciating the higher and lower notes, it may be generally stated that all vibrations from 8 in a second to 24,000, are appreciated by the ear, and are consequently sound.

Sound, like light and heat, requires attracted matter; this is acted upon by a new attraction, and in the conflict between the old and new attractions vibrations ensue; whilst the vibration continues, the force may be propagated to other matter which may also take on vibrations.

I have always thought that odours constituted a further range of actions and reactions. I am the more confirmed in that view, the more I watch those animals, as the bloodhound, which have the nerves of the nose highly developed. Upon this matter, however, we are much in the same position as the man born blind, who can only receive his ideas of light through the medium of the eyes of others, for man has literally only a rudimentary nose, if it be compared with that of other animals.

A theory is not to be a mere mental creation, but a law or principle to guide our actions and bring forth fruit. The law which I have developed is so pre-eminently of practical application, that every human action may be regulated by it. When we desire to obtain any result, we begin by generating new attractions. For this purpose we select substances having the lowest equivalent, because the least weight would answer our purpose. Hydrogen and carbon have the lowest equivalent, and coal being an hydro-carbon, is that matter which is pre-eminently adapted to combine with oxygen, the more especially as the product of the new attraction is readily dissipated. If we compare zinc with coal, we find that it has an equivalent eight times higher, and its energy of combustion with oxygen is perhaps not more than one-third that of carbon: moreover, the cost of zinc is forty times dearer than coals; consequently, as a source of power, zinc would be 960 times dearer than coals.

Our theory thus indicates why we select coals for light, heat, motion, and chemical changes, instead of zinc; and this difference of cost prevents the voltaic battery, the most perfect human device, from universal application.

In animals, the hydrogen and carbon in the food they consume is the source of power, and the horse without hay and oats is as powerless as the steam-engine without coals, or the battery without zinc.

Starting with the new attraction of hydrogen and carbon, with oxygen as a source of power, we must take care so to apply it upon attracted matter, that we may produce, according to our necessity, heat, light, motion, or electricity; for it would not be difficult, in fact it constantly happens in practice, for one variety of force to be produced when another is desired, and whatever is thus improperly generated is wasted.

In physics and physiology, in mechanics and medicine, facts, no less than theory, declare that no effect occurs without material cause, that no initial change takes place without equivalent result, and in all cases there is but one source, in fact a complete "Monogenesis of all Physical Forces."

In consequence of the "monogenetic origin of physical forces," each possesses within itself the power of a new attraction, which, according to the amount of the initial change, can produce an equivalent or relational amount of any other force. Electricity may produce light, heat, or motion; motion may produce heat, light, electricity; light may produce electricity, motion, heat; heat may produce motion, electricity, light; and so we may ring the changes of the convertibility of physical forces *ad infinitum*.

Whenever a new attraction acts upon matter under attraction, the attraction already existing seeks to maintain itself, and in consequence of this resistance time is occupied, and, according to the energy of the change, so is the time diminished or increased.

I know no part of physical science which presents more important matter for consideration than the phenomenon of time: for let us suppose that a change of matter could take place without time; the coals in our grates would be consumed instantly—if our house caught light, the whole would momentarily vanish—if we set in motion any body, it would arrive at its destination quicker than thought, and be dashed to pieces. Chemistry supplies us with substances the particles of which are held together so slightly, that upon the slightest application of force they are separated; iodide of nitrogen, for instance, separates upon the slightest agitation into its component parts. The safety of the proper use of gunpowder depends upon its progressive action, which is slow as compared with iodide of nitrogen, or with some varieties of gun-cotton.

Man derives the idea of time from the resistance to change. If the total changes constituting an event are performed with energy, but little time is occupied; if the resistance to change is great, considerable time is evinced. The sum total of all time is the representation of all the events which have happened from the commencement of matter to the present moment; and the number of revolutions of the earth round the sun, or of the earth upon its axis, are generally the events which are counted as our measure of time.

From the nature of time, one preceded all subsequent events, namely, the first rushing together or attraction of particles of matter, which gave to every object its composition, form, and position. We must look for the cause of this primary attraction to a source extrinsic from matter, as it could not have caused itself to take on that power. From this consideration the mind is led to contemplate an Immaterial Power to confer this property on matter. This argument is independent and altogether different from the argument of design; but this is not the proper place to enter into this consideration, which I now leave to your own meditations, or refer you to the seventh chapter of my 'Sources on Physics' for its further development.

Every event from which we derive our ideas of time has a beginning, the generation of a new attraction—and an end, the destruction of a former attraction;—and as events have followed since matter existed, and will continue till matter shall cease, time began with matter, and will terminate when matter shall cease, and "the great globe, yea, all which it inherit, shall dissolve." From these views we find that time can have none, no, not even the feeblest quality of eternity; and that however exaggeratedly it may be increased, time never becomes eternity. Time is a mere repetition of events, each having a beginning and an end. Eternity is not made up of events, and has therefore no beginning and no end.

I have now completed, as far as the limited time will permit, a short sketch of the views of the Monogenesis of Physical Forces which my study of nature and natural phenomena has forced my mind to adopt. This doctrine has the merit of discarding the notions of æthers, essences, imponderables, or a plurality of forces being attached to matter, and places such vague assumptions rather amongst the mental creations of the philosopher, than amongst the realities of nature.

I am free to confess that this combination of physical facts and known laws into one consistent doctrine, was a matter of intense study and profound thought; but should it fortunately have the same power on your minds, to render physical science of easy application, as it has had upon mine, you will pardon me for occupying your attention whilst I have endeavoured to teach, that attraction acting on attracted matter is the source of all force; and that therefore every physical force has a monogenetic origin, and, when generated, a truly equivalent power.

EDUCATION AND TRAINING OF OFFICERS FOR THE SCIENTIFIC CORPS.

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Commissioners appointed by the Secretary at War to consider the best mode of re-organizing the System of Training Officers for the Scientific Corps.

The Royal Engineers' Establishment at Chatham.

I.—*The Nature of the Instruction afforded to young Officers.*

The course of instruction, which usually occupies about fifteen months, is comprehended under the heads of—

1. Field duty.
2. Scientific instruction.

1. Under the first head are comprised some of those duties which are required of the military engineer in the field, such as sapping, mining, batteries of position, intrenchments, formation of military bridges for the passage of rivers by artillery, cavalry, and infantry; the formation of stockades and their destruction by gunpowder; subaqueous explosions, escalading, telegraphing, the use of the voltaic battery and the diving-bell.

2. Under the second head, the officer, whilst employed upon the above duties, is also expected to devote a portion of his time to reading the best professional authors on military engineering, and, as a proof of his diligence, he is required from time to time to produce translations of the best examples of sieges, defences, extracts of mining operations, &c., accompanied with neatly drawn plans illustrative of the operations detailed; after which he is required to prepare projects founded on the above elementary course of study—the attack of fortresses; the demolition of revetments, bridges, &c.; the formation of military bridges; and the repairs of bridges which have been destroyed; with memoirs on systems, and on the projects of other officers or individuals which may be deemed worthy of investigation; with such other exercises of a similar character as the director of the establishment may consider to be necessary. To these are added a course of practical architecture, with a series of lectures on civil engineering, including the details of erecting and working a steam-engine, which is practically explained on a small engine belonging to the establishment, the whole of the working parts of which are taken to pieces and put together again by the officer.

A small laboratory affords the means of practising such operations in analytical chemistry as are required of the engineers, and it also enables an officer to satisfy himself from actual investigation of the properties of the various building materials with which he may be working. Surveying, with military reconnoitring and practical astronomy, complete the course of study as detailed under the second head.

This description of the course of instruction is abstracted from the official synopsis; and we should observe in reference to it, and to the staff of instructors provided for the establishment, that, with the exception of the courses in architecture (which, if correctly described, should be called building), surveying, and practical astronomy, it would be more accurate to say, that the young engineer (at all events, until very recently,) has hitherto received little or no instruction at Chatham. He is only afforded *time*, and he may make out for himself, as he best can, the principles on which the various operations depend; but there are no professors of fortification, military art, construction, or civil engineering, &c., to set him right when he is proceeding on erroneous principles in drawing up the various projects required from him, or to give him information on points on which he may desire it; and, in fact, he is left very much to himself, without any stimulus or definite purpose being placed before him to induce him to apply himself vigorously to the attainment of a sound knowledge of his profession, both theoretically and practically.

II.—*A more extensive course of Instruction required.*

In addition to the inquiries we thought it necessary to make regarding the qualifications of the young officers when they joined at Chatham, we considered it desirable to ascertain whether any additional instruction at that establishment could be advantageously given, so as to render them better qualified for the proper performance of their various duties; and we now beg to add extracts from some of the opinions with which we have been favoured on this subject.

Colonel Sandham observes that—"Geology, analytical chemistry, photography, the use of the electric telegraph, and book-keeping, which could be taught with the architectural course, might be added to the course with advantage."

Colonel Portlock makes the following remarks on the Chatham course:—"The time, however, has latterly been too short, and the scheme of instruction is far too limited, not embracing lectures on military tactics and science (viewed in a general light), nor lectures on civil engineering and architecture. Professorships in these branches seem absolutely necessary to prepare an engineer for the various duties he has to perform."

Lieutenant-Colonel Simmons recommends that the following additions should be made to the existing course of instruction:—"1st. A practical acquaintance with the employment and distribution of labour under various conditions, such as an abundance or a very reduced amount of tools, animal labour, or practical means, &c., in making field works or permanent works entailing large excavations and embankments in parapets and ramparts, including the application of modern science as in use in the construction of large earthworks and excavations of all sorts on railways, and in the making of docks and breakwaters. The best way of acquiring this knowledge is by practical acquaintance with the subject itself, at present only to be acquired upon the large civil works in progress in the country. As civil engineers might possibly evince jealousy in allowing officers to visit and remain upon these works a sufficient time to allow of their becoming practically acquainted with their mode of execution, it might be worthy of consideration whether troops might not be employed, with advantage to themselves and to the country, in executing any such works that may be in course of construction in the country, or even whether it might not be advantageous on some of the waste lands adjoining some one of the permanent camps now being established in the country, to make such works, either in the shape of butts for target-practice, or intrenchments to the camp itself; and so, at the same time, to instruct soldiers and officers of the army generally in that important branch of their service, without the application of which they can scarcely expect to pass through a campaign in actual warfare. It is to be observed, that a knowledge of this description of work is almost as essential to the soldier and officer in the state to which war is now reduced as the use of the particular arm they are called upon to use.—2nd. A practical knowledge of road-making, with the study of the materials best adapted for metalling.—3rd. A practical acquaintance with making both floating and standing bridges, and the adaptation of boats and materials of all descriptions to each. This would include a knowledge of the strength and application of materials under the most variable circumstances.—4th. A far greater practical acquaintance with field-sketching, including the estimation of heights and distances. Upon these sketches the student might be required to indicate the occupation of the ground either for a permanent or temporary camp, due regard being had to drainage and supply of water as well as defence, and the application of field-works to strengthen given positions.—5th. It would appear advisable, if engineer officers are to be continued in the construction and charge of barracks, that the architectural course should be extended. On this subject, however, I speak with extreme diffidence, as my acquaintance with the course does not extend beyond the year 1838."

Captain Galton observes, that "he is of opinion that it is possible, and very desirable, to give further instruction to engineer officers. The profession of an engineer officer requires knowledge, first, of military duties, and, secondly, of civil duties. A thoroughly practical acquaintance with the first can only be acquired in time of war. Practical knowledge of the second can be given at all times. In both, the knowledge of a certain amount of mathematics, modern languages, drawing, history, and geography may be considered essential; these might be taught to a great extent before the State education begins. For the efficient performance of both duties, it is essential that the officers should be conversant with the application of mathematics to every variety of mechanical question; and that they should possess a thorough knowledge of machinery, and of the strength and other qualities of all materials used in engineering works, and the modes in which these materials are worked and applied. They should be conversant with chemistry, metallurgy, geology, and mineralogy......This knowledge should be made available, by teaching them to design, in a detailed manner, civil and military works, according to specified conditions; and it should be still further tested by the construction of large models. A knowledge of geology, surveying, and also of practical astronomy, is required in civil and military engineering; surveying is, I believe, taught efficiently by the present system. Fortification, the art of attack, mining, artillery, and instruction in the duties of an engineer officer in the field, should be taught in a more comprehensive manner than is at present the case, and castrametation, the duties of the quartermaster-general's department, military science, tactics, and strategy, in which no instruction whatever is given, should be added to the course......I think that the commissions should be given provisionally on leaving the military college, and not confirmed until the officers are ready to join the corps for duty......The whole education would not occupy less than three or four years. It may be urged that the age at which an officer would join his corps after this education would be greater than that at which it is considered desirable that line officers should enter the army. But it must be recollected that they would be, to all intents and purposes, in the army, and learning their profession, from the time of passing the first examination."

Captain Scott, the present Superintendent of Surveying, Practical Astronomy, &c., observes—"I think that to the present instruction in practical architecture should be added a six months' course of civil engineering, to be carried on—1st. By a series of twelve lectures, well adapted to give an officer a general view of the nature and extent of the works which in the civil branch of his profession he may be called upon to perform. 2nd. By drawing up abstracts from good professional works, to obtain a more accurate knowledge of the details of the subjects than could be conveyed by lectures. 3rd. By designing and detailing in supplied data, and with the assistance of good examples, of which descriptions and estimates have been published, various engineering works of a suitable character. 4th. By visiting, under the guidance of a competent officer, instructive civil engineering works. 5th. By a short course of chemical analysis, sufficient to enable an officer to examine roughly, though with the requisite degree of accuracy for such a purpose, the various building materials and other bodies with which he may have to deal, and thus, as far as possible, to supply the want of experience in judging of their fitness for their intended application. 6th. By a similar course of practical geology, carried on chiefly by examining, under the guidance of a competent officer, localities rich in instructive varieties of formation, and making a report on the tract of country assigned for his military reconnaissance. With many officers, the great impediment to study in after life arises from their ignorance of the manner in which they should set to work. These courses would remove the difficulty in two very important branches of education. 7th. By a sufficient degree of experimental instruction in the elements of electricity and magnetism to enable an officer to deal intelligently with the numerous practical engineering applications which these sciences now have. Officers have now the means of acquiring a knowledge of analytical chemistry and magnetism, but they are not compelled to avail themselves of them......With reference to the second part of the question, I consider the general mode of instruction pursued here well adapted to the purposes intended; but I should recommend that means were granted for enabling experimental constructions to be carried on more extensively than at present."

After passing through this course of instruction at Chatham, the young officer of engineers must acquire professional information in the best way he can. Colonel Sandham states, "Hitherto an officer has had great difficulties to contend with in his endeavours to improve himself; scarcely an officer of the corps could obtain leave of absence from his duties even for such an object; this, and the expenses of travelling and of collecting information, have almost entirely prevented his seeking information beyond what a library could afford."

III.—*Nature of the Engineer Duties.*

On quitting Chatham, the young officer is ordered to some foreign colony, or to some out-station in England, Ireland, or Scotland, where his duties are more nearly allied to those of a civil than to those of a military engineer. He is placed under the command of officers who design new works, and he has persons under him employed to superintend and to be answerable for carrying out the details of construction. Not, indeed, that the system under which his duties are carried on bears any close resemblance to that under which the civil engineer is employed; for, unlike the latter, he is not often placed in a situation where he is required to apply his theoretical knowledge practically, neither is he made responsible for the works carried on under his orders; and thus he is not placed in a position to gain that practical knowledge which his education and instruction at Woolwich and Chatham have failed to afford him.

In some instances he is placed in circumstances where he is obliged to think for himself, by being made responsible for the execution of important works; but even here complete responsibility is seldom given to him, as he is very liable to be directed to hand them over, in an incomplete state, to a successor; and thus young officers cease to take interest in the performance of their professional duties.

Such officers as are attached to the companies of Royal Sappers and Miners, when they return from foreign service, accompany them to Chatham, to enable the men to pass through the usual course of field instruction; but the proportion of officers that return a second time to Chatham, and thus have the opportunity of keeping up or renewing their knowledge of purely military duties, is exceedingly small; so that when a war breaks out, the rust of years has to be rubbed off; at a very great disadvantage, and at a very inconvenient time, and a considerable proportion of the youngest officers of the corps are amongst those selected for service in the field.

This small proportion of officers that revisit Chatham is, according to the existing system of carrying on the engineer duties, entirely dependent on the small number of sappers and miners which are kept up in the British army, compared with the same force in foreign armies; but it certainly need not be made dependent on any such contingency: and we shall presently state in what manner the drawback we have alluded to might be done away with.

IV.—*Comparison with the French System at Metz.*

In France a very different system is pursued. An elaborate course of instruction at a school of application for two years at Metz, after two years of high theoretical teaching at the Polytechnic, is followed by continued practical exercises and theoretical discussions in the various schools into which the French divide their practical field instruction, until the officers of engineers are promoted to the rank of second captain. Up to that time they continue to do duty with their men; they are constantly in practical training in military field duties, just as much as the officers belonging to the artillery, infantry, and cavalry are being trained in their especial duties. The earlier part of the French system of practical instruction, that is, the part carried on at the School of Application at Metz, is especially theoretical. The English system of instruction at Chatham is almost entirely practical, but it requires extension, even as regards the practical part of the military operations, by the yearly exhibition of sham sieges, in which, to be effective, and in accordance with the usual operations of war, the troops of the garrison should be called on to take part, and additional theoretical professional instruction is absolutely indispensable.

This will probably be made more apparent by a comparison of the relative amount of the staff employed in instructing the young officers at Metz, and the young officers and the Royal Sappers and Miners at Chatham.

At Metz for the young officers of Artillery and Engineers.	*At Chatham for the young officers and Royal Sappers and Miners.*
1 General officer as commandant.	1 Colonel as director.
1 Colonel or lieut.-col. as second in command and director of studies.	2 Captains as adjutants.
1 Major of artillery.	
1 Major of engineers.	
5 Captains of artillery.	
3 Captains of engineers.	
1 Surgeon.	
INSTRUCTORS.	INSTRUCTORS.
9 Professors.	1 Captain. } Recently appointed instructors in
4 Assistant professors.	1 Lieutenant. } fieldworks, superintendents of the young officers in the halls of study and of the Royal Sappers and Miners in school.
1 Drawing master. The professors being principally captains of artillery or of engineers.	1 Captain. Superintendent of surveying and practical astronomy, chemistry, and civil works, and in the halls of study.
	1 Captain. Superintending the instruction in the electric, the magneto-electric, and other field telegraphs. Recently appointed.
	1 Clerk of works for the architectural course.
These are quite independent of the officers who are employed in command of and charged with the instruction of the *men* of the French engineers, which instruction is carried on quite apart from the school of application.	The captains of companies of Royal Sappers and Miners at head quarters take part in the superintendence of their companies in the schools and in the field, and they are detailed for such special instruction to the junior officers as may be found most advantageous.

If even the staff of officers employed in giving instruction in what has hitherto been termed the practical class at the Royal Military Academy at Woolwich be added to the number employed at Chatham, the disproportion in the relative numbers of the instructors in France and England will not be materially lessened.

Indeed it may be broadly and distinctly stated, that until recently, the Royal Engineer establishment at Chatham has only had one officer specially appointed to afford instruction to the young officers, viz., the superintendent for surveying and practical astronomy; and Capt. Galton says, "Surveying is, I believe, efficiently taught by the present system."

V.—*Suggestions with regard to the Future Instruction.*

Comparing the establishment at Chatham with the establishment at Metz, not only as regards the educational staff, but also with reference to the subjects and system of study, and taking into consideration the answers we have received from officers of engineers, some of which have been already quoted, we cannot doubt that the establishment at Chatham is susceptible of considerable improvement; and we would recommend that it should be made thoroughly efficient for the practical application and the extension of the scientific knowledge which the young officers should have acquired at a military academy or college before they are provisionally commissioned.

This may be most efficiently done by the appointment of officers of experience and acknowledged ability as instructors in the various branches of study, and by altogether relinquishing the system which has hitherto prevailed of obliging the young officers to pick up their knowledge on most subjects, as they best can, by referring entirely to books.

We also consider that the appointment of assistant director (or as we should designate him, director of studies), which was abolished in 1821, should be revived.

It also seems very desirable to have a board of improvement, under the presidency of the director of the establishment, consisting of the director and assistant director, two officers specially named by the inspector-general of fortifications to represent the wants of the service as regards the subjects of instruction which should be afforded to the officers of engineers, and of three of the instructing officers. This board should meet half-yearly, for the purpose of considering what changes should be made, from time to time, in the instruction, in order that the proper representation may be submitted for the consideration of the superior authorities.

It appears that the instruction at Chatham is mainly defective as regards the omission of the higher branches of military science, and that it requires regular courses of study in fortification and the attack and defence of places, architecture (not merely building), construction, military art and history, tactics, and strategy. The study of the sciences of chemistry, metallurgy, geology, and mineralogy, and that of German and French, should also be continued; and, as we have already observed, properly qualified persons should be appointed to carry on such instruction, which, when once established on a proper footing, and thoroughly systematised, might advantageously be opened to all officers belonging to the garrison who desire it.

But we must observe, in addition, that the system itself apparently requires to be essentially changed. Most of the officers who have been connected with the instruction at Chatham speak of the want of a stimulus to induce the young officers to exert themselves in pursuing their course of study; and Lieut.-Colonel M'Kerlie, now one of the members of the Irish Board of Works, who was for many years superintendent of surveying and practical astronomy at Chatham, says:—"The course which I would propose to remedy these defects, so far as they result from the system, and, as far as possible, to insure that on leaving Chatham the officers should be competent to enter upon their duties as engineers, would be to specify a time—say fifteen or eighteen months—within which they should be required to acquire the necessary professional knowledge, and at the end of that time that they should undergo a searching examination by a board of officers altogether unconnected with the establishment; when, if found qualified, they should be gazetted to the full rank and pay of lieutenants, their previous rank being only temporary or probationary, with pay as at present. Their studies I would propose to leave in a great degree to the officers themselves, but would provide ample means for their guidance and assistance, through the appointment of competent officers as superintendents, and by instituting series of lectures on the several branches of study and inquiry. I do not think it would be desirable to make subject to alteration the relative positions of the officers as determined on leaving Woolwich, provided the necessary acquirements were attained within the prescribed time; but in the event of an officer failing in this, unless through sickness, which would 'be specially considered,' he would be passed over."

VI.—*System recommended to be followed at Chatham.*

It appears to us that these drawbacks would be most effectually removed by fully carrying out, for the establishment at Chatham, the same principles of management that we have already advocated with reference to the Royal Military Academy, and thus we should recommend that—

1. All young officers of engineers that proceed to Chatham for the purpose of receiving instruction at the Royal Engineer Establishment should only be *provisionally* commissioned.

2. All of the same promotion should join at the same time, proceed through the same course of instruction, and finally be examined at its close to ascertain the extent to which they have benefitted; and we should also recommend, as an additional stimulus, as well as for the more convenient arrangement of the courses of instruction, that the Honourable the Court of Directors of the East India Company should be invited to concur in an arrangement by which their young officers of engineers should join at the same time, and proceed through the same course of instruction.

3. If the results of the examination, which should be conducted in the same manner and on the same principles as we have already explained with regard to the examinations at the Royal Military Academy, prove that there has been gross inattention or gross idleness on the part of any of the young officers, the permanent commission might be altogether withheld, or be given under certain modifications in another arm of the service, as in France, Prussia, and Austria; but we think this course should not be resorted to except on very strong grounds, and with the special sanction of the commander-in-chief.

4. The final classification in the order of merit, which should determine the relative positions of the young officers in their corps, should depend partly on the marks obtained during this officer's examination, and partly on the marks awarded to the

cadet at the Royal Military Academy; the marks obtained at the Academy being added to those awarded for the final examination at Chatham.

5. This final classification for each promotion should also decide who are entitled to receive the *increased rates of pay* awarded to the engineers.

6. The duration of the course would require to be extended to eighteen months, and this period should not be exceeded except for illness.

7. With the increased force of officers of Engineers and of the Royal Sappers and Miners at the establishment, consequent on Chatham being made the head-quarters of the corps now styled the corps of Royal Engineers, we consider that the appointment of a director of studies would be highly advantageous; and that professors or instructors in military art, strategy, and tactics, civil engineering, architecture, French and German, should be appointed.

Colonel Sandham also calls attention to the necessity for a lecture-room, chemical laboratory, &c., thus:—"As all engineer officers on obtaining their commissions commence their duties in a state of pupilage at Chatham, I consider it essential that a theatre for lectures, a proper chemical laboratory, and rooms for the electric telegraph and photographic instruction, should be built; and that officers of experience and acknowledged talents should be selected from the corps, and employed as instructors in the subjects that may be from time to time introduced into the course; such, for instance, as geology, mineralogy, chemistry, photography, the use of electric and other telegraphs; and that officers so selected and employed should receive a liberal remuneration during their employment as instructors. And I consider that placing every facility, and affording every reasonable assistance and encouragement to officers of engineers to enable them to collect and impart knowledge and information, without reference to their length of service, would tend more than anything to most completely qualify them for the discharge of their various duties."

Having thus briefly pointed out the changes which should be made in the system to be followed at Chatham, we should add that it should be made apparent to all, that officers who continue to study, and thus make themselves fully acquainted with the varied duties of their profession, both theoretically and practically, will in future derive advantage from it; and that for such as do so, their superior qualifications will hereafter be held to be the best claim to advancement.

If the course of instruction at Chatham be re-organised in the manner we have ventured to recommend, we consider that all officers of engineers should, as a rule, be periodically permitted to attend this course of applied study and practical working, and thus have the opportunity of renewing their acquaintance with the ordinary military operations of war, and of keeping up their knowledge of scientific subjects bearing on their profession.

We are of opinion that the studies which are necessary to young engineer officers should be followed by all, and nothing should be left optional, or according to their particular wishes.

The case is altogether different as regards the officers who revisit Chatham after a period of service in other parts; the true bent of their minds is by that time fully developed and known, and facilities should then be afforded to them for pursuing such studies only as they consider to be most in accordance with their individual tastes and capacities.

It will be remarked in the evidence that the officers of engineers do not consider that there is any necessity for a distinct establishment analogous to the senior department at Sandhurst, but there is a very general agreement of opinion as to the necessity for a periodical return to Chatham.

The strength of the corps of engineers should be such as will admit of this arrangement being made; and by this means, whenever a war again breaks out, a very large body of officers, all perfectly cognisant of field and siege operations, could at once be made available for military service in the field, their military knowledge being aided and assisted by the experience obtained during their charge of civil works and buildings.

We have thought it necessary to call special attention to the practice followed in the French army, of keeping the young officers of engineers constantly doing duty with their men until they attain the rank of second captain; but in doing so, it must not be inferred that we consider the French arrangement to be wholly advantageous to the public service; but we have adverted to it mainly to show, in contrast with the English practice, the necessity that exists for allowing our officers of engineers to be periodically made conversant with military operations in the field. With such an arrangement as we have suggested sanctioned and carried into operation, and with certain alterations in the manner of carrying on the engineer duties, by which the young officers should have opportunities afforded to them of being made practically acquainted with the working details of large public undertakings, and by their being made responsible for the works carried on under their orders, so as to induce them to take greater interest in their profession, we should prefer the English to the French system; as it can scarcely be doubted, that the more the young officers are obliged to depend on their own resources, and the sooner they are accustomed to do so, the greater the probability of their proving efficient public officers.

We cannot conclude the subject without calling especial attention to the urgent necessity that exists for affording the young engineer officers greater opportunities than they at present possess, of becoming more practically acquainted with the manner of executing extensive new works of various descriptions, such as military buildings of all kinds, railways, docks, breakwaters, harbours of refuge, drainage, &c. It is not for us to point out the particular manner in which this should be done, but we could not do less than call attention to the subject.

Thus, Sir John Burgoyne states that—"Every part of the duties of an engineer in the field depends essentially on the arts and operations, constructive and scientific, that are in constant use in civil life and in peace. The more, therefore, that officers of this corps can be charged with the designing and practising of those arts and operations in ordinary times, the more competent they will be for the various calls that may be made upon them in war. The drills and exercises for the ordinary military duties of an engineer in the field are of easy acquirement; but occasions are numerous where the officers may be of great service by having a good knowledge of constructive, geodesical, and other arts and sciences."

Lieutenant-Colonel Simmons observes that—"Engineer officers might very properly be considered as government engineers, to be employed upon all government works of every nature, at home and abroad, such as docks, breakwaters, drainage, surveying, &c. This measure would probably be attended with great saving to the country, and the works themselves would be executed equally efficiently, that is, if a proper system were adopted, by the formation of a central board of high science to approve the plans and projects; and throwing the entire responsibility of the works upon the officers who plan and execute, and even making them responsible under penalty of professional disgrace and dismissal. ......The objection ordinarily made to this practice by the civil profession, viz., that it would be taking the bread in many cases out of their mouths, ought not to be listened to; for surely the country, after going to the enormous expense of educating and maintaining a number of professional men, has an undoubted right to the employment of their professional services. The true objection, then, hinges upon the question, whether or not a corps of military engineers is necessary to the government?—a question as to the reply to which I conceive there can be no shadow of a doubt......Much benefit would also accrue to the public service if officers were assisted in travelling to visit public works, both civil and military, at home and abroad. This assistance might be given as a reward to merit, and in all cases careful reports should be made by the officers, from which the use they have made of the opportunities thus given to them might be judged of."

Major Du Cane, R.E., remarks—"But as it has been found desirable to employ officers of engineers upon duties which do not strictly belong to their military profession, and which come under the head of civil appointments, and as an engineer officer possessed of a certain knowledge of such duties has a great advantage over, and will be found (especially in some of our colonies) more useful to the public service than, an officer who does not possess such knowledge, I am strongly of opinion that instruction, assistance, and encouragement should be given to officers of engineers in the prosecution of such extra duties. Among the first of these I would name civil engineering, by which term I mean particularly the construction of railways, machinery, bridges, canals, dockyards, public buildings, &c. Instruction in these subjects might be given at Chatham to the young officers on joining, and might be made to form a part of their course, following after the military portion.......I am also of opinion that every means should be afforded to engineer officers to travel through the United Kingdom and on the continent, so as to make themselves acquainted with the construction, and principles of construction, of large and important works, civil and military. This facility is afforded by the Hon. East India Company to their officers of engineers, and by the United States and continental nations to their officers."

Other testimony to the same effect might be cited.

The question is very fairly put by Lieutenant-Colonel Simmons, whether or not a corps of military engineers is necessary to the government? If it is necessary, then there can be no doubt that the more they are employed by the government, the more varied the nature of their duties may be, the more efficient they will be found when the emergency arises for which their services in a purely military capacity are more particularly wanted; and it cannot surely be otherwise than a very mistaken economy, to call in a civilian to superintend works of a military or *quasi military* character, unless the number of military engineers be so limited that none can be obtained when they are wanted.

We have not thought it consistent with the object for which we were appointed, to attempt to enter into the consideration of the propriety of any re-adjustment of the duties of the two corps. If the question be brought under consideration, there is very little doubt that the propriety of any changes will be made to rest on well ascertained facts, and not on opinions; and if any changes are made, they will probably be based on other grounds than mere educational ones.

Having been impressed with the necessity of treating military education as a whole, we have urged that it ought to be brought under the direction of a special department; and that the importance of military academies has appeared to us to claim more systematic attention and more real encouragement than they have hitherto received,—and without this we believe it is impossible that military science can hold its proper place in the army.

THE PHILADELPHIA GAS WORKS.*

Extracts from the Engineer's Report for the Year 1856.

At the several manufacturing stations no new constructions have been undertaken in the past year; the improvements completed being only those that had been previously commenced. Of these the most important is the large *gasholder*, No. 12, which was so far completed in the autumn as to be in good working condition. It was put in operation early in the winter, and has continued to work with great steadiness and regularity.

Its efficiency as a great reservoir and regulator of pressure, during the hours of maximum consumption, has fully equalled every expectation. Its advantages in these respects cannot easily be over-estimated, and by its steady action during several violent gales of wind, it proves that a gasholder of very large dimensions is much more dependable than those that are smaller.† Notwithstanding the unexpected obstacles encountered in the construction of this gasholder and tank, by reason of the difficult character of the foundations and casualties of the weather, it is worthy of note, that its cost per cubic foot of capacity is much less than that of any other gasholder ever built at these works, with the exception only of No. 11, which being also of unusually large size, was constructed at less cost per cubic foot than any other of which I have any knowledge in the United States. Had the unlooked-for difficulties alluded to not occurred, the relative cost of No. 12 would have been below that of No. 11, and it may now be esteemed an established truth, that in all large works economy is promoted by the use of gasholders of very large dimensions. As it is believed two gasholders of as large capacity as these, are not to be found at any other gasworks, the present may be considered a suitable occasion for a brief description of them.‡

No. 11 was built in 1850, and has been in almost constant use since that year. It is of telescopic plan, 140 feet in diameter and 70 feet high, containing one million cubic feet.

Gasholder No. 12 was put in operation early in December last; it is like the other, telescopic in form, 160 feet in diameter and 90 feet high, containing one million eight hundred thousand cubic feet. The tank is 162 feet in clear diameter, and 46 feet deep, excavated in gravel and clay, with a central mound 25 feet high.

When the excavation for this tank had been sunk nearly to the depth required for the foundation and floor, the substratum of stiff clay was forced upward by the pressure of water beneath, revealing a quicksand that existed about 55 feet below the top level of the tank, which had not been detected by borings previously made to a depth of more than 50 feet, for the purpose of proving the nature of the ground. This unwelcome discovery made it necessary, for the proper security of the foundations, to adopt some expedient for reaching a firm bed of gravel, which was found to lie about 70 feet from the surface. The great influx of water at this depth, of more than 40 feet below tide, forbade any other mode of reaching this solid bottom than by driving piles. Some thousands were driven in such positions as would allow the tank walls, the guide towers, and the floor, to rest on heavy timbers secured by bolting to the piles after the latter had been driven home in the solid gravel below. These timbers are laid close together, radiating from the central mound to the outer circumference of the foundation walls; their joints were tightly caulked, and the whole covered with a bed of hydraulic concrete.

The tank walls are of rubble masonry, built in two separate rings, the outer one, 4 feet thick, laid in gravel mortar; the inner one, 18 inches thick, laid in hydraulic cement, with an interstice of 6 inches filled in with hydraulic concrete. To increase the tightness of the bottom, it is covered by a dome-shaped pavement of brick, grouted with hydraulic cement. An annular wall of stone is built within the tank, midway between the outer wall and the centre. Upon this are placed twenty-four trestle frames 35 feet high, which sustain the crown of the gas-holder, so as to prevent the swag of the sheets when unsupported by the gas. No rafters are used, nor any interior framework, except a series of tie-rods, which are secured to the crown sheets in such a way as to distribute over its entire area the weight of the centre-post and the vertical sides. This arrangement was adopted in consequence of the great weight required to give the holder such pressure as would control all the others connected with the several works, all of which are more than three miles distant, and some two and three times more remote.

To facilitate the future increase of its pressure, the legs on which the inner section stands, and against which the outer section is guided, are made of cast-iron, and hollow, for receiving the additional weights that may hereafter be required.

To support and guide the gasholder, there are twelve towers of cast-iron, 95 feet high, standing on stone bases; their form is pentagonal, about 12 feet in diameter. The girders connecting the towers are in the form of a heavy balustrade, with open quatrefoil panels, and are placed 15 feet below the summits of the towers. The weight of metal in the whole structure is over 1000 tons; that of the gasholder alone about 300 tons.

To those who are not familiar with the properties of gases, it may appear incredible that a vast structure, weighing upwards of 600,000 lb., can be sustained with safety, resting solely upon a fluid so light and subtle as illuminating gas, whose density is less than half that of atmospheric air, or only $\frac{1}{1600}$th part the weight of water. But the great diameter of this machine gives it an area of 20,000 square feet, and the whole pressure due to its weight is only 30 lb. on the square foot, equal to a column of water not quite 6 inches high. It is therefore raised with the greatest ease by the inflowing gas, by which it can be lifted out of the water of the tank to a height of 90 feet; and as the gas is consumed or passed into the other holders, it is gently lowered, with the silent, steady motion of a great pneumatic press.

Another structure which has been completed during the past year, is the *hydraulic elevator*, used for raising coals from the wharf into the coal stores recently constructed at the First Ward works.

The construction and operation of this machine are of extreme simplicity. Two rectangular water-tight boxes, made of boiler iron, capable of holding about 1½ ton of water each, are suspended to the ends of a strong chain that passes over a wheel placed at the top of the hoisting tower. The length of the chain is such, that one box is level with the railroad track on the wharf when the other is level with a similar track leading into the attic

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* From the 'Journal of the Franklin Institute.'

† Since the presentation of this report to the Trustees, the occurrence of the great snowstorm of January 18th, accompanied by a gale of unusual violence, has afforded another opportunity for testing the stability of this gasholder. At the time of the storm it was raised more than 40 feet high, containing over 800,000 cubic feet of gas, and showed not the slightest symptom of unsteadiness or excessive strain.

‡ The dimensions, with engravings and description, of this gasholder, were given in the *C.E. & A. Journal*, Vol. XVII. (1854) p. 865, and Vol. XVIII. (1855), p. 285.

of the coal stores; a short section of rail track on top of each box is adjusted to fit these main tracks when the boxes are in place.

A loaded car being run on to the lower box, and a light car on the upper one, water is allowed to flow into the latter from a cistern, until its weight preponderates, when it descends and raises the loaded car, its velocity being regulated by means of a powerful friction break, which is worked by an attendant, who likewise works the valves for supplying the water. When the descending car reaches the bottom of the tower, a self-acting valve opens and allows its load of water to escape.

After the coals have been delivered from the vessel at the wharf, into an iron car, placed on a railway laid along the water's edge, they need no further handling, being drawn by a mule to the platform of the elevator, by which they are hoisted 60 feet, to a track leading into the attic of the coal stores, when they are dropped from the car, at a height which allows the pile to trim itself to the slope of the roof; thus filling up the store more completely than could be done by any other mode, and saving more than three-fourths the expense of storing in the usual way. As the two coal-stores now erected are capable of holding only about one-half the coal required for the winter's supply, it will be a measure of good economy to build two more in the present year; whereby the saving of expense in handling and hauling may be gained upon the whole quantity used, and the coals may be more perfectly protected from damage, than they can be in temporary sheds.

In constructing the *retort benches* at the First Ward station, provision was made for their adaptation to various different plans of setting the retorts in the fire arches, without disturbing the permanent masonry. The superior facilities for making comparative trials of different plans thus secured, have not been without their proper fruits.

The assistant engineer, under whose immediate direction the works at this station are placed, has introduced a new plan of setting in an open arch, disencumbered of the usual complex arrangement of flues, from which he has produced results much more economical than any heretofore obtained at the older works. The daily yield when the beds are new and in good condition has been over 8000 cubic feet of gas from each retort, or about 25,000 from a bed of three. The average yield, during the operations of an entire season, has been nearly 7000 feet a day from each retort, or 20,000 feet from the bed of three.

The contrast of results derivable from different modes of setting the retorts is exhibited very clearly in a trial, made at the request of a trustee, of another plan of setting used in a neighbouring city. In order to ensure the utmost fairness and accuracy of the comparison, the retorts used were of the same pattern, exactly alike in all respects. The beds in which they were placed were immediately contiguous in the same section of retort bench, and were worked by the same gang of stokers, using the same kinds of coal and fuel. The trial was continued many months, and until the retorts were used up, so far as practical economy of use would permit. The contrast is remarkable and instructive. When the new setting was first put at work, with the flue dampers adjusted according to instructions given by its suggestor, the daily yield was about 3700 feet to the retort, or 11,000 to the bed of three retorts. By a different adjustment, found upon experiment to produce the best results obtainable, the yield was increased to 4300 feet per day from each retort, or about 13,000 from each bed of three. This was the utmost they could be made to yield, without endangering the destruction of the bed by melting down the furnace.

As these results speak for themselves, they require but brief comment. The cost for retorts, for retort-house room, and for labour of working, is the same in both the plans of setting; the daily product in one case exceeds that in the other by one-half.

The setting in open arches, when fully introduced, will much increase the capacity and profitable results of our works: the other would take largely from us in both these respects. The practical difference between the adoption of the one or the other, in its money value, on our present scale of operations, would amount annually to the interest on a capital of more than half a million of dollars.

Another year's trial of the cellular retort, for the production of *gas from vegetable substances*, has confirmed the results heretofore reported, with respect to the quantity and illuminating quality of the gas thus obtained. As there seemed to be some doubt as to the permanency of this gas, it was thought worth while to test it in such way as would bring the question to a satisfactory solution.

A considerable quantity of it (30,000 cubic feet) was stored in a gasholder by itself, and after remaining thus isolated several weeks, was tested photometrically. It had not changed perceptibly, having retained its illuminating power as completely as coal gas under similar trial.

With the present relative prices of wood and coal in the Philadelphia market, the cost of making gas from the former is somewhat the lower, but the difference is not sufficient to justify the immediate abandonment of the latter. Should a commercial change occur, by which the price of coals should be again advanced to the high point reached two or three years ago, there might arise important advantages to these works and its customers, from the ability to make the substitution of wood for coal. It will therefore be consistent with good policy to continue, as heretofore, the use of such number of wood retorts as can be supplied with that material without sensibly affecting its market price, particularly as their use is accompanied with some immediate profit, and entails no extra cost for the contingent advantages it presents.

A careful and accurate analysis and photometric examination of wood gas has been made by two eminent analytical chemists (Dr. Wolcott Gibbs, of New York, and Dr. F. A. Genth, of Philadelphia), whose report of their chemical results furnishes a highly satisfactory explanation of certain curious phenomena that accompany the combustion of this gas. They examined two varieties of gas, one made from old field pine, the other from small second-growth oak, with the following results:—

Composition.

	Gas from Pine.	Gas from Oak.
Hydrogen	32·71	30·44
Light carburetted hydrogen	21·50	33·12
Olefiant gas and hydro-carbon vapours	10·57	6·46
Carbonic oxide	27·11	26·11
Carbonic acid	4·90	0·48
Oxygen	0·66	None
Nitrogen	2·55	3·39
	100·00	100·00
Specific gravity	0·663	0·580

These gases were collected at the Ninth Ward Works, and taken to New York for analysis. Their illuminating power was tested, and found to be over twenty-six candles for a 5 feet burner. A subsequent series of photometric trials of wood gas, previously passed through a long pipe exposed to a temperature of 15° Fah., gave an average of 18·3 candles from a burner consuming 4·6 feet per hour.

The conclusion at which these gentlemen arrive from their elaborate examination is, "that wood gas, in illuminating power, is fully equal to the average of coal gas."

The growing magnitude of the operations at the different offices and works managed under the gas trust, and their constant mutual dependence, have created a necessity for frequent intercommunication of intelligence, and official directions, such as can be most perfectly obtained only by means of the *magnetic telegraph*. No time, therefore, has been lost in carrying into effect the recent directions of the board upon this subject; and the contractor is moving so promptly, that the line will very soon be in readiness for use. Of the advantages to be derived from this it is not easy to form in advance anything like an adequate estimate. In the management and control of the numerous gasholders, many miles apart, but in close mechanical connection, it will add greatly to their security. In the regulation of the street-main pressure, at various points during the hours of lighting, it will prevent the inconveniences that now so frequently result from the want of prompt information at the works. In regulating the lighting and extinguishing of the public lamps, in giving a knowledge of the exact locality of fires, and in a vast number of other matters, it will be truly of inestimable value.

The several factories belonging to the Trust have produced in the year 1856, 434,742,000 cubic feet of gas; of which 163,930,000 cubic feet were made at the works in First Ward, 184,357,000 in Ninth Ward, and 86,455,000 in Fifteenth Ward.

The largest quantity used in twenty-four hours, was 2,166,000 cubic feet, on the last night of the year; and the largest daily product of the several works has been, 799,000 in First Ward, 1,084,000 in Ninth Ward, and 440,000 in Fifteenth Ward. These maximum daily productions did not occur simultaneously, and therefore their aggregate amount was not produced on any one day, it having been found most convenient to manage the different factories in such way, that one might be in full working when the yield of another had fallen off by reason of the wear of its retorts.

The largest daily average yield of each retort in the year was

7194 feet at the works in First Ward,			
5382	„	„	Ninth Ward,
5150	„	„	Fifteenth Ward.

The largest quantity from each pound of coal respectively, made for any full day's work—

$4\frac{82}{100}$ feet at the works in First Ward,			
$4\frac{65}{100}$	„	„	Ninth Ward,
$4\frac{64}{100}$	„	„	Fifteenth Ward.

John C. Cresson, *Engineer*.

INSTITUTION OF CIVIL ENGINEERS.

May 12.—Robert Stephenson, M.P., President, in the Chair.

In commencing the discussion upon Mr. Rennie's Paper, "*On the Employment of Rubble Beton or Concrete in works of Engineering and Architecture*," the author gave some further details of works which had been alluded to, and particularly of the Pont de l'Alma. It was stated that the material composing the arches was found originally to dry so irregularly, as to cause cracks in several places. This was first remedied by forming large detached blocks of the concrete *in situ*, and then cementing them together. But a further improvement was made. It was found, that in making an arch of nearly 5 feet in thickness, there was unequal expansion and contraction of the materials. To obviate this, a ring of small stones set in cement was first laid, on which the coating of Vassy cement concrete was spread. In fact, the arch was built in two rings. As regarded expense, it had been said that the Pont de l'Alma had cost 40,000*l*., but it was believed that 50,000*l*. was more nearly correct. Now a bridge built at Liege of dressed stone, of 550 feet in length and 30 feet in width, or 60 feet longer and half the width of the Alma bridge, had cost only 26,000*l*. This did not show any great economy in cost in favour of the use of concrete; but, as regarded time, the one was built in nine months, as stated in the Paper, whereas the Liege bridge occupied three years in its erection.

It was presumed that the Paper was to be taken as a history of rubble and concrete up to a certain date, for it did not convey any idea of the extent of its use at the present time. There were now existing in various parts of Great Britain some remarkable works in rubble masonry, which had not been alluded to; amongst which might be mentioned the Liverpool and the Birkenhead Docks. It was thought that working in rubble had been greatly neglected, and that engineers had gone to the opposite extreme of building in expensive ashlar. But what was to be most carefully guarded against was the adoption of a hybrid masonry, consisting partly of ashlar and partly of rubble. This was looked upon as a dangerous system, as the unequal settling was almost sure to cause the ashlar facing to split, or part from the rubble backing.

It was remarked, as a generally received opinion, that concrete made with carefully washed gravel and sand was preferable to that which contained an admixture of loam. Now in some instances this had been proved not to be the case, for loam had been used with positive advantage. If expensive processes of making concrete were adopted, it would be better to resort at once to rubble work.

To this it was replied. that it had been shown that the composition of the sand ought to bear some relation to the lime with which it was mixed, and that under certain circumstances the presence of marl in the sand was necessary. A careful examination of the treatises on the subject of rubble masonry showed that little was known as to the weight it would sustain or the duty it would perform. It was of great importance to ascertain the resisting powers of rubble composed of different materials, and set in different limes and cements; and also the composition and action of the ingredients which entered into the concrete, or which were mixed up with the rubble.

A distinction ought to be drawn between concrete or beton, and rubble work. The former was generally used for foundations, or for making an apron between the piers of a bridge to prevent the evil effects of scour, and also in breakwaters, where large masses of that material were thrown in. In rubble work the stone formed about three-fourths or five-sixths of the whole mass, whilst in concrete the proportion was very much less. In this respect the material of ancient buildings occupied a place between the modern concrete and rubble, for in the works of the Romans the stone formed about one-third of the whole mass. The beton used in Russia had been subjected to a pressure of 5 tons per square foot. It was made of a particular clay, burnt according to the formula of Vicat; and thus a perfect artificial hydraulic lime had been formed, nearly equal to natural lime.

A description was given of the system followed by the late Mr. Walker and Captain Huddart, in using washed gravel for the backing of quay walls at the East and West India Docks and other places, by which great solidity was attained. Mr. John Rennie subsequently introduced the use of lime with the gravel, forming concrete. Mr. James Walker had used cement concrete very extensively in marine works, at Dover, Alderney, and other places, with great success. The concrete used at the two former places was composed of Portland cement mixed with shingle, in the proportions of one part of cement to ten parts of shingle, moulded into blocks varying from 6 to 10 tons in weight.

The general dimensions of that part of the breakwater so constructed were—medium width, 90 feet, composed of a hearting of cement concrete blocks 60 feet in breadth, protected by range work of blocks of Roach Portland stone faced with granite, of an average thickness of 15 feet on each side. The foundation of the wall was 45 feet below low water of spring tides, and the top rose to 20 feet above that mark, making a total height of 65 feet.

It had been observed that the quality of the Portland cement was not always uniform, and that expansion or disintegration of the blocks had taken place two or three months after they were made, and before they were bedded in position, which operation was generally delayed for six or nine months, to allow them to become thoroughly dry. The manufacture of Portland cement was evidently one which required much care, and was not free from risk, though its general employment was satisfactory, and its use was daily extending for all works of civil engineering and architecture.

To this it was replied, that the cases of expansion which had been noticed probably arose from the presence of too much lime in the cement —the result of careless or improper manufacture, but such results had not been observed in cement supplied by good manufacturers. The lime so found in a free state, and not well incorporated with the other ingredients, would undergo the action of slaking by the atmosphere, and still more rapidly by sea water, and disintegration would ensue. The manufacture of this cement was essentially one of confidence, and such defects as those mentioned rarely if ever occurred with the produce of experienced manufacturers.

With regard to the works at Dover, it was stated that though nearly half a million cubic feet of concrete in blocks were now laid annually, the proportion of breakage scarcely little exceeded 1 per cent. The cost of the concrete blocks was assumed to be about one-half of the cost of the stone walls which had originally been intended to have been constructed. The large cubic contents, and consequent weight of these blocks, the uniformity of their size, and their close contact in the work, were relied on as prominent advantages in their use.

The French engineers had used concrete blocks, made of lime and artificial pozzolana, at Marseilles, Rochefort, Algiers, and Cherbourg. After a few years' exposure to the sea water, these blocks had disintegrated and fallen to pieces—a result ascribed by M. Vicat to the presence of magnesia in the sea water, which acted injuriously on the lime. It was not without hesitation, therefore, that some years later they had commenced the employment of Portland cement for their beton works; but the results ascertained in the interval as to its durability when exposed to the action of sea water, appeared to have justified the present general adoption of that material, even to the extent of using the blocks in external walls without the protection of stone casing.

The injection of Portland cement into the foundations of the Pont de l'Alma was noticed as a method of forming beton under water which, though allowable in exceptional cases, could not be recommended on the score of economy, as in the case in question a quantity of cement, costing not less than 1500*l*., had been employed, one-third of which had in all probability been washed away by the current, and had never set at all.

At Alderney the depth of water was greater than at Dover, and there was abundance of stone, which was thrown in as "pierre perdue," to form the substratum; and from a depth of 12 feet below low water a vertical stone wall was brought up, backed by concrete blocks, to form the hearting.

Descriptions were given of the large blocks of concrete used at the new harbour works at Marseilles and at Algiers. They weighed upwards of 50 tons each, and were moulded close to the spot where they were to be used, and then thrown into the sea. At Algiers it was believed that considerable disintegration had taken place, as it was evident that large cavities existed in the work. When the sea was agitated it was scarcely possible to walk on the mole, on account of the jets of water, which were driven through the apertures with great velocity to considerable distances. The local engineers anticipated that these cavities would in time be closed by the accretions of shells, by which several had been already stopped; but this presumed that the disintegration of the blocks was not also progressing. It was questioned whether this disintegration had not arisen from the use of artificial instead of natural pozzolana.

Instances were adduced of the absolute overthrowing of walls from the excessive expansion of the cement used; and even of a thin coating of the same kind of cement having expanded in the same remarkable degree. It was explained that this must have arisen from the admixture of an undue quantity of lime in the cement, an error not unfrequently fallen into by inexperienced manufacturers.

The now too general system of using a quantity of lime in the making of bricks was denounced as injurious; as the lime when acted upon by water expanded, split the bricks, and destroyed the work. An instance was adduced where a lighthouse had been pulled down entirely in consequence of this action.

The extensive use of concrete by the ancients was noticed, and the magnificent works in Rome were quoted as instances of its durability. There it had been used for vaulting, by first constructing ribs of tiles and pozzolano cement, and filling in with concrete. The excellent quality of the natural material, which abounded near Rome, had no doubt contributed to its general and successful employment.

The works of the French engineers descriptive of their processes in using beton were mentioned, and a Paper on the subject was promised during the ensuing session, when it was hoped that the members would be prepared to give the comparative prices of marine and other constructions of concrete, and of squared blocks, or of "pierre perdue," as that question had been cautiously avoided on the present occasion.

It was a question whether rubble concrete was really either so effective or so cheap as good bricks and cement for the superstructure of a bridge, however good and applicable it might be for the foundations, to which it had been generally restricted in this country. In such positions it was excellent, and but for its use many hazardous works could scarcely have been executed.

The Paper read was "*A Description of the Method of Building Bridges upon Brick Cylinders in India.*" By G. B. Bruce, M. Inst. C.E.

The author began by adverting generally to the constitution of Indian railways as joint stock undertakings, having a certain rate of interest guaranteed to them by the East India Company, in return for which the railway companies were constrained to submit to a degree of government control and interference which militated very much against the speedy and judicious execution of the works.

The Paper next referred to the Madras Railway in particular, which had the city of Madras as its terminus on one side of the peninsula, and Beypoor, near Calicut, on the other, and extending over a length of 450 miles.

Eighty miles of this line had been opened for traffic, and the remaining part was under construction. All had been executed by the railway company's own engineers, a system which the author stated had been found to answer exceedingly well.

The bridge to which this Paper was specially appropriated was built over the river Poiney, about 70 miles from Madras, and consisted of fifty-six arches, each of 30 feet span, a small sized arch being best suited to the powers of the native workmen, and the character of the site of the bridge itself. The bed of the river being of sand to an unknown depth, it was necessary to resort to some description of artificial foundation, and in England the probable expedient would have been timber piling, but in Madras the expense of timber precluded its use in that way, and the usual native expedient of brick cylinders was resorted to.

Each pier was founded upon fourteen cylinders built of radiated bricks, of 2 ft. 6 in. internal, and 5 feet external diameter, sunk to a depth of 15 feet below the bed of the river, and filled with broken stones and bricks. Besides the cylinders, immediately under the piers there were two rows of cylinders stretching the entire length of the bridge, one under each of the inverts, to protect them against the effect of any scour through the arches, forming as it were two brick walls across the stream founded at 15 feet below the bed of the river.

The cylinders were placed as closely together as possible, and the interstices between them filled up with broken stone to as great a depth as it could conveniently be placed. The masonry was commenced at a depth of 5 feet below the bed of the river, on the top of the cylinders; this it was believed would prove sufficient precaution against the effects of the stream. Should there, however, be any tendency to undermine the foundations, this could be guarded against, by throwing in an apron of rubble-stone on the down-stream side of the bridge.

The masonry was of gneiss rock, found in the neighbourhood, and quarried by the application of fire, which caused it to split off in regular layers, varying in thickness from 3 inches to 1 foot. The total cost of the bridge was about 14,000*l.*, or 7*l.* per lineal foot.

The author, in conclusion, observed, that the system of building on brick cylinders was similar in principle to that sometimes pursued in this country, where piers were built on large cast-iron cylinders, which, from the difficulty of procuring them, and their greatly increased cost, were not so well adapted for public works in India; and it was doubted whether any plans could be devised which, for efficiency, readiness of execution, and economy, would be so well suited to the purpose as the brick cylinders of India.

Attention was directed to a Paper by Captain (now Colonel) Goodwyn, B.E., read before the Institution in February 1842, giving an account of a very similar method of obtaining foundations in Bengal.* His description was: "As soon as the masonry (of the cylinder) has hardened sufficiently, the well-sinker fixes a plumb-line to the top of the cylinder, as a guide, and descends withinside, carrying an instrument called a 'phaora,' or 'mamooti,' somewhat similar in shape to a hoe: with this he excavates the earth, until the water is too deep; he then commences the use of the 'jham,' which resembles the 'phaora' in shape, but is about 36 inches long and 27 inches wide, and is suspended to a cord passing over a pulley above the cylinder. Upon this instrument the well-sinker descends, and, diving into the water, excavates with the 'jham' the soft earth under the sides of the curb, and is at intervals drawn up with the instrument. The cylinder descends gradually from 6 inches to $2\frac{1}{2}$ feet per day, as the earth is withdrawn from beneath it, and relays of workmen keep it constantly going, lest the sand should settle around it, and cause it to hang up."

* See *Journal*, Vol. V. (1842) p. 168.

This process appeared to differ somewhat from that employed at Madras, and the wells were different in Bengal, inasmuch as they appeared to be coved over, and the weight of the superstructure was thus thrown upon the outer walls of the cylinders, whereas, in Madras, the wells were filled up with material which rendered the whole a solid mass.

The improvements introduced by Colonel Colvin, of forming square or elongated masses of brickwork, with several wells in each, had been further extended by Colonel Sir Proby Cautley, who had made each mass of the full size of the foundation of the structure to be placed in it; in this way he established the piers of the great Solani aqueduct on the Ganges Canal. Some engineers filled in the wells with loose rubble, with the object of providing for any sinking away of the sand from beneath the cylinders, which frequently occurred, as the foundations were placed on the sandy beds of rivers which were dry in certain seasons, but became torrents at other periods. Depths of from 20 to 30 feet of sand were not unfrequently washed away, and it had been therefore necessary in some instances to carry these wells down as deep as 40 feet.

These wells acted in a double capacity—as piles holding by lateral friction, and as forming a mass under the building. The system was not universally applicable; for instance, in a river constantly full of water there would be considerable difficulty in using it, in fact, other systems would probably be cheaper: the Indian rivers, which were generally dry for a large portion of the year, could not be traversed by any other system so expeditiously or economically, nor the works be otherwise rendered so permanent.

May 19.—Robert Stephenson, M.P., President, in the Chair.

The Paper read was, "*On the disturbances of Suspension Bridges, and the modes of counteracting them.*" By Messrs. A. S. Lukin and C. E. Conder.

This Paper brought under consideration the various kinds of suspension bridges, and examined their greater or less liability to undulations of the roadway, and other disturbances, occasioned by a traversing load, or other causes. These disturbances were attributed, chiefly, to the flexibility of the chains, and were enumerated as follows:

1. Undulations caused by traversing loads.
2. Reaction on the roadway of the chains when set in agitation.
3. Transverse swing.
4. Distortions caused by the gravitating tendency of the chains.
5. The effect of unequal loading in bridges of multiple-spans.

The first class of disturbances might be reduced by increasing the mass of the chains. The objection to this was, that not only would such an expedient prove wasteful of material, but the greater the weight of the chains the greater the danger of their destroying the platform, if once set in agitation. Again, the roadway might be supported by a rigid girder, strong enough to withstand any distortion of the chains. Such a girder would, however, be nearly strong enough to carry the load independently of the chains, which would become dangerous auxiliaries to an inflexible platform.

The Niagara Suspension Bridge was adverted to, as having its liability to undulate much reduced, not only by connecting the upper and lower platforms with lattice trussing, but also by employing strong upper and under bracing-rods.

It was contended, that while a certain degree of stiffness in the platform would be advantageous, as equalising the distribution of the load on the chains, the main point for inquiry must be the arrangement of chains and rods best calculated to abate the liability to disturbance. With this view six modes of arrangement were described and illustrated, viz.—

1. The ordinary suspension bridge.
2. The mode of suspension by a double set of crossed chains (Russell's).
3. The single-rod direct suspension.
4. The chain with slanting rods (Dredge's).
5. The double-rod direct suspension.
6. A new mode, distinguished as the convergent suspension, of which two varieties were exhibited and explained by means of diagrams and models.

1. It was pointed out, that while the ordinary form of suspension bridge effected a marked economy of material, its great flexibility and liability to undulate and swing, operated against its employment for railway traffic.

2. The mode of suspension by crossed chains (as in Mr. Russell's bridge), while tending in some degree to reduce these disadvantages, required an enormous increase of material, together with a double height of tower.

3. It was stated that the single-rod direct suspension, while perfect in theory, as regarded freedom from undulation, was defective, owing to the length required for the rods, the sharp angles at which they met the roadway, and their consequent liability to stretch and "sag."

4. The introduction of a chain to support the slanting rods (as in Mr. Dredge's bridge), diminished these evils and shortened the rods, at the same time that it secured a more equable distribution of the tensions. But this arrangement, in common with the preceding mode of direct suspension, imposed powerful horizontal strains on the roadway; and the excessive strength thus demanded in the platform militated against economy, if it did not even impair the safety of the whole structure.

5. The double-rod direct suspension entirely relieved the platform from any horizontal strain. But the great length and angle of its extreme rods entailed and increased all the other evils to which the single-rod direct method was exposed.

6. The convergent mode of suspension was devised to avoid, as far as practicable, the several defects which had been pointed out in the five arrangements above mentioned. From a double set of chains (each extending from the top of one tower to the platform level at the opposite extremity), a double set of rods were suspended, slanting in opposite directions, so that a pair of rods converged to every point by which the platform was suspended. There was thus an entire absence of horizontal strain on the roadway, which might, therefore, be made of extreme lightness, while the advantages of direct suspension would be to a great extent secured, the undulations of the roadway and the tendency to lateral swing being reduced to a minimum; and the reaction of the chains on the platform would be much diminished by the radiating play of the rods. It was shown, by means of tables, that the convergent principle admitted considerable economy of material. Two designs were exhibited, the second of which, although theoretically inferior to the first, effected a great saving in the weight of the chains, by allowing a sharper curvature. At the same time it was submitted, as a matter worthy of inquiry, whether an application of the convergent method might not be arrived at still better suited for large spans.

A mode was suggested of connecting each pair of rods with the platform, by means of a self-adjusting lever, the play of which, by equalising the horizontal strains, would tend to diminish the derangements caused by an unequally distributed load.

It was pointed out, that the gravitating tendency of the chains would cease to operate as a source of disturbance, if their sectional weight were so adjusted (by ballasting or other means) as to cause them to hang naturally in the curves due to the conditions of suspension.

The effect of unequal loading in bridges of multiple-spans was then adverted to, as giving rise to danger, through the unequal tensions induced in the chains on opposite sides of a tower. A table was given, showing that the employment of convergent rods reduced this danger to some extent. Inverted chains below the platform were also advocated in bridges of multiple-spans designed for railway traffic.

The mathematical reasoning and formulæ upon which the foregoing conclusions were based were not considered suitable for reading aloud, and were therefore given separately in an appendix.

It was announced that the next meeting for the reading of Papers would be held on November 10th, until which time the meeting was adjourned.

The Manby Testimonial.

The members of the Institution of Civil Engineers had for some time entertained the intention of demonstrating in an appropriate manner their personal esteem for Mr. Charles Manby, with their sense of the valuable services rendered to them individually and collectively; and at the same time of acknowledging the ability with which he had during eighteen years performed the duties of Secretary to the Society. Advantage was taken of the opportunity of his retiring from the post of paid Secretary, to carry this intention into effect: a committee was formed, and in a very short period upwards of 2000*l*. was subscribed, with which it was determined to purchase a fitting testimonial, and to present the balance in cash. The ceremony of presentation took place in the theatre of the Institution, on the 23rd May last, in the presence of a large assemblage of the members and of Mr. Manby's private friends, who had been permitted to join in the tribute to his merit.

Mr. Robert Stephenson, M.P., the President of the Institution, took the chair, and said, the object of the meeting was well known. Mr. Manby having, after eighteen years' service, resigned the position of paid Secretary, it had been resolved to offer to him a testimony of the respect and esteem in which he was held; and in doing this he would make a few brief observations on the circumstances under which Mr. Manby had become connected with the Institution, the duties he had performed, and the services he had rendered. After the usual struggles and vicissitudes, the young Society, although very ably directed by Mr. Thomas Webster, had scarcely established itself among the scientific bodies of the metropolis. The minutes of its proceedings were but meagrely reported, and its transactions were scarcely known beyond the members themselves. From the time however when Mr. Manby undertook the duties of Secretary, new vigour was infused into all their proceedings, the number of members increased, the character of the Papers improved, and the care bestowed on the editing and publication eventually rendered the records of the proceedings a most useful text-book for the profession. Mr. Manby's sphere of usefulness was not, however, confined to the performance of his official duties, for he was ever ready to give advice to the younger members and to afford aid to the senior members from his well-stored mind, in reference to every department of engineering, as well as in a variety of ways, rendered more pleasing by the alacrity and cheerfulness with which the friendly offices were performed. The value of the information afforded was enhanced by its accuracy, which was to some extent to be attributed to the practical foundation of his professional education, the early portion of his life having been spent in the workshop as a mechanical engineer, at the period when the profession was beginning to assume its present importance. In some degree, therefore, Mr. Manby lost the official character of Secretary, and became the friend and companion of the majority of the members of the engineering profession.

Mr. Stephenson then presented the testimonial, consisting of a timepiece and a pair of candelabra, with the sum of 2000*l*. The timepiece and candelabra bore the following inscription:—"Presented by the Members of the Institution of Civil Engineers and a few personal friends, with the sum of Two Thousand Pounds, to Charles Manby, as a token of esteem, and in recognition of his valuable services during a period of eighteen years as Secretary of the Institution, May 1857."

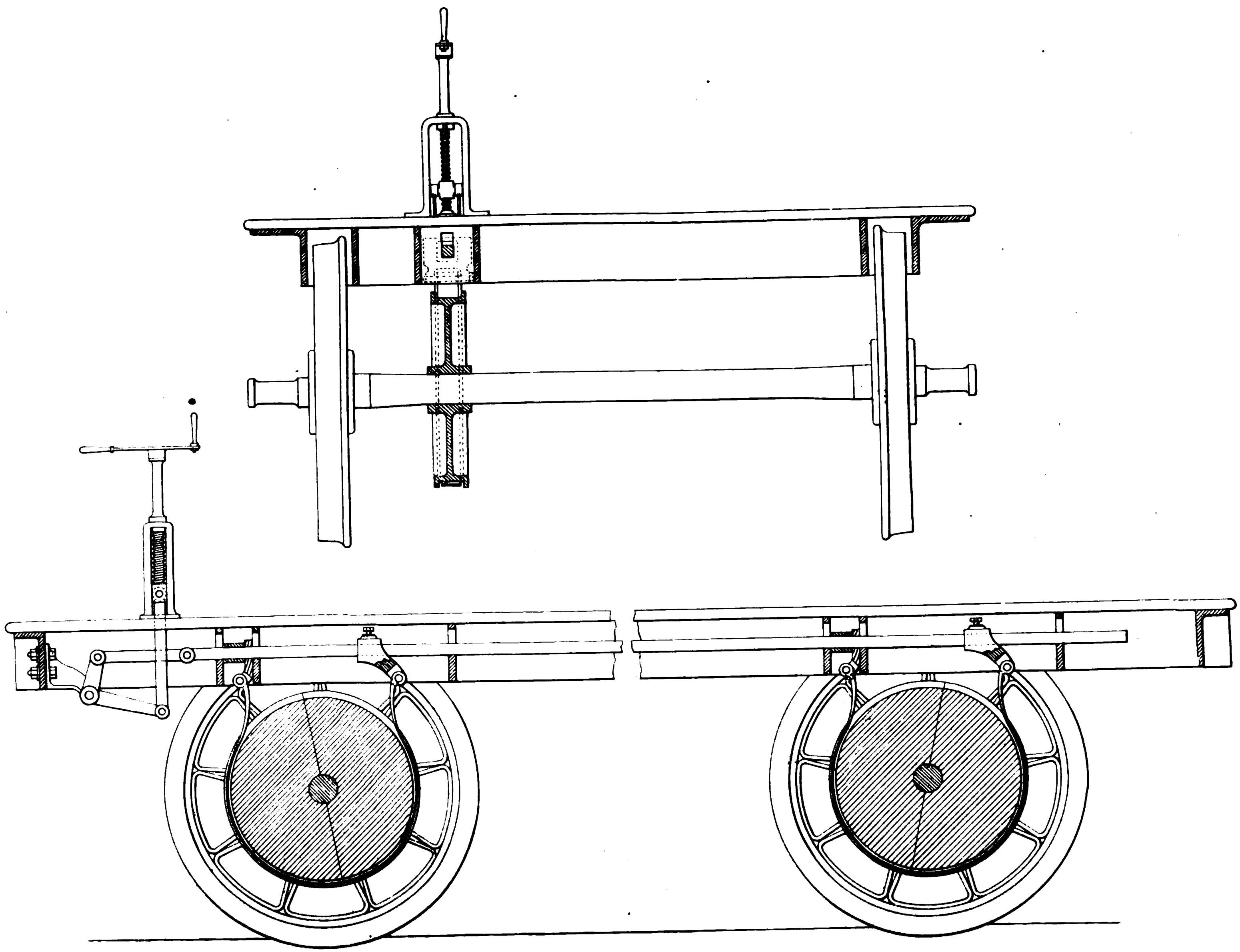
Mr. Manby, after a very appropriate reply, stated that his connection with the Institution dated from a period long antecedent to his appointment as Secretary. He had been, he was proud to say, apprenticed at an early age as a practical mechanic, and earned his bread by daily toil. He was sent up to London by his late excellent father to work upon contracts at the docks, where he was noticed by Mr. John Rennie, by whom, as also by Mr. Telford, he was afforded invaluable opportunities of improvement; and became known to Nimmo, Provis, and Palmer, and to them, as well as to Field, Maudsley, Bramah, and Simpson, he was under great obligation. They had permitted him to attend the meetings of the then infant Society of Engineers; and when his father intrusted to him the construction of the first pair of marine engines with oscillating cylinders, and the building of the *Aaron Manby*, the first iron steamship that ever made a sea voyage, it was to the Institution he resorted for advice in difficulties; and he was happy to record the expression of his gratitude for the aid so kindly and unreservedly afforded to him.

He then slightly sketched his career in France, under his father, and in the government service,—his return to England, and occupations in the ironworks of South Wales,—and his settling in London, when he embraced the earliest opportunity of joining the Institution, at that time presided over by Mr. Walker, and under the able direction of Mr. Thomas Webster, whose exertions, in giving to the still young Society a constitution and good laws, and in attracting to its meetings men of scientific eminence, should ever be gratefully remembered. On an emergency, Mr. Manby's aid was sought by Mr. Simpson and Mr. Bramah, to perform the secretarial duties, and eventually, in 1839, he was appointed Secretary. The position was novel for a man whose career had hitherto been essentially practical, and he felt the disadvantage of succeeding a Cambridge man, whose pursuits were purely literary and scientific; but again good friends lent a hand, and several literary men and members of the press, who had since attained well-deserved eminence, afforded him invaluable counsel and assistance.

The stirring period of the engineering history of the country was commencing, and it was evident how much good would result from bringing into intimate contact the men of talent and energy, whose professional contests tended to estrange them from each other. With this object steadily in view it was necessary to be useful to all; and eventually—after certain necessary changes, which consecutively introduced to the Presidential chair Sir John Rennie, Mr. Field, Sir William Cubitt, the late Mr. Rendel, Mr. Simpson, and Mr. Robert Stephenson, and brought into the Council the well-known names of Bidder, Brunel, Locke, and Hawkshaw, as Vice-Presidents, with Hawksley, Fowler, Errington, McClean, Gregory, Wood, Russell, and others—the value of the Institution was recognised, and it became the arena where the men of the day met, and whilst mutually learning to estimate their several powers, they formed friendships which had tended to most beneficial results, and were imbued with ambition to execute the great works conferring such inestimable benefits on society.

The labour required for obtaining such results was no doubt considerable, but the Council judiciously directed the course, and it had been fortunately successful. The Institution had been extensively useful, and was as well known and respected abroad as at home, for it had been a pleasing duty to Mr. Manby to give a cordial welcome to all foreign

SUTHERLAND'S PATENT RAILWAY BREAK.



J. R. Jobbins.

engineers and scientific men, and to obtain for them that favourable reception they might not otherwise have experienced. It only depended on the members to extend this sphere of utility, and to connect the Institution with the records of the great works distinctive of the nineteenth century. The value of the testimonial was greatly enhanced by the kind feeling which prompted it, and he should look upon it with pardonable pride. He asked as a favour to be permitted to devote a portion of the amount of the testimonial to establishing an annual premium which should bear his name. There was another point on which he would wish to say a few words: the engineering profession reckoned among its numbers many rich and prosperous men, but there were also many less fortunate members, to whom aid in time of sickness or need, or succour to a struggling and bereaved family, would be inestimable. Yet the engineers were the only professional body not possessing some kind of a mutual aid society. Would it not be possible to originate some plan for thus doing good? His time and means might be freely commanded, and he should feel happy in devoting to such an object a further portion of that which had been so generously placed at his disposal. It only remained for him to renew his heartfelt thanks, not only for the munificent present, but for the kindness and friendship with which he had been favoured during so many years.

Mr. Locke, M.P., Vice-President, proposed a vote of thanks to the President for having taken the chair on the occasion, and having so kindly expressed the unanimous feelings of the members towards their valued officer and friend, to whom they all wished every prosperity in the career in which he was now embarked.

SOUTH KENSINGTON MUSEUM.

The New Government Museum at South Kensington was opened on the 24th ult. The objects exhibited are very numerous and diversified. In the Museum of Ornamental Art are upwards of four thousand specimens, although only a small portion of them are at present exhibited, one thousand of them being at the Manchester Art-Treasures Exhibition, and the remainder circulated among the various provincial schools of art. This department includes many hundreds of plaster casts representing the architectural styles of ancient Greece and Rome, the Renaissance style of Italy, France, Flanders, &c. There are also many photographs, engravings, and coloured drawings, illustrating the decorations of palaces and churches, chiefly Italian, the most important works of art in the Louvre, &c. There is a splendid collection of porcelain from the royal manufactory at Sèvres, and an equally choice selection of English origin, the products of the manufactory of Messrs. Minton and Co., and some beautiful specimens of ancient and modern painted glass.

The Educational collections, which originated with the Society of Arts, by whom an exhibition of apparatus, diagrams, and books, was organised in 1854, afford most complete information respecting school buildings and fittings, general education, drawing and the fine arts, music, household economy, geography and astronomy, natural history, chemistry, physics, mechanics, apparatus for teaching the deaf and dumb, idiots, &c., and physical training. These constitute the principal classes into which this part of the museum is divided. The Educational Library numbers five thousand volumes.

In the Commissioners of Patents museum is a selection of models of various kinds, besides several hundred volumes of specimens, and drawings of specifications of patents. The illustrations of the steam engine are extremely interesting.

The Architectural Museum, which was founded in 1851, in Cannon-row, is intended to afford the means of studying architectural art, as developed in all countries, and during every age; as far as is practicable, the various casts and specimens will be ranged in the order of their dates. Lectures will be delivered here during the session, some having special reference to art-workmen.

The sculpture department, which is in the west gallery, already contains contributions from Bailey, Bell, Foley, Munro, Calder Marshall, and the late Sir Richard Westmacott. It is intended to contain the works of British sculptors, both living and dead.

In the Gallery of British Fine Arts the magnificent paintings and drawings, as is well known, are, for the most part, the munificent gift of Mr. John Sheepshanks. The collection comprehends some of the choicest works of Calcott, Collins, Constable, Etty, Landseer, Leslie, Mulready, Redgrave, Turner, and Wilkie.

The Economic museum is divided into the following classes:—Building designs, exhibiting the arrangements of dwellings, &c., for the working classes; materials for building and household purposes; fittings, furniture, and household utensils; fabrics and clothing; food, fuel, and other household stores; sanitary department; miscellaneous articles; and the economic library.

The Museum may be regarded as a most thoroughly useful and practical attempt to educate the people in the various branches of art, not only with a view to improve their social condition, but, at the same time, to refine and elevate their minds and pursuits.

SUTHERLAND'S PATENT RAILWAY BREAK.

(*With Engravings, Plate* XX.)

This invention is intended to act as a simple and efficient substitute for the breaks ordinarily employed on railways. Its construction is as follows:—A flanched drum or friction pulley, formed in two halves, is fixed upon each of the running axles of the carriages. These drums, which are situated in a line with each other, are acted upon by friction straps or bands of metal, which encompass a greater portion of their circumference, and are each attached, at one of their ends, to a rod running lengthwise of the carriage, and situated directly over the drums. The other ends of the straps are attached to brackets, fitted loosely upon the bar, but confined from moving endwise therewith by means of cross bars attached to the framing. One end of the longitudinal rod is connected with a bell-crank lever, to which motion is given by means of a screw, worked by hand in the ordinary manner, the revolution of which in either direction, causes the longitudinal rod to be moved in the direction of its length, and thus to tighten the straps upon the friction drums, or to relieve them therefrom as required. The Patentee specifies that if found necessary, or preferred, the metal straps may be lined with wood or other suitable material.

If the practical difficulties which have hitherto prevented the introduction of a break of this description are found on trial to be overcome by Mr. Sutherland's very simple arrangement, it will doubtless, owing to its lightness and the nicety with which the amount of friction applied may be regulated, come into extensive use.

THE SOCIETY OF ARTS.

The one hundred and third anniversary dinner of this Society took place at the Crystal Palace, Sydenham, on the 23rd ult. Nearly three hundred gentlemen were present, The chair was taken by Lord Stanley, M.P.

The Chairman, on proposing "Prosperity to the Society for the Encouragement of Arts, Manufactures, and Commerce," said he need not recall what the purpose of that Society is, or what had been its history during the century of its existence. Still he referred to the past to show out of what elements it sprung. In 1721 an effort was made for the establishment of an association to promote mechanical invention, but it failed. In 1748 another effort of the same kind succeeded, not in England, but in America: and it was rather a remarkable fact, that the prospectuses of the society that had succeeded and the society that had not became the foundation of the Society of Arts 140 years ago. Thus present failures were not always real failures, for such failures sowed the seeds of enterprises that were to come to maturity. He specified the objects originally aimed at by the Society of Arts, in order to show how much many of these objects had been taken up by societies which sprang from theirs. Philosophy at first, he urged, included every range of subject; but in the course of time it became divided into branches which required specific application; and so at one time all the sciences and all the arts were comprehended in the programme of their institution, but such societies as the Royal Academy branched off from it, in accordance with the inevitable law of progress in study—a law as inevitable as that the plant should yield its seed, and that the seed should spring up and grow. At present the Society had directed its attention to two great purposes, the union of mechanics' institutes and the promotion of certificate examinations which might be of service like academical degrees, but to a lower class of the community. There were now 360 mechanics' institutes in union with the Society, and a vast majority of them were certainly in good working order. As to the certificate examinations he could not speak with certainty relative to their success, but it might be encouraging to know that while at first only 50 candidates appeared for examination, they had now now more than 230.

The Prizes awarded by the Society's Examiners at the examination held in London during the first week of June, were also distributed to the successful candidates on the 23rd ult. Sir J. Pakington, Bart., M.P., presided. The Sixth Annual Conference between representatives from the Institutions in Union and the Council of the Society, was held on the 24th ult. at the Society's House, in the Adelphi. And also the Annual General Meeting on the same day. Colonel Sykes presided.

THE TWO WATER COLOUR SOCIETIES.

Each of these societies opened their annual exhibition on the 27th April, and they will well repay a visit, as although there may be nothing strikingly superior to what has been seen before, there is scarcely a work in the two collections that may not be looked at with pleasure. The "Old" Society certainly makes the best display. Not only are the veterans of the body at their former level, but the recent members have exerted themselves to the utmost, and the result is a collection in which there are many conspicuous beauties. The Old Society presents 317 pictures. Mr. W. Hunt still contributes his very natural studies of peasant life; Mr. W. Topham has exceeded himself in his "Zouave's Story of the War;" Mr. Carl Haag's head of a "Roman Pilgrim," is one of the most striking works of the collection. Mr. Burton has again achieved a great success in his "Faust's First Sight of Margaret." A remarkably fine landscape by Mr. C. Branwhite, "Kilgerran Castle, North Wales," is among the best productions of the exhibition. The architectural subjects are very few in number; among them may be particularly mentioned "Bramshill, Hants," an excellent picture, by Mr. Nash; and a good interior of "Milan Cathedral," by Mr. Read.

The exibition of the New Society consists of 354 drawings, including some works of high merit, but taken altogether, somewhat disappointing, as from this society productions of conspicuous excellence have hitherto been expected. The landscapes of Mr. W. Bennett are still admirably prominent. Mr. W. Telbin's broad Venetian view, with the buildings very distinctly shown, is a very successful effort of that meritorious artist. Mr. Vacher, who formerly brought home such gorgeous reminisences of Venice, has presented instead some Algerian scenery admirably painted.

REGISTER OF NEW PATENTS.

MOULDING METALS.

John Kinniburgh, Renfrew, *Patentee*, November 13, 1856.

The invention relates principally to the manufacture or moulding of metal pipes or hollow or tubular articles of cylindrical contour, but is also applicable in the manufacture or moulding of other metallic articles more or less resembling pipes in general structure. In moulding and casting pipes or similar articles according to this invention, core bars capable of expanding and collapsing or contracting in diametrical dimensions are used; these expanding and collapsing core bars are each composed of three, more or less, longitudinal pieces of curved metal or segmental metal plates combined together, so as to form a bar of the desired diameter, with their longitudinal junction edges in contact with each other. When three segmental pieces are used, one of them, curved to correspond to the largest diameter to which the core bar is to be adjusted, is a fixture as regards the adjusting action, being fast upon a bottom or end plate. In the axial line of this fixed plate, or in the line from which its curvature is struck, there is a central adjusting spindle, somewhat longer than the core bar segments, capable of revolution in a foot-step in the end plate at the bottom, and in a collar bearing in arms connected to the upper end of the fixed segment. On this spindle there are keyed two or more small eccentrics, their radii of eccentricity being coincident, so that they give their effect simultaneously on the same side of the spindle. Connecting-rods pass radially outwards from these eccentrics, and are jointed to the inner side of a long narrow externally wedge-shaped piece which virtually forms a fourth segment of the core bar; this wedge-piece is guided so as to travel in an accurate radial line by fixed end guide pieces. The two main adjustable segments, which are similar to the fixed segment, are each hinged, jointed to, or otherwise put in contact with the fixed segment, one on each side, so that their free contiguous ends are capable of folding over towards or from each other, these contiguous edges being formed with inclines to correspond to the inclines on the intermediate wedge-piece.

It is intended to keep the core bar always or nearly always in a vertical position, both whilst being prepared for the mould and whilst its coating is being dried in the stove. When the core bar is thus kept in a vertical position, the segments have no tendency to fall outwards and do not require retaining links or catches. When the core bar is to be used, it is set to its moulding diameter by turning the spindle until the eccentrics thereon press out the wedge piece far enough to bring the adjustable segments into the position necessary to complete the circle of which the fixed segment forms part. The bar is coated with loam or other suitable material by means of a vertically traversing hopper made to encircle it; this hopper is bored accurately to the diameter of the inside of the pipe, and being at the bottom end of the core bar, it is caused to rise gradually up; the coating material, supplied to it in any convenient way, being laid upon the bar by the action of the bored-out surface to a thickness equal to that of the annular space between such bored-out surface and the outside of the core bar.

The faucet portion of the core is formed at the bottom, the coating material being applied to the bottom of the core bar, and then brought to the proper form by a scraper shaped to the section of the faucet. The core bar coated in this manner is placed in the stove in its vertical position, and is more equably dried than if placed in a horizontal position, as is customary, the heat acting equally on all parts of the vertical sides. When the core bar is to be removed from the newly-produced casting, the central spindle is turned so as to cause the eccentrics to draw in the narrow wedge piece and leave the contiguous edges of the adjustable segments free; this allows the adjustable segments to be folded over upon their joints and be turned inwards to fully contract the core bar's diametrical dimensions, and thereby facilitate its removal from the casting. The narrow wedge piece may be traversed inwards by means of various mechanical arrangements, instead of the eccentric movement, if found desirable.

The invention also relates to coating the core bars with loam or moulding sand, and the apparatus for effecting the same. The core bar to be coated with loam or moulding sand is placed in a vertical position on a low carriage, the wheels of which run on rails laid down between standards. The lower end of the spindle of the core bar projects through an aperture in the carriage, and when the spindle is brought under the centre of the cross head, the lower end is received into a hollow nut, which can be raised or lowered by means of a screw working in a boss cast on the sole plate. The upper end of the spindle is centred, and held in like manner by a screw pendent from the cross head. When the core bar has been properly placed in position and adjusted, the funnel or hopper is lowered to the bottom of the core bar and filled with loam; the hopper is then slightly raised, which causes a portion of the loam to pass through the space between the hopper and the core bar. The hopper is then lowered, which has the effect of compressing or consolidating the loam which passed between the annular space on lifting the hopper; thus, by alternately lifting and lowering the hopper, the core bar becomes quickly coated with loam, care being taken to raise the hopper somewhat higher after each compressing or downward action. The thickness of the coating of loam deposited on the core bar will correspond to the annular space or distance between the lower edge of the hopper and the exterior of the core bar. The size of the lower part of the hopper must therefore be regulated according to the required thickness of the coating of loam, which will correspond to the internal diameter of the pipe or other article to be cast. The core of the faucet portion of the pipe is formed by placing a quantity of the loam or moulding sand around the lower part of the core bar, and giving it the required form by means of a template, the internal part of which corresponds to the shape of the faucet. When the core has been thus formed, the spindle is released from the screws, and the core is wheeled away into the stove to be dried. During the operation of drying the core, it is kept in a vertical position, by which means it is more rapidly and uniformly dried than by the usual mode of placing it horizontally. In order to remove the core bar after the casting is completed, it is only necessary to turn the central spindle by means of the key or spanner fitted to its squared end, so as to cause the eccentrics to withdraw the wedge-shaped piece of metal or the segment to which it is attached inwards; this action admits of the moveable segments collapsing or folding over each other, so that the contracted core bar may be removed from the interior of the casting with the utmost facility.

Claims.—1. The general arrangement and construction of machinery or apparatus for moulding pipes or other tubular or hollow articles.

2. The system of constructing adjustable core bars which are capable of being expanded or contracted by means of a longitudinal wedge-shaped piece of metal actuated by eccentrics.

3. The system of constructing adjustable core bars in which one of the segments of the core bar is actuated by means of one or more eccentrics or other mechanical equivalent.

4. The arrangement and construction of the machinery or apparatus for supporting and maintaining the core bar in a vertical position during the operation of coating it with loam or moulding sand.

5. The mode of coating the core bar with a layer of loam or moulding sand by means of a hopper to which a vertical motion is given.

6. The system of drying the coated core bars in a vertical or upright position, in order to facilitate the operation of drying and effect it in a more uniform manner than by the ordinary mode.

SMOKE AND AIR FLUES.

David Ogilvy Boyd, Welbeck-street, *Patentee*, October 3, 1856.

The object of this invention is to facilitate the construction of air flues or passages to supply fresh air to and withdraw vitiated air from the several rooms of houses. For these purposes, instead of separating the different flues of a stack by means of solid partitions of brick or other material, the patentee forms such partitions of hollow bricks of clay, iron, or other material, laid one upon the other in building the partitions, so that the passages in the bricks range from top to bottom of the parts of the two flues which they divide. The iron brick of the description used for this purpose, is furnished with wings, which build into the joints of the brickwork, and it also has at one end a socket for receiving the opposite end of another similar brick. Instead of employing hollow bricks to form air flues between smoke flues, as above described, plates of clay, iron, or other material, are sometimes employed, which are built into the front and back walls of the stack, two tiers of plates are used to form each partition, and the interval between the two tiers forms the air flue.

The hollow bricks and the plates mentioned are described as being constructed of iron, because this is the material which is preferred, but clay or other material may be substituted. In a ventilating flue, forming a separation between two smoke flues, plain plates are used instead of plates having wings and sockets, as those before described; in this case the bricks or stones of which the stack is built have grooves formed in them, into which the clay or earthenware plates fit. The connections between the air flues and the rooms to be ventilated are formed by pipes or passages, which are conducted to apertures in the ceilings and skirtings, or elsewhere, as when ventilating flues or passages have heretofore been employed.

ARTIFICIAL STONE.

Frederick Ransome, Ipswich, *Patentee*, September 27, 1856.

This invention is applicable, first, to those descriptions of artificial stone which are compounded with sand, clay, and other mineral or earthy substances, together with soluble silica or a soluble silicate; and the invention consists in adding to the composition of such artificial stone a substance which will fuse more readily than the sand, and will run into and fill the pores of the stone, and render it more dense than when compounded without such addition. The substances employed for this purpose are pumice stone, or a readily fusible glass. When pumice stone is employed it is prepared in the following manner:—Finely-powdered pumice stone is mixed with a solution of soluble silica sp. gr. (1·700) so as to form a stiff paste capable of being moulded into balls of about 1 inch diameter and fused in an ordinary crucible. When fused, it is ground into a powder and again mixed with a solution of silica, so as again to form a paste. The ingredients are mixed in the following proportions by measure:—Siliceous sand, 30 parts; finely-powdered silica, 10 parts; solution of silica, 5 parts sp. gr. 1·700; powdered pipe clay, 5 parts; pumice stone prepared in the way above described, 5 to 10 parts. When a readily fusible glass is employed in the manufacture of artificial stone, the glass is prepared by fusing together in a reverberatory furnace or crucibles, silicate of soda, 100 parts sp. gr. 1·400; Oxide of lead, 100 parts. And in preparing artificial stone the patentee substitutes for the 5 to 10 parts of prepared pumice stone in the mixture before mentioned 5 to 10 parts of this fusible glass.

The invention also consists in a method of rendering artificial or natural stone, bricks, and other materials used for building purposes less liable to decay. For this purpose the stone or other material is coated or saturated wholly or superficially with a solution of soluble silicate, and has afterwards applied to it a solution of chloride of calcium, by which an insoluble silicate of lime is formed in the body of the stone or other material. Instead of a soluble silicate and chloride of calcium other preparations may be used; this invention consisting in the application in succession of two solutions, which by mutual decomposition produce an insoluble substance, which is deposited in the structure, and on to the surface of the stone or other material. When a soluble silicate is employed, a solution of silicate of soda or potash is taken, (the sp. gr. of which must depend upon the texture of the stone to be operated upon, but generally about the sp. gr. of 1·400 at ordinary temperatures,) and after having removed from the stone as much extraneous matter as is convenient, the solution is applied over the surface of the stone or other material with a brush or otherwise, until it has absorbed a sufficiency. Soon after, in a similar manner, a solution of cloride of calcium is applied, taking care to incorporate the two solutions as much as possible by means of a brush or otherwise. By this application the silica combines with the lime, forming silicate of lime in the pores and on the surface of the stone or other material, whilst the chlorine, combining with the soda or potash forming chloride of sodium or potassium, is readily removed by washing. When the stone or other material is of a very porous nature, the strength of the silicate solution may be increased, and one coating will be sufficient; but if, on the other hand, the stone or other material is very slightly porous, then the strength of the silicate solution should be reduced, and several coats should be laid on. Or, for some descriptions of stone, more particularly sandstones or freestones, a saturated solution of sulphate of alumina is used instead of the silicate of soda or potash, followed by a solution of baryta, by which means a compound precipitate of alumina and baryta is produced. Where convenient, instead of applying the solutions by means of a brush, the stone or other material may be immersed in the several solutions. When desired, the precipitates can be coloured to any tint to suit the stone or other material by means of soluble salts of chrome or iron mixed with the solutions employed.

The patentee remarks in reference to this part of the invention, that wood has before been treated by two solutions mutually decomposing each other; he does not, therefore, claim the process as applied to wood, but only as applied to artificial and natural stone, bricks, and other materials used for building purposes. In some descriptions of stone and other building materials there is contained a free sulphate or carbonate of soda or other soluble salt which is liable to effloresce; to prevent this, and partially to indurate the stone or other substance, a solution of barium or calcium is employed, using a concentrated solution of the chloride of barium or calcium by preference.

RAILWAY SIGNALS.

W. H. Moore, Wenlock-place, City-road, *Patentee*.

This invention proposes to arrange an apparatus in connection with a line of railway, so that the passage of a train by acting on suitable instruments raises a stump, which, when another train passes, comes in contact with instruments in connection with the whistle of the engine, so as to cause the same to sound. The stump, when raised, is retained in position for a suitable time, which is regulated by the escape of air, water, or other suitable substance through a small orifice from a regulating vessel. At the same time that the stump is raised a visible signal is also brought up, and this visible signal gradually descends as the air or other substance escapes from the regulating vessel, so that the position of this signal indicates the time which has elapsed since the passage of a train along the line.

NOTES OF THE MONTH.

In our description of "Warehouses, Chorlton-street, Manchester," *ante* page 169, the designs were stated to have been prepared by Mr. T. Roach Smith: it should have been, by Mr. T. Roger Smith, of Adam-street, Adelphi.

The foundation-stone of a new Roman Catholic Church has been laid at Coalisland, county Tyrone. At Cookstown a similar class of edifice is in progress of erection, in the Gothic style, with a tower and spire, from the designs of Mr. J. J. McCarthy, architect.

The church of Kilmore, county Kerry, is to be built, as also that of Brackaville, county Tyrone, under the direction of the architect to the Ecclesiastical Commissioners.

A large sum of money (said to be 45,000*l.*) is to be expended in the erection of additional Courts for the Incumbered Estates Commissioners and the Lord Justice of Appeal, in immediate proximity with the "Four Courts" in Dublin.

A church of magnificent proportions is about to be erected at Dadzeele, in the diocese of Bruges, from the designs of Messrs. Pugin and Murray. It will be constructed principally of brick, as most of the ancient Belgian churches. The windows, copings, &c., will be worked out of stone brought from France. The works are to be commenced at the fall of this year.

An American Institute of Architects has just been formed at New York. "All the leading architects have coincided; trustees have been elected, funds subscribed, an opening address has been made by Mr. Upjohn, the Nestor of New York, and another by Mr. Walters, the architect of the Capitol. At the next meeting—the first regular one for the transaction of business—Mr. Calvert Vaux was to read the paper of the evening."

The iron churches recently erected in London are found to answer every purpose for which they were designed. There are now five of them, one in each of the following districts:—Kennington, Kentish-town, Newington Butts, St. George's East, and Holloway. The Holloway church cost £1000, and is capable of accommodating 700 people. It is described as "a most comfortable place of worship, well ventilated, warm in winter, cool in summer, and can easily be taken down when no longer needed in the district." It is 90 feet long, 40 feet wide, and 20 feet high, lined with wood, which is covered with canvas and papered.

In the year 1856-57 the sum total of 202,467*l.* was expended on national collections, against 228,866*l* in 1855-56. 46,490*l.* were appropriated to the British Museum establishment, 49,768*l.* to the buildings, and 20,454*l.* to purchases; 12,077*l.* to the National Gallery; 5,815*l.* to scientific works and experiments; 500*l.* to the Royal Geographical Society; 58,966*l.* to the Department of Science and Art; 7,312*l.* to the Museum of Practical Geology; and 1,000*l.* to the Royal Society. The total amount expended on the purchase and laying out of the Kensington-gore estate from 1851 to 1856 inclusive is 277,309*l.*

The following is an account of the expenditure of public money in the department under the control or management of the Commissioners of works and Public Buildings in the year ended the 31st March, 1856,—viz., 183,934*l.* for royal palaces and public buildings; 81,377*l.* for royal parks and pleasure gardens; 124,945*l.* for the New Houses of Parliament; 13,158*l.* for the general Repository of Public Record; 5,554*l.* for Holyhead Harbour, &c.; 21,807*l.* for the salaries and expenses of the Office of Works, &c.; 64,962*l.* for the British Museum buildings; 21,407*l.* for Battersea-park; 19,658*l.* for Chelsea-bridge; 22,962*l.* for the Chelsea Embankment and public roadway; 2,837*l.* for the British Embassy House in Paris; sundry other sums for other foreign embassies; 150*l.* for the British Protestant Cemetery in Madrid; 5,952*l.* for the Downing-street improvements, new public offices, &c.; 11,000*l.* for Buckingham House in Pall-mall; 3,726*l.* for Windsor improvements; 484*l.* for geological survey; and 200*l.* for the Nelson monument, making a grand total of 604,707*l.* expended. The balance on the account amounted to 292,349*l.* (net). Particulars of certain "special accounts" are appended.

The grand total amount of expenditure on arterial drainage in Ireland, up to the date of the final award, is 926,106*l.*, including the sum of 122,170*l.*, the amount of awards made final between the 31st of December last and the date of the return. The total amount charged under the final awards to proprietors, owners, and counties is 565,680*l.* This and other particulars are embodied in a return moved for by Lord Duncan, M.P.

Mr. John Baker, of Thirsk, has just taken out a patent on behalf of Mr. J. H. Headley, of Walpole, Canada, which seems likely to open out a new field in architecture. The novelty of the plan consists in plating or veneering a mass of coarse stone so as to present an exterior coat of marble. After a variety of experiments Mr. Headley has attained great success in imitating the qualities and varieties of different kinds of marble. He has employed oxide of iron largely as a colouring material, and finds that by silicate of potash extra hardness is given to the block, which renders it susceptible of a high degree of polish. The material has been extensively used in Canada for the last two years, and has realised everything anticipated. The patent right has been sold in eight countries for £12,000. Messrs. Peto and Brassey have paid £4000 for a license to use it in the construction of the bridges of the Grand Trunk Railway. Hydraulic pressure is used to the extent of 1000 lb. to the square inch, and 30,000 blocks are turned out of a machine on the rotatory principle daily, and are ready for building, thus saving the squaring of stone or the burning of brick, and making a much more handsome structure, and at a lower cost. The machinery will be exhibited in London, in August next.

Prof. Way has specified his improvements in obtaining light by electricity. "What I claim," he states, "is, the use of a flowing electrode of mercury in combination with apparatus for regulating the distance apart of the two electrodes; and I also claim the combination of a small overflowing cup, or regulated surface of mercury, as a second electrode with a flowing electrode of mercury in apparatus for obtaining light by electricity.

The Institution of Mechanical Engineers commenced their meeting at Manchester, on the 24th ult., under the presidency of Mr. Joseph Whitworth.

The statue of Watt was fixed on its pedestal, in front of the Manchester Royal Infirmary, on the 25th ult. The statue is in bronze, after Chantrey's, and will occupy the corresponding pedestal to Dr. Dalton's.

The Stockton and Darlington Railway, the earliest in the kingdom, opened in September, 1825, still possesses its first engine, now an antiquated piece of workmanship. Its weight is about 8 tons; and that its speed cannot have been very great may be inferred from the fact that a race came off between it and a stage-coach. It is placed on a pedestal in front of the Darlington railway station.

At the dinner given to Mr. C. Manby, at Greenwich, on the 23rd May last, Mr. Scott Russell said, the most remarkable feature connected with it was, that a body of men should be found who would subscribe 700,000*l.* for an undertaking, the success of which was declared to be very problematical; that feeling would, however, be diminished when it was known that three-fourths of the shares in the undertaking were held by Members and Associates of the Institution of Civil Engineers. That fact alone spoke volumes for the safety of the structure. Mr. Brunel had desired to have the smallest ship capable of taking its own fuel to Australia and back, and conveying such a cargo of goods and passengers as should be remunerative. Calculation showed the actual dimensions necessary, and the system of cellular construction adopted at the Britannia Bridge afforded the strength for these vastly increased proportions, which had at first surprised even English engineers, with their habit of regarding everything as possible. The size did not now astonish even the merchants, who contemplated finding cargoes for her without trouble.

The promoters of the Isthmus of Suez Canal Company held a meeting on the 24th ult. at the London Tavern, Sir James Duke presiding, when the following resolution was agreed to:—"That the proposed ship canal across the Isthmus of Suez having been declared practical by competent engineers, and all nations being invited to join in the undertaking, which will not be placed under the exclusive protection of any individual government; this meeting, being perfectly satisfied with the explanation given by M. de Lesseps, considers its success will prove eminently advantageous to the commercial interests of Great Britain."

The publication of the Ordnance Maps for Scotland, on a scale of one inch per mile is now begun. They are reduced from the six-inch maps, and published in sheets measuring 24 inches by 18 inches each, delineating an area 24 miles long by 18 miles broad. Sheet 32, the only one yet ready, embraces the country on both sides of Edinburgh, from Linlithgow on the west, to Prestonpans on the east, and in the other direction from Penicuik to Dalgetty in Fife.

Under the title of Helioscope, Mons. Porro, the French astronomer, has just constructed a telescope of the Newtonian form, by which he is enabled to observe the sun without the intervention of a piece of darkened glass (which is always difficult to obtain sufficiently pure and free from colour), and without being inconvenienced by the heat, which in instruments of any magnitude soon destroys the darkened glass, and endangers the eyesight of the observer. In the first telescope of this kind, which has been constructed under the direction of the inventor, the large mirror has an aperture of 2 decimetres and a focal distance of 24 decimetres. The excess of light and heat is got rid of by means of three reflectors, suitably arranged. The image of the sun thus obtained is perfectly white and well defined; the intensity of the light can be regulated at pleasure, and the heat is almost nothing at the eye-piece, so that the observer is enabled to work comfortably for many hours.

A new national bank is to be built at Clonmel, according to the drawings furnished by Mr. William Caldbeck, architect.

A number of ladies have formed themselves into a Society of Female Artists, and for the exhibition of their productions have sent 358 works of art to No. 315, Oxford-street, where they are now on view.

On the 4th ult. the roof of the nave and the wall and roof of the south arcade of the Roman Catholic Cathedral, building in Cecil-street, Plymouth, fell to the ground suddenly. The building, which is in the Gothic style, was approaching completion: it is 150 feet long, 50 feet wide, and 77 feet across the transept. The walls are of rough ashlar, and the doors, windows, &c. are finished with worked Bath stone. The arcades on each side of the nave are divided from it by four octagonal columns of Bath stone, 18½ inches in diameter, and above 17 feet long, up to the neck of the mould. These columns supported brick arches, which received the walls sustaining the roof of the nave. The roof formed two sides of an equilateral triangle, and was covered with slate. It is said that zinc was laid between the joints of the columns, and, as it offered more resistance and was neither so thick nor malleable as lead, which is generally used, the stone splintered and peeled, in consequence of which two of the columns on the north side were condemned, and replaced by new ones. It is also stated that the wall over was unusually thick and high for the diameter of the columns, each of which had to sustain a weight estimated by some at 20 tons, and by others at 30 tons, when the weight of the roofs of the nave and the wings was added to that of the walls. It is alleged that the bricks were not good, and it is certain the brickwork was considered defective, for the architect, Mr. Hansom, of Clifton, was in the act of superintending the re-construction of one of the arches when the fall occurred. The four southern columns gave way in the middle, and the roof of the nave came down, carrying with it the roof of the south arcade, one of the transept piers, half of the transept arch, and a part of the roof, leaving the other part in a very hazardous condition, as some of the principals are dislodged, and might, in the event of stormy weather, bring down the remainder of the transept roof and the eastern roof, when all the walls of the cathedral would be exposed to danger. The western wall, the apex of which is about 50 feet high, stands now perfectly denuded. Under the directions of Mr. Hodge, the town surveyor, stakes were immediately driven into the adjacent ground and poles carried across. The injury by the fall is estimated at from 500*l.* to 1,000*l.*

Died, on June 2nd, J. Hargreave Stevens, Surveyor, under the Metropolitan Building Act, for the Western District of the City of London. Mr. Stevens was intimately associated with the City Solicitor, Mr. Pearson, in the plans for metropolitan railways which he has at different times brought before the public.

COMPETITIONS.

Plans and estimates are wanted for Day and Sunday Schools, teacher's house, &c. to be erected at Heckmondwike, Yorkshire. Premium 10*l.* Particulars may be obtained of Mr. G. Burnley, Heckmondwike.

The owner of the Bellfield Park Estate, Weymouth, offers a premium of fifty guineas for Plans for laying out this property for building purposes: it comprises 120 acres. The estate is surrounded by roads, is finely timbered, and is abundantly supplied with spring water. The aspect of the property is due south, and 100 feet above the level of the sea. The designs are to be sent to Mr. Robert Damon, Weymouth, by the 6th instant.

The Council of the Borough of Brighton are desirous of obtaining Designs and Plans for appropriating the northern buildings comprised in the Pavilion Estate. 200*l.* will be paid for the best, and 50*l.* for the second-best designs. Designs to be sent in by the 10th inst, to Mr. Charles Sharood, Town Clerk, Brighton.

The Trustees of the Walsall Blue Coat and National Schools invite Plans for New Schools and Class Rooms in Walsall, to contain 300 boys and 200 girls, and an industrial room for the latter, with a separate house for the master and mistress. The plans must conform to the requirements of the Committee of Council on Education; and separate playgrounds are desired. The architect whose plan is adopted to superintend the erection of the buildings on the usual terms. The site may be viewed on application to Mr. Thurstan, No. 30, Digbeth, Walsall, to whom the plans are to be sent by the 20th inst.

Designs are invited for a Monument to be erected at Sheffield, to such natives of the town as perished in the war with Russia. The monument is proposed to be of an architectural character, embodying incidents of the late war, and on which spaces must be arranged so that the name of every man commemorated may be legibly inscribed. The style, size, and material of the monument to be left entirely to the competitors. The cost of the whole complete not to exceed 1200*l.* For the best or selected design a premium of 30 guineas will be accorded, and for the second best 20 guineas. Such designs to become the property of the Committee. The premium for the best design will be given in addition to the usual commission. All designs must be on the scale of one quarter of an inch to a foot, and must consist of plans, elevations, and specifications, and be sent in or on before the 15th August next, addressed to the Town Clerk, Sheffield. The designs will be afterwards publicly exhibited.

The municipal authorities of Bourdeaux have invited artists of all countries to submit designs for a Fountain of monumental character to be erected in that city. The choice of material is left open, and may be of several kinds; the cost is not to exceed 8000*l.* A premium of 240*l.* will be awarded, if a design of sufficient merit to justify it be presented. In addition, the sum of 160*l.* will be placed at the disposal of the jury, and be appropriated as they may decide. In the event of the execution of the selected design being confided to the author of it, he is to receive, independently of the selected design, an honorarium equal to the twentieth of the whole outlay. The designs are to be sent in by the 20th of November next.

The Board of Superintendence of Kilmainham Gaol have awarded the premiums for the three best designs for enlarging and remodelling the prison, to Mr. John M'Curdy, first; Mr. E. H. Carson, second; and Mr. Gray, third. It is proposed to give greatly increased accommodation for prisoners on the separate system.

The Committee for the New Schools at Brislington, Somerset, have selected the designs of Messrs. Pope and Bindon, architects, of Bristol.

The Committee for the new Church, Swanwick, Nottinghamshire, have chosen the design of Mr. B. Wilson, of Alfreton, Derbyshire.

Twenty-three sets of designs for the proposed Church of St. Peter and St. Paul, at Bern, were sent in. The jury have given the first prize to the design, in the Romanesque or Transitional style, by MM. Deperthes and Marechal, of Rheims. The second prize to M. Tugginer, of Soleure; the third to M. Lendi, of Freiburg; the fourth, a third gold medal, to Mr. Goldie, of Sheffield. The following were classed as equals, and rewarded with silver medals:—J. C. Boissonas, Geneva; Kasper Jeuch, Baden; T. Zeerleder, Bern; J. L. Pedley, Southampton; G. Mossdorf, Lucerne.

The Burial Board, Chichester, have selected the designs of Mr. Geo. Rake, of Portsea, for the new cemetery buildings. Fifty-two sets of designs were sent in.

The Directors have selected the plans by Mr. Edward Holmes, of Birmingham, for the new Corn Exchange, at Alcester. There were twenty-one competitors.

The Town Council of Aberdeen have selected two from the designs sent in for the New Grammar School to be erected in that city. No. 1, by Mr. George Smith, Edinburgh, premium 100*l.*; and No. 2, by Mr. Matthews, Aberdeen, premium 50*l.*

The Burial Board, Oldham, have selected the designs of Mr. Wiggington, of Dudley, for the chapels, lodges, &c. for the New Cemetery.

The Town Council of Hertford have adopted the plans of Mr. T. Evans, of Abingdon-street, Westminster, for the improvement of the Corn Exchange.

NEW PATENTS.

PROVISIONAL PROTECTIONS GRANTED UNDER THE PATENT LAWS AMENDMENT ACT.

Dated February 8.

316. J. Bernard, Albany, Piccadilly—Improvements in fastenings for uniting wood, metal, cloth, leather, and other materials

Dated February 6.

383. H. Myers, Rathbone-place, C. Askew and J. Askew, Charles-street, Hampstead-road—Improvements in railway and other breaks, and communicator between the guard and driver of railway carriages

Dated March 5.

650. T. J. Thompson, Greenwood Park, Newry, county Down—Improvements in the construction of gasometers, whereby they are rendered applicable to lighting railway carriages

Dated March 20.

778. J. F. Maire, Rue de l'Echiquier, Paris—Improved cooking apparatus, producing a saving of fuel and time

Dated March 21.

804. B. Blackburne, Clapham-common, Surrey—Improvements in the manufacture of pens

Dated March 30.

874. J. H. Taylor, Alma-street, Hoxton—Improvements in apparatus for regulating the flow of fluids applicable to waterclosets and other similar purposes

Dated April 4.

950. J. H. Johnson, Lincoln's-inn-fields—Improvements in steam-hammers. (Communication from M. J. D. Farcot, Port St. Ouen, Paris)

Dated April 5.

958. B. Predavalle, Great Russell-street, Bedford-square—A new motive power

964. J. Slack, Manchester—Improvements in lubricating certain parts of looms for weaving

Dated April 7.

980. H. Brierley, Chorley, Lancaster—Improved mules or machinery to be used in spinning

Dated April 11.

1022. J. B. Robinson, Beverley, York—Improvements in machinery or apparatus for effecting agricultural operations

Dated April 13.

1046. P. McFarlane, Comrie, Perthshire—Improvements in looms for weaving

Dated April 16.

1078. T. L. Scowen, Allen-road, Stoke Newington—Invention of the horizontal fix-expanding-canopy for carriages, boats, and places

Dated April 18.

1098. W. H. D. Granville, Holborn-hill—Improvements in fire-arms and in the means of loading the same

Dated April 23.

1142. S. P. Hecht, Gresham-street—Improvements in the manufacture of moulds for making fancy tobacco pipes and other ornamental articles from plastic materials. (Communication)

1156. J. T. Way, Welbeck-street—Improvement in the manufacture of soap

Dated April 25.

1173. C. T. R. Prynne, Newton Abbot, Devonshire—Improved apparatus, to be used for totally or partially benumbing any part of the human frame previous to a surgical operation, for the purpose of performing the said operation without pain

Dated April 28.

1200. D. Chadwick, Salford, and H. Frost, Manchester—Improvements in apparatus for measuring water and other liquids and gas, applicable also to the purpose of obtaining motive power

Dated April 29.

1201. J. H. Reed, Charles-street, Berkeley-square—Improvements in propelling ships or vessels

Dated April 30.

1211. F. Walton, Haughton Dale Mills, near Manchester—Improvements in the manufacture of plastic compositions

1213. H. Ball, Great Russell-street, Birmingham—Improvements in repeating and other fire-arms

Dated May 1.

1228. P. A. Barteau, G. Guy, and C. Corroy, Paris—Improvements in the production of artificial stone

1230. J. Ratcliffe, Blackburn, Lancashire—Improvements in preparing or in machinery for preparing yarns or threads for weaving

1232. A. A. Blandy, Baltimore, Maryland, United States—Improved mode of moulding and casting the plates or bases of artificial teeth

Dated May 2.

1234. S. Hilton, Albion-street, Bethnal-green—Improvements in furnaces

1236. A. A. De R. Hely, Oxford-street—Improvements applicable in the burning of gas

1237. P. R. Jones, Clapham-rise—Improved composition for the purpose of curing or preventing the scab in sheep and lambs, which will also greatly promote the growth of the wool, and destroy ticks, lice, and other vermin or impurities, keep the skin clean and healthy, and cure the mange in horses, dogs, and other animals

1238. H. Levy, High-street, Sheffield—Improvements in moleskins, velveteens, cords, and such like materials

1240. A. J. Paterson, Edinburgh—Improved method of constructing and propelling vessels

1242. J. S. Greenhow, Chelmsford—Improvement in alarum apparatus when using electric currents

1244. B. C. Tilghman, Philadelphia, United States—Improvements in treating fatty and oily substances

1246. W. E. Wiley, Gt. Hampton-street, Birmingham—Improvements in boxes or cases for containing needles, leads for pencils, pens, and other articles

1248. P. Fairbairn, Leeds, and T. Marsden, Broughton, near Manchester—Improvements in machinery for heckling flax, hemp, tow, and other fibrous materials

Dated May 4.

1250. J. Fox, Preston, Lancashire—Improvements in the music scale, and musical instruments

1251. A. Gatti, Coppice-row, Clerkenwell—Improvements in the making of all kinds of seeds, buds, and fruits, for artificial flowers and fruits

1252. J. Stanley, Whitechapel-road—Improvements in the construction and mode of applying cranes and other hoisting machines to hoisting, suspending, lowering, and weighing purposes, also in generating, transmitting, and applying motive power for the same

1254. J. Howard, jun. and W. Howard, Market-place, Leek, Staffordshire—Improved apparatus for the manufacture of cheese

1256. J. Leslie, Conduit-street—Improvements in apparatus for ventilating buildings

1258. J. T. Way, Welbeck-street—Improvements in obtaining light by electricity, and in employing light so obtained for lighthouses, and for giving signals

1260. J. A. Petiet, Paris—Improvements in actuating railway breaks

1262. E. Davies, Leeds—Improved construction of pressure gauge

Dated May 5.

1264. J. Herrero, Rue Vivienne, Paris—Improved inking and stamping machine

1268. L. le Chevalier Cottam, Winsley-street, Oxford-street—Improvements in stable fittings

1270. W. Wilkins, Wapping—Improved method of laying submarine telegraph cables

1272. H. E. Hoole, Sheffield—Improvements in stove grates

Dated May 6.

1276. B. Hingley, and S. Hingley, Cradley, Worcestershire—Improvements in anchors

1278. H. T. Ropes, Liverpool—Improvements in refrigerators or portable ice-houses. (Communication)

1280. H. Hogarth, Adelphi-terrace—Improved apparatus for raising and floating vessels or other heavy bodies

1282. G. T. Bousfield, Loughborough-park, Brixton—Improvements in machinery for pulverising clay and other substances. (Communication)

1283. W. E. Newton, Chancery-lane—Improved machinery for manufacturing paper, part of which is applicable to other purposes. (Communication)

1284. W. E. Newton, Chancery-lane—Improvements in locks for doors, safes, and other purposes. (Communication)

1285. F. M. Schwab, Carlisle-street, Middlesex—Improvements in breech-loading fire-arms

1286. P. A. le Comte de Fontainemoreau, London, Paris, and Brussels—Improvements in the preservation of grain and alimentary substances in general. (Communication)

Dated May 7.

1288. H. Mackworth, Clifton, Gloucestershire—Improvements in the classification, preparation, and treatment of mineral substances, coke, and furnace cinders, and in removing and depositing such substances, and in machinery and apparatus for such purposes

1290. R. Bennett, Redditch, Worcestershire—Improved method of papering needles, or making up needles for sale

1292. W. C. Aberdein, New North-road, Islington—The tubular elastic fastener and stud for gentlemen's shirt collars and wristbands, and other garments

1294. C. T. Bright, Harrow, and C. De Bergue, Dowgate Hill—Improvements in apparatus to be employed in the laying or sinking of submarine telegraph cables

1296. L. C. Dolléans, Essex-street—Improvements in ornamenting porcelain, china, opal-glass, and similar products, by lithographic chromo-lithographic printing and gilding

1298. J. Crawford, Glasgow—Improvements in heating and cooking apparatus

1300. W. C. Cambridge, Bristol—Improved machinery for winnowing corn and separating seeds

Dated May 8.

1301. F. G. H. Woodward, Horatio-terrace, Old Kent Road—Invention of medicine for the cure of dropsy

1302. C. Tayler, Deptford—Improvements in the manufacture of sheets of material suitable for covering floors, and for other useful purposes

1304. T. Lipkan, South-street, Finsbury—Improved anti-syphilitic compound

1305. J. W Schlesinger, Grove, South Lambeth—Improvements in the backs and covers of account books and other books. (Communication)

1306. L. Heinemann and A. Heinemann, Manchester—Improvements in waterproofing woven fabrics and fibrous materials

Dated May 9.

1307. W. Glover, Manchester—Improvements in machinery for weaving

1308. G. Hoppell, Uttoxeter, Staffordshire—Improvements in ventilating mines and such like places

1309. W. Hebdon, Pavilion, Weedon, Northampton—Testing the strength of woollen cloth, linen, and all other woven fabrics, also of every description of material upon which a strain can be exerted

1310. J. H. Francis, Ossulston-street, St. Pancras, and R. Ord, Morpeth-cottage, East-street, Islington—Improvements in the means and apparatus employed for cleaning casks

1311. W. P. Miles, Dartmouth-villas, Perry-vale, Sydenham—Improved guage-cutting machine

1312. J. S. Maccarthy, Newman-street, Oxford-street—Improvements in driving or ramming paving blocks and other surfaces

1313. F. Watkins, Victoria Works, Smethwick, near Birmingham—Improvements in machinery for making rivets, bolts, and spikes. (Communication)

1314. A. P. How, Mark-lane—Improvements in circular brushes for sweeping boiler and other tubes

1315. J. Pym, Pimlico—Improvements in machinery to be employed on the water for raising and lowering weights

1316. H. Hobbs, Cambridge-street, St. Pancras, and E. Easton, Grove, Southwark—Improved mode of preventing the incrustation of steam boilers

Dated May 11.

1317. R. Wilson, Patricroft, near Manchester—Improvements in machinery or apparatus for raising or forcing fluids

1318. J. J. Myers, Bugle-street, Southampton—A new method of regulating paper laid on to be printed on one or both sides, at and by cylinder printing machines, by means of guides, whereby the present waste of paper in progress of printing is avoided

1319. A. Dawson, Barnes-place, Mile-end-road—Improved wrought-iron cock, suitable for water, steam, or gas

1320. C. W. Siemens, John-street, Adelphi—Improvements in furnaces, and in the application of heated currents

1321. J. Miller, New Lanark, Lanarkshire—Improvements in oil cans or apparatus for lubricating machinery

1322. J. Miller, New Lanark, Lanarkshire—Improvements in water meters, jars, and

1323. W. G. Borron, Glasgow—Improvements in closing or stoppering bottles other receptacles

1324. J. D. Mucklow, Blackford Bridge, Lancashire—Improvements in the manufacture of rollers or cylinders to be employed for printing calico and other surfaces

1325. R. Fitton and S. Hall, Oldham, Lancashire—Improvements in machinery or apparatus for spinning cotton and other fibrous substances

1326. S. Hallett, Clarges-street, Piccadilly—Improvements in pianofortes. (Communication from J. Becker, New York)

1327. A. V. Newton, Chancery-lane—Improved machinery for cutting veneers. (Communication)

1329. R. A. Brooman, Fleet-street—Improved locomotive apparatus for rail and ordinary roads. (Communication)

Dated May 12.

1331. F. Cotterill, Birmingham—A new or improved method of preventing the picking of ordinary locks, and other fastenings

1332. C. A. Buisson, Paris—Improvements in rotary engines

1333. R. C. Carbonino (Widow de Favre), Paris—Improvements in nose-bags

1334. J. Westlake, Helston, Cornwall—Improvements in cleaning, separating, and dressing ores of pulverised tin, copper, lead, silver, and other minerals, ores, and substances

1335. J. D. Malcolm, Leicester-square—Improvements in the construction of buffing apparatus for railway engines and carriages

1336. W. H. Barlow, Derby, and W. H. Mills, Great George-street, Westminster—Improvements in the permanent ways of railways

1337. T. Lambert, Short-street, New-cut, and O. Wakefield, Lambeth-terrace, Surrey Improvements in apparatus for drawing off water and other fluids

1338. J. C. Dubois, Paris—Improvements in castors

1339. R. A. Brooman, Fleet-street—Improvements in the preparation of steel, and in the steeling or manufacture of tyres, shafts, axles, and other forgings. (Communication)

1340. J. R. Cochrane, Glasgow—Improvements in the treatment or manufacture of ornamental fabrics

1341. W. E. Newton, Chancery-lane—Improvements in furnaces specially adapted to the generation of steam for motive power, but applicable to furnaces for other purposes. (Communication)

1342. W. Massey, and J. Smith, Newport, Salop—Improvements in machinery for ploughing and cultivating land

1343. W. Massey, Newport, Salop—Improvements in engines for the cultivation of land by steam power

Dated May 13.

1344. T. Briggs, Woodhouse-lane, Leeds, and J. Starkey, Parker-street, Liverpool—Improvements in machines for washing, wringing, and mangling

1345. S. Yeldham, Stamford-street—The better application and arrangement of indices to books of all kinds.

1346. W. W. Bonney, Fulham—Invention of a chemical composition or agent to be employed in lieu of or to be substituted for argol, tartar, and tartaric acid. (Communication)

1347. E. Eley, Union-place, City-road—Improvements in the manufacture and application of pipes for heating purposes

1348. H. Tolkien, London, and J. Middleton, Finsbury—Improvements in pianofortes

1349. A. Fitzgibbon, Canada—Improvements in the form of rails for use in railways and tramways

1350. R. S. Newall, Gateshead, Durham—Improvements in the manufacture of wire strands for electrical purposes

1351. R. D. Kay, Accrington, Lancaster—Improvements in machinery or apparatus for printing woven or felted fabrics. (Communication)

1352. N. Ager, Upper Ebury-street, Pimlico—Improvements in connecting spindles of locks and latches with their knobs and handles

1353. J. Peak, Wigan—Improvements in the manufacture of gas

1354. M. Henry, Fleet-street—Improvements in winding weft, and in the machinery employed therein, part of which is applicable to spinning machinery. (Communication from Muloteaux and Co.)

1355. J. Fielding, Ashton-under-Lyne—Improvement in apparatus applicable to steam pipes or cylinders used for heating and drying, which said apparatus may be similarly employed wherever steam is used for such purpose

1356. W. A. Alderton, Brighton—Improvements in spindles for door locks, latches, and other similar purposes

Dated May 14.

1358. V. Sauerbrey, Essex-street, Strand—Improvements in the manufacture of fire-arms

1359. W. Sissons and P. White, Kingston-upon-Hull—Improvements in steam pile-driving machinery
1360. W. Ashby, Croydon—Improvements in water-wheels
1361. W. Hyde and J. Hyde, Dudley, Worcester—Improvements in the construction of vices
1362. D. Hesse and M. Hesse, Manchester — Improvements in the manufacture of shirts, shirt fronts, and other articles of wearing apparel
1363. G. Crawford, Edinburgh—Improvements in piano-fortes
1364. J. Stevenson, Glasgow—Improvements in lighting apartments and passages
1365. E. Hollingworth, Weston Underwood, Derbyshire—Improved machinery or apparatus for washing linen and other articles
1366. J. Sharrocks, Lower Healey, Lancashire—Improvements in machinery or apparatus for pressing bricks, tiles, and other plastic substances
1367. D. Reading, Claverdon, Warwick—A new or improved spring for carriages or other vehicles
1368. J. Carr, Killyleagh, county Down, Ireland—Improvements in machinery for hackling flax, hemp, and other fibrous substances
1369. C Bartholomew, Rotherham, and J. Heptinstall, Masbro', Yorkshire—Improvements in machinery for rolling tyres and hoops for railway and other wheels, and also other articles made of iron and steel

Dated May 15.

1370. J. Aizlewood, Baths Foundry, Rotherham—Improvements in hat and umbrella stands
1371. M. J. Vanderboght, Rue Neuve, Brussels—A new system of machinery producing simultaneously the three-fold effect of casting, breaking-off, and rubbing (smoothing) of printing characters
1372. W. H. King, Netherend, Worcestershire—Improvements in kilns and stoves
1373. F. Whitaker, Islington — Improvements in the construction of machinery for sewing and embroidering
1374. E. P. Walker, New York, United States—Improvements in machinery for hulling and scouring coffee and similar substances
1375. I. Whitesmith and W. Whitesmith, Glasgow—Improvements in weaving
1376. H. Schmidt, Surrey-street, Strand—A new apparatus for advertising in railway carriages, omnibuses, cabriolets, and other vehicles, and in theatres and public places
1377. D. Carter, Honley, near Huddersfield—Improvements in machinery or apparatus for cleansing the waste of woollen or other fibrous manufactures, or for recovering the wool or other fibres from such waste substances or materials
1378. E. Gripper, Winchester-wharf, Southwark—Improved machinery or apparatus for washing, drying, and cleansing corn, seed, Egyptian beans, or other pulse
1379. S. Sands, Nottingham—Improvements in the manufacture of fringes. (Communication)
1380. W. Marriott and D. Sugden, Huddersfield—Improvements in heating press plates for pressing woollen, worsted, cotton, silk, or other fabrics, paper, and other articles
1381. R. A. Brooman, Fleet-street—Improvement in the construction of oil-cans. (Communication)
1382. R. A. Brooman, Fleet-street—Improvements in machinery to be employed in the refining of sugar. (Communication from P. A. de Coster, Paris)
1383. F. Parker, Elm House, Homerton—Improved tell-tale for public vehicles
1384. H. Brown, Whitechapel-road—Improved material resembling ivory

Dated May 16.

1385. C. W. Ramié, Camberwell—A mode of attaching handles to table cutlery
1386. H. Jones, Birmingham—Improvement or improvements in engines for raising beer and other liquids
1387. H. Trappes, Manchester—Improvement in the construction of a sliding drawer, applicable to all steam-engines, either fixed or locomotive, for the distribution of steam, aeriform, or liquids, used either as a motive power or for any industrial or artistic purpose. (Communication)
1388. G. H. Creswell, Devonport—Improvements in apparatus for supplying ink or other mixture for stamps used in stamping letters and other articles
1389. J. Ellis, Port Hope, Canada—Improvements in the manufacture of artificial stone
1390. C. Cowper, Southampton-buildings, Chancery-lane—Improvements in preparing solutions and extracts of the colouring matter of madder and other tinctorial substances for dyeing and printing. (Communication from F. Mitscherlich, Ellenburg, Prussia)
1391. N. Ogle, Jersey—Improved method of propelling and ventilating ships
1392. W. Hill, Carlisle—Improvements in railway breaks
1393. R. Bradly and W. Craven, Wakefield—Improvements in machinery or apparatus for making bricks or tiles

Dated May 18.

1394. R. Bodmer, Thavies-inn, Holborn—Improvements in locomotive steam-engines. (Communication)
1395. J. Avery, Essex-street, Strand—Improvements in mills for grinding corn and other like substances. (Communication from J. Perrigault, France)
1396. I. L. Pulvermacher, Paris—Improvements in pipes or tubes for smoking
1397. W. E. Newton, Chancery-lane — Improvements in the manufacture of boots, shoes, and other coverings for the feet. (Communication)
1398. J. Apperley, and W. Clissold, Dudbridge, Gloucester—Improvement in carding engines, and in condensers applicable thereto
1399. W. Clark, Chancery-lane—Improvements in the manufacture of silk, and in the machinery used therein. (Communication)

Dated May 19.

1401. J. Carnaby, Snow-hill—Improved registering index for gas and other meters
1402. T. W. Roys, Southampton, Long Island, New York, United States—Improvements applicable to explosive shells
1403. C. Reeves, Birmingham—New or improved grinding and polishing machinery, to be used in the manufacture of knives, matchets, swords, and other similar articles
1404. E. A. Cowper, Great George-street, Westminster—Improvements in furnaces for heating air and other elastic fluids
1405. J. F. P. L. von Sparre, Eisleben, Prussia—Improvements in separating substances of different specific gravities, and in the machinery and apparatuses employed therein
1406. J. Hope, Bishops Auckland, Durham—Improved screw-nut and ratchet-brace for working the same
1407. W. Whitehead, Huddersfield—Improvements in cards for Jacquard mechanism
1408. J. U. Ott, Zell, Zurich, Switzerland, and F. A. M. Udloff, Somers-town—Improvements in ruling paper, and in the pens or instruments for the same
1409. J. W. Burton, Ipswich, and G. Pye, Lombard-street—Improvement in pressing and crushing flax, hemp, and other fibrous substances
1410. M. B. Rowland, Acton-green, Middlesex—Improvements in soap and detergent preparations or compounds
1411. L. Cornides, Trafalgar-square—Improvements in the manufacture of gelatine and glue

Dated May 20.

1412. C. W. Harrison, Woolwich—Improvements in obtaining light by electricity
1413. J. Hardley, Shide, Isle of Wight—Improved apparatus for bruising and grinding vegetable substances
1414. A. Foulkes, Chester—Improvements in sewing or pointing gloves, and in machinery for such purposes
1415. P. Ingwersen, New Oxford-street—A certain remedy to prevent and dissolve the deposits in boilers and steam generators. (Communication from J. Scheibl, Pesth, and J. Offermann, Brünn)
1416. A. A. Usher, Birmingham—New or improved moderator lamp
1417. H. Keogh, Hugh-street and F. A. Keogh, Inner Temple—Lighting the public gas-lamps in the cities and towns of Great Britain and Ireland by electricity, and for turning off and on the gas to same simultaneously
1420. J. Lethuillier, Paris—Improved machine for moulding and compressing bricks, tiles, and other articles made of soft materials
1421. E. Aldis, North-street, Manchester—Improvements in cramps for flooring and other purposes
1422. J. Harrison, New Church-road, South Hackney—Improvements in railway signals
1423. J. Abbot, jun, Bilston, R. H. Thomas, Kidsgrove, J. Young, Bilston, and J. E. Hunt, Highfields, near Bilston, all in the county of Stafford—Improved machinery for blooming iron
1424. J. Jakens, Bury, Lancaster—Improvements applicable to printing and dyeing woven fabrics and fibrous materials
1425. J. H. Tozer, Liverpool—Improvements applicable to travelling caps and other coverings for the head
1426. W. S. Clark, High Holborn—Improvements in machines for cleaning and polishing knives. (Communication from J. Wilcox, Philadelphia, United States)
1427. W. Clark, Chancery-lane—Improvements in the preparation of the colouring matter called murexide. (Communication)
1428. E. C. Kemp, Birmingham—Improvements in chandelier or other pendent gas-lights, and in the fittings for the same
1429. E. C. Kemp, Birmingham—Improvements in unions for gas pipes and other pipes or tubes. (Communication)

Dated May 21.

1430. J. Hopkins, St. George's-in-the-East, and G. Pearce, Mile-end—Improvements in trucks
1431. P. A. le Comte de Fontainemoreau, South-street, Finsbury—Improvements in the processes for detaching or separating calcareous rocks. (Communication)
1432. W. Owen, Ardwick, near Manchester—Improvements in machinery or apparatus for stretching woven fabrics
1433. W. Blacklidge, jun., Hoghton, Lancashire, and G. Read, Bolton-le-Moors—Improvements in the construction of churns, which said improvements are also applicable to other agitating or stirring apparatus
1434. W. Todd, Heywood, Lancaster—Improvements in the treatment of yarns or threads, and in the apparatus for performing the same
1435. W. Foster, Black-dike Mills, Bradford—Improvements in the making of worsted and woollen yarn
1436. W. Beech, Burslem, Stafford—Improvements in generating and applying motive power
1437. W. E. Newton, Chancery-lane—Improved method of sewing or stitching fabrics together. (Communication)

Dated May 22.

1439. J. G. Taylor, Glasgow—Improvements in writing materials
1440. M. Drukker, London-wall—Improvements in apparatus for indicating the passage of time
1441. C. Muratori, Rue Lafitte, Paris—Obtaining a new sort of white by silicate of magnesia and oxide of zinc, or by silicate of magnesia and carbonate of lead, in the first case a composition of zinc, and in the second a composition of lead
1443. W. Hensman, Linslade, Buckinghamshire—Improvements in drills for sowing seeds and depositing manure
1445. P. M. Parsons, Duke-street, Adelphi—Improvements in making moulds for casting railway chairs and other articles in metal, and in apparatus for that purpose
1446. J. T. Wright, and E. P. Wright, Birmingham—A new or improved manufacture of cloths or coverings for railway trucks and other vehicles, ricks, and other such like purposes
1447. F. Walton and J. Pinson, Wolverhampton—New or improved machinery for stamping or raising metals
1448. B. H. Hine, and W. Onion, Nottingham—Improvements in knitting machinery for the manufacture of ribbed fabrics
1449. J. R. Engledue and W. Cullis, Southampton—Improvements in ventilators for ships' cabins, apartments, and places
1450. S. Fox, Deepcar Works, Sheffield—Improvement in the manufacture of flat steel wire, used for the manufacture of the ribs and stretchers of umbrellas and parasols
1451. P. Efferts, Nelson-square, Blackfriars-road — Improvements in machinery for making bricks
1452. A. de Schuttenbach, St. Petersburg—Improvements in preparing fatty matters for the manufacture of candles and purposes

Dated May 23.

1453. W. Carron, Birmingham—A new or improved nail, spike, or bolt, and machinery for manufacturing the same
1454. N. J. H. Duplais, South-street, Finsbury—Improvements in the manufacture of felt hats and bonnets
1455. P. F. Coulon, South-street, Finsbury—Improvements in velvetting paper and textile fabrics
1456. E. Travis, Oldham, and J. L. Casartelli, Manchester—Improved apparatus for regulating the supply and discharge of steam, air, water, and other fluids
1457. J. Rankin, Manchester—Improvements in ventilators
1458. T. H. Roberts, Plymouth—Machinery or apparatus for cleaning the inside of casks and puncheons
1459. T. Silver, Philadelphia, United States—Improved steam-engine governor.
1460. G. O. de la Barre, Great Titchfield-street, Cavendish-square—Improvements in obtaining and applying motive power. (Communication)
1461. J. Phillips, Clipston-street, Portland-road—Improved apparatus for supporting and propelling the human body in water

Dated May 25.

1463. W. J. H. Rodd, Earl's-court, Westminster—A method of sailing or propelling a vessel or vessels out of or on the surface of the water
1465. S. C. Sheard and G. Underwood, Smethwick, near Birmingham—Improvements in supplying boilers with water, generating steam, and consuming smoke, and which said improvements are applicable to marine, locomotive, stationary, and other boilers
1469. N. C. Szerelmey, Bermuda-place, Peckham—Improvements in preparing combinations of materials for coating wooden and iron ships or other vessels
1471. W. Fox, Boulogne-sur-Mer, France—Improvements in the manufacture of steel pens
1472. H. W. Tyler, Norfolk-crescent, Hyde-park—Improvements in the permanent way of railways
1473. H. Cogan, Trent, Somerset—Improved adjustable connection or joint, particularly applicable to agricultural implements
1474. R. A. Brooman, Fleet-street—Improvements in pumps. (Communication)
1475. M. J. A. Mille, Paris—Improvements in producing gas

1477. L. D. Aubert, Paris—Improvements in fastenings for securing rails in the chairs
1478. W. S. Underhill, Newport, Salop—Improvements in wringing machines
1479. W. E. Newton, Chancery-lane—Improved mode of relieving the slide-valves of steam-engines from unnecessary pressure. (Communication)
1480. R. J. Hendrie, jun., Blossom-street, Norton-folgate—Improvement in steam boiler and other furnaces

Dated May 27.

1481. J. E. Cook, Greenock—Improved composition for the prevention of the decay and fouling of ships' bottoms and other exposed surfaces
1483. C. D. Davies, Holloway—Improvements in the application of coir or cocoa-nut tree fibre as a substitute for hair in the manufacture of cloths used in seed crushing
1485. W. S. Clark, High Holborn—Improvement in printing presses. (Communication)
1487. W. S. Clark and B. Moore, High Holborn—Improvements in churns for producing butter. (A communication)
1489. R. Parkinson and J. Standish, Blackburn, Lancashire—Improvements in machinery or apparatus used in the preparation of cotton, wool, flax, or other fibrous materials to be spun
1491. W. I. Ellis, Vulcan Foundry, Warrington, Lancashire—Improvements in steam engines
1493. R. Low, Union-street, Woolwich, and W. Press, Stepney-causeway—Improvements in the construction of vices
1495. E. Welch, Penge, Surrey—Improvements in fireplaces and flues, and apparatus connected therewith
1497. J. L. Codet-Négrier, Paris—Improvements in the manufacture of boots, shoes, harness, and other articles
1499. R. Cresswell, Conduit-street—A new article to be called "typha velvet," suitable for carpets, furniture hangings, wearing apparel, and other useful purposes
1501. J. Williamson and F. Williamson, Keighley; J. Wright, Griffe Mill, Bradford; and J. Wadsworth, Oldfield, Yorkshire—Improvements in looms
1503. F. Jossa, St. Helen's Colliery, Durham—Improvements in hammers worked by atmospheric pressure
1505. M. Petrovitch, Belgrade, Servia—Improvement of projectiles used with fire-arms
1506. T. Grahame, Upper Seymour-street, Portman-square—Improvements in inland navigation
1507. T. T. Jopling, Dunning-street Foundry, Sunderland—Improvements in water-gauges of steam boilers
1509. R. E. Hodges, Southampton-row, Bloomsbury—Improvements in gauges and scales
1511. W. E. Newton, Chancery-lane—Improved method of applying photography to the use of engravers
1513. T. Hart, Watt's-terrace, Old Kent-road—Improvements in the manufacture of lamp glasses, applicable to railway carriage and other lamps

Dated May 28.

1515. Alexander Simpson, Chancery-lane—A new or improved slop and toilet pail. (Communication)

Dated May 29.

1519. J. Salles, Paris—Improved apparatus for printing and stamping
1521. J. Merrylees, Paisley—Improvements in the manufacture or production of carpets and other ornamental fabrics

Dated May 30.

1523. L. Heinemann and A. Heinemann, Manchester—Improvements in those parts of printing machines called "doctors"
1525. P. B. Chapuis, Lyons—Improvements in machinery for manufacturing ribbons, trimmings, fringes, and healds
1527. M. Clark, St. Mary Cray, H. Oldfield and W. Salmon, Foots Cray, Kent—Improvements in machinery or apparatus used in the manufacture of paper
1529. L. F. Kenny, Stanley-street, Pimlico, London—Improvements in window frames and sashes
1531. R. E. Ridley, Hexham, Northumberland—Improvements in the permanent way of railways
1533. F. C. Warlich, Hope-cottage, Kentish-town—Improvements in generating steam
1535. G. Hornsey, Southampton—Improved apparatus for the engine-rooms of steam vessels for communicating signals and orders from the captain on deck to the engineer or attendant below
1537. T. Wilson, Chiswick—Improvements in floating bodies used in washing machines

Dated June 1.

1538. L. P. Lambert-Alexandre, and L. P. F. Mallet, Paris—Improvements in machinery for propelling vessels
1539. F. P. Fellows, Wolverhampton—Improvements in the manufacture of hinges, cocks, and other jointed articles, or articles of which one part is required to be capable of turning upon or in another part of the same article
1541. J. A. Salmon, Glasgow—Improvements in steam engines, and in apparatus for feeding boilers, and in furnaces
1542. L. L Bequemie, Paris—Improvements in cocks. (A communication)
1543. G. Tingle, Northwood, Staffordshire—Improvement or improvements in machinery for the manufacture of articles from clay and other plastic substances
1545. H. Thompson, Regent-street—Improvements in pianofortes
1546. T. Slater, Finkee-street, Hull—Improvement in ploughs
1547. S. Hoga, Marylebone-street—Improvement in coating the surfaces of the cells of galvanic batteries, and also the surfaces of crucibles
1549. H. L. Muller, jun., Paris—Invention of a new means of advertising

Dated June 2.

1551. W. S. Clark and B. Moore, High Holborn—Improvements in animal traps
1552. P. A. le Comte de Fontainemoreau, London—Improved means of floating submerged bodies. (A communication)
1553. N. Bentley, Salford, and J. Alcock, Little Bolton, Lancashire—Improvements in machinery or apparatus for forging and stamping metals, which is also applicable to pile-driving, crushing ores and seeds, beetling and fulling woven fabrics, and other similar purposes
1554. J. Allen and J. Gibson, Manchester—Improved union joint
1555. J. Stevens, Darlington Works, Southwark-bridge-road—Improvements in water gas-meters
1556. N. Corrado, Cardington-street, Hampstead-road—Improvements in purifying fatty matter

Dated June 3.

1557. P. R. Arrowsmith, and R. Caunce, Bolton-le-Moors—Improvements in machinery for carding cotton and other fibrous materials
1558. P. E. Chappuis, Fleet-street—Improvements in stereoscopes.
1559. E. Roy, Rue de l'Echiquier, Paris—Improvements in the construction of railway vehicles for the special purpose of allowing them to run freely on short curved lines
1560. C. Robertson, London—Apparatus for cleaning the bottoms of iron ships while afloat
1561. S. Lees, J. Lees, and F. Lees, Rochdale—Improvements in machinery for warping cotton, worsted, and other fibrous substances
1562. W. Jones, Kelvey-cottage, Swansea—Improvements in heating and compressing artificial fuel
1563. S. Morand, Manchester—Improvements in apparatus used for stretching and drying fabrics
1564. G. Remington, Hereford-square, Old Brompton, and J. B. Balcombe, Sutherland terrace, Loughborough-road, Brixton—Improvements in locomotive engines, applicable to common roads
1565. J. Deeley, West Bromwich, Stafford—Improved means for preventing the explosion of steam-boilers
1566. R. A. Brooman, Fleet-street—Improvements in gas burners. (Communication)
1567. J. Jobson, Bulwark-street, Dover—Improvements in oil-cans or feeders
1568. W. Barr, Panton-street, Haymarket—Improvements in actual measurement for delineating garments. (Communication)

Dated June 4.

1569. L. P. Therrin, Grand Rue Dieppe, Seine Inférieure, France—Improvements in railway breaks, applicable to railway carriages, called railway lever breaks
1570. H. C. Jennings, Great Tower-street—Improvements in the manufacture of paper, papier-maché, and other similar substances
1572. V. Blumberg, Bloomfield-lodge, Notting-hill—Improvements in the manufacture of billiard tables
1573. W. Miller, Buckingham-street, Strand—Improvements in the manufacture of sugar, and in the apparatus used therein
1574. W. Harding, Forest-hill, Kent—Improvement in pistol holsters
1575. T. W. Roys, Southampton, Long Island, New York—Improvements applicable to fire-arms
1576. J. King, Observatory-street, Oxford—Improvements in the manufacture of shirts
1577. T. L. Boote and R. Boote, Burslem—Improvements in the manufacture of ornamental pottery and articles made from clay and other like plastic materials

Dated June 5.

1578. B. H. Collyer, Park-road, Regent's-park—Improved mode of preparing the residue of beetroot, mangel-wurtzel, and other species of the genus betâ left in sugar making and distillation, to be used as material in making paper, papier-maché, millboard, and other similar manufactures
1579. R. Roberts, Heaton Norris, Lancaster, and W. Shaw and S. Shaw, Geecross, Chester—Improvements in machinery for weaving and folding fabrics
1580. E. Rousille, Jurançon, near Pau, France—Improvements in manufacturing stearic acid
1581. J. E. M. J. Clair, Annonay, France—Improvements in propelling on water and in the air. (Communication from J. Robatel, Lyons)
1582. T. Wheelhouse, Salford, and J Greenwood, Pendleton, Lancaster—Improvements in ventilating vehicles or carriages in motion
1583. H. Schmidt, Surrey-street, Strand—New cork roller for lithographic printing. (Communication)
1584. G. Collier, Halifax—Improvements in preparing printed or parti-coloured yarns for manufacture into fabrics
1585. F. Jossa, Bishops Auckland, Durham—Improvements in uniting iron and steel
1587. W. E. Newton, Chancery-lane—Improvements in the manufacture of paper, papier-mache, cardboard, and other similar articles. (Communication from N. Voelter, jun. Heidenheim, Wurtemburg)
1589. E. K. Muspratt, Liverpool, and B. W. Gerland, Lloyd-street, Greenheys, Manchester—Improvements in treating waste liquors produced in the manufacture of chlorine, and in separating nickel, cobalt, and copper, from liquors containing them in combination with manganese and iron

Dated June 6.

1590. T. G. Shaw, Dartmouth-row, Blackheath—Improvement in bedsteads. (Communication)
1591. F. O. Ward, Cork-street, Burlington-gardens, and F. Wynants, Ixelles, Brussells—Improvements in manufacturing manure and obtaining accessory products
1592. H. Powers, Florence—An improved machine for punching, stamping, or cutting metals and other substances
1593. R. Dinglinger, Berlin—Improvements in pumps, which improvements are also applicable to steam engines
1594. E. H. Hudson, Burley, Otley, Yorkshire—Improvements in means or apparatus to prevent driving straps lapping on the shafting when they shift off their pulleys
1595. H. J. Noé, Paris—Improvements in portable stereoscopes
1596. J. Rogers, Bartholomew-close—Improvements in machinery for winding or folding drapery and other like goods
1597. E. Edwards, Englefield-terrace, De Beauvoir Town, Kingsland—An improved mode of fastening stair rods and other rods
1598. A. F. Sherman, Roxbury, Norfolk, Massachusetts, United States—Improvements in machinery for breaking, hatchelling, roving, spinning, and tarring hemp, flax, manilla, or any fibrous material or materials
1599. A. J. V. Dopter, Paris—Improvements in ornamenting cloth, wood, metal, leather, and other surfaces

Dated June 8.

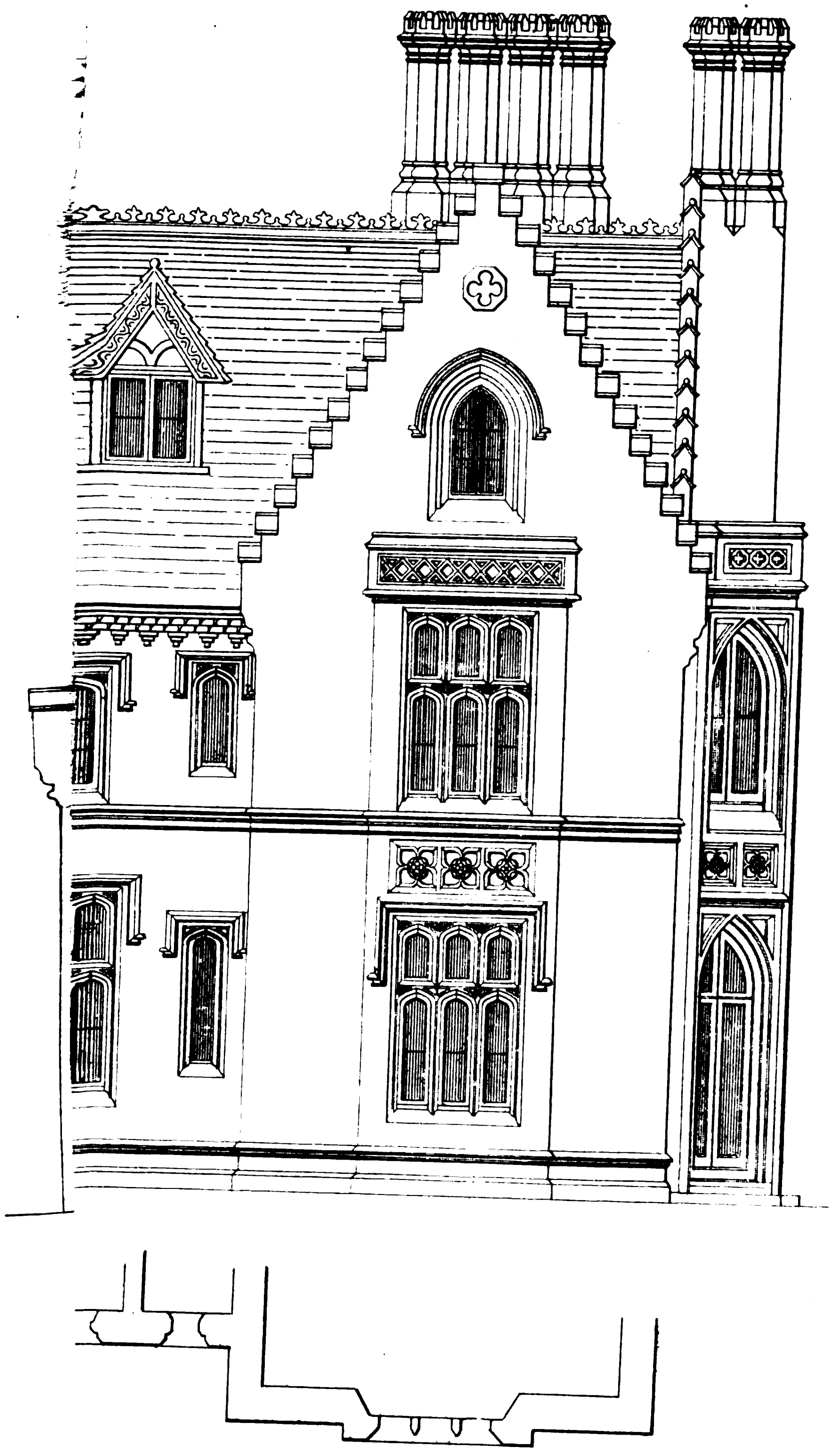
1601. D. Bethune, Cambridge-terrace, Hyde-park—Improvements in apparatus f[illegible] preventing or consuming smoke in furnaces and chimneys
1602. J. Brown, Golds Green, West Bromwich—Certain improvements adapted to th[illegible] prevention of steam-boiler explosions
1603. E. Brooks, Birmingham—A new or improved manufacture of gun barrels, a[illegible] other articles of like manufacture

Dated June 9.

1605. W. Wright, Forth-street, Newcastle-on-Tyne—Improvements in apparatus [illegible] annealing glass in ovens
1607. J. Robertson, Valley-field, Midlothian—Improvements in machinery or appara[illegible] for treating or preparing and boiling rags and other materials
1609. J. H. Tuck, Pall-mall—Improvements in the application of light to facilitate [illegible] rations under water
1611. P. A. le Comte de Fontainemoreau, South-street, Finsbury—Improvements in construction of axle bearings. (Communication from F. Morel)
1613. R. A. Brooman, Fleet-street—Improvements in furnaces. (Communication)
1615. W. E. Newton, Chancery-lane—Improved life boat. (Communication)
1619. J. A. Burdon, South-street, Finsbury—Improvements in apparatus for produ[illegible] expansion in steam and other motive-power engines
1621. T. Daniel, Darley Mills, near Derby—Improvements in drawing frames

PATENTS APPLIED FOR WITH COMPLETE SPECIFICATION.

1419. G Sharp, and W. Elder, Jarrow, Durham—Improvements in steam-ha[illegible] and machinery for forging iron and other substances.—May 20
1612. J. Gedge, Wellington-street South—Improvements in constructing gas ret[illegible] the furnaces of steam-engines or other furnaces. (Communication from N. Del[illegible] Tournay, Belgium)—June 9
1617. T. Hale, Massachusetts, United States—A new and useful or improved app[illegible] for heating and ventilating a building. (Communication from J. Sawyer)—Ju[illegible]
1658. T. Turner, Wolverhampton—Improvements in apparatus to be employed [illegible] alarm and detector in cases of burglary—June 12



'BRIDGE, SURREY.

3ARNES, ARCHT

Note. The moulded & ornamental work is in Red Brick.

J.R. Jobbins.

MANSION OF C. BUXTON, ESQ., NEAR WEYBRIDGE, SURREY.

(*With an Engraving, Plate* XXI.)

OUR engraving represents the north elevation of this building. We have already given its south elevation, with a description, at p. 68 of the present volume of the *Journal*, to which we beg to refer our readers.

ON CHOIRS AND CHANCELS.*

By ARTHUR ASHPITEL.

Mr. Ashpitel commenced by commenting on the different positions an architect finds himself in while designing churches in the revived mediæval styles. That any one with any feeling for Gothic art must see how necessary it was to the effect of the building to have a long chancel; that in ancient buildings these were seldom less than one-third of the total length of the edifice, and that often the chancel was equal in length to the nave; that a notion had lately sprung up that the laity ought always to be excluded from the chancel, while at the same time, by a strange anomaly in all our cathedrals, the laity were all huddled into the choirs, and the naves left vacant, so that it was a reproach on the part of the utilitarians, that one-third of our churches and three-fourths of our cathedrals were utterly wasted. Mr. Ashpitel then said, that impressed with these notions, he carefully observed, on a late visit to Italy, the construction of choirs and chancels, the uses made of them, and the traditions attached to their uses. He would first call their attention to what the choir or χοροs was in the early Christian Church; then to its changes during the mediæval period; and lastly to its present state and use in Southern Europe.

The Christian Church was not a copy of, or derived from, the Pagan temple in any way, but from the Roman Basilica, or Hall of Justice. From worshipping in caves and catacombs, the early Christians were permitted by wealthy converts to occupy their halls (which were attached to most great men's houses) for the purposes of worship; and the form was found so convenient, that in the time of Constantine many were converted into, and many buildings of similar form erected as, Christian churches.

Mr. Ashpitel then went into a close description of most of those still existing at Rome, and exhibited a plan of the San Clemente, which still retains in every respect all the features it possessed in the days of Constantine. There was a large semicircular niche at the end of the building, in the middle of which the altar stood, the seats for the bishop and presbyters being close to the wall behind it. This was on a platform raised some steps, never less than three; at the top there was a railing called "cancelli." In front was a space inclosed by marble slabs about 4 feet high, extending a short way down the nave, in which the "chorus psallentium" or choir of singers sat, and from whence it derived its name of choir or χοροs; on each side of this were the ambones or pulpits for reading the gospels and epistles, and for preaching. Within the inclosure were sung the psalms, hymns, and doxologies.

He then remarked on the usage of the words "Pagan" and "Christian" Art as regarded architecture, and explained how the use of these terms, originally intended to do honour to mediæval art, were ridiculous and offensive in the extreme to the ears of Italians. "What!" have they often said, "are those buildings in which the Holy Apostles and their successors have preached, which have been imbued with the blood of saints and martyrs, where synods and councils have sate, and which exist to the present day unaltered—are these to be called Pagan; while that style which we know to have been brought from the East by the Crusaders, and, however it may have flourished in the North, has never even taken root in Rome—is this, the *Saracenic*, to be called *Christian*? while the true early Christian—the style of the Apostolic age—is to be called *Pagan*? Mohammedan called Christian, and Christian Pagan — it is insulting to our common sense." It was difficult to answer such remarks.

Mr. Ashpitel then took a rapid sketch of the rise and progress of the Monastic Orders, and particularly of the custom still observed in the Romish Church, whenever there was a "Conventus" or assembling of the clergy, of meeting every third hour of the day and night in the church, and reciting and singing certain services called the Canonical Hours, or more commonly the Breviary Services. These were sung in the choir. The great Roman authority, Carranza, attributed their introduction to Pope Damasus the First (A.D. 371), but our learned divines, Bingham and Joseph Mede, thought them to be later.

Soon after their introduction, choirs seem to have been inclosed. The best authority on this point is the celebrated Durandus, who says in his 'Rationale'—"In the primitive Church the peribolus or wall which encircles the choir was only elbow-high, and which is still observed in some churches (this wall of course stood in the middle of the nave before the altar); but in this time (he says) almost always a veil is hung up, or a wall interposed between the clergy and the people, lest they should mutually look at each other." From this system of raising the peribolus or wall round the choir, may be traced the present state of choirs and chancels; one great difference being that the cancelli or rails, which formerly separated the altars from choirs, now separate the choirs from the naves.

That the laity in old times were admitted into the choirs is proved by many instances, in none more so than by Barclay in his 'Shippe of Fools,' several passages from which were read, one of which in particular, alluding to the indecent behaviour in churches, talks of men "clapping with their heels in churche and in queere;" besides the custom in our own country, France, and in Belgium.

In Italy the laity enter the choirs and take their seats in the stalls just as they do here; and it is said they always have done so. The word "chancel" is unknown in Italy as applied to a part of the building—"cancelli" mean only the gates or rails before the choir or "coro." What we call chancel or choir, they call by the primitive term of tribune (the βημα of the early Christians). The word "coro" is applied to any part of the building, side chapel or otherwise, where the choir assembles, such being shifted from place to place according to the weather, or to convenience. But *while* the choir *are* assembled there, and *it is* a "coro," the gates are shut (oftentimes curtains are drawn) and the laity are carefully excluded.

Mr. Ashpitel then explained how a friend of his was puzzled by talking of the choir as of the east end of a large church, when the sacristan said, "No, sir, this is the tribune—the choir is now in the second chapel on the right of the nave—next week it will be in the Spanish Chapel in the Green Cloister." And he also instanced, as the most striking illustration, that the churches built by the Jesuits have no choirs or chancels. Ignatius Loyola, finding how the recital of the breviary services at every third hour interfered with the active life he required of his followers, would not suffer them to do so, and consequently choirs were useless, and are never built in his churches.

He then showed that the notion that the laity should never enter the choir was quite novel, and had arisen since the publication of a translation of parts of Durandus, who says, "That the Council of Mayence had determined that the part which is divided by the rails from the altar should be open only to the clergy while chanting," "psallentibus tantum pateat clericis."—Now, curiously enough, this dogma is not to be found in the canons of the Council of Mayence, but it is in those of the second Council of Tours (A.D. 560), and would quite agree with the notion of the present practice, if we suppose by "psallens clericus" was meant, as it is in the present day, the choir *while* the breviary offices are going on—in other words, the *choir* WHILE it is a *choir*—but on reading the words of the canon itself, it goes on to say, "but, for praying and for communicating let the holy of holies itself be open to the laity and to women, as the custom is."

He then entered at length into the question of the canons of the fourth Council of Toledo, and of the sixth of Constantinople, and described the use of the churches in Rome; that different services are held in different parts of the edifices, as the number of persons present or other convenience may require, the laity being freely admitted to all parts of the building, with one exception only—that they are always excluded from the chapels *while* the breviary services are celebrating; but as soon as these are over the gates are thrown open, and masses or other public services said, and the laity admitted again.

Mr. Ashpitel then alluded to some traditions extant among the English Catholics at Rome, one that the separation of the sexes in churches was said to have been an innovation of Zuinglius. The passage in Saint Augustine de Civitate Dei, he was told,

* Paper read before the Society of Antiquaries.

alludes to a practice still in use at Rome, that on certain occasions men alone go to certain churches and women to others; not that there is a separation of the sexes in the same church. He also explained that there is no "orientation," as it is called, of churches in Italy; and that there is a tradition that the framers of the Prayer-Book used the phrase *north* side of the altar, disliking the use of the words "Gospel side," or "Cornu Evangelii." He also related another tradition, that the modern pronunciation of Latin was introduced in the time of Elizabeth, that those who had received a foreign education, and so be suspected as seminary priests, might be detected as soon as they quoted a classic authority. He concluded by a hope, that the subject might be more carefully investigated; and more particularly, whether morning prayer and occasional services might not still be held in chancels, rather than scattering people thinly over a large cold church; and also, whether the fact of the Church of England having determined that the altar should be *moveable*, may not have had, and may not still have, a most important bearing on this subject.

Mr. John Henry Parker, F.S.A., subsequently read some additional observations *on Chancels*, supplementary to Mr. Ashpitel's paper. Mr. Ashpitel having confined his attention chiefly to Italy, Mr. Parker read the principal instances which occurred to him showing the early practice in France and England. He agreed with Mr. Ashpitel that the word "chancel" originally signified the space inclosed by a cancellus or screen, and was in that sense synonymous with the choir, or place for the chorus; but this was not necessarily or always the eastern limb of the church; and in this sense there were frequently several chancels in the same church, each chantry-chapel having its own cancellus, and being frequently called by the name of chancel, as in the Constitutions of Archbishop Gray, A.D. 1256, and those of the Legate Othobon, A.D. 1268. The principal chancel, or chorus, was also frequently placed in the nave—or at least partly in the nave—both in France and England, in early times. In the South of France the chorus is placed in the centre of the church, and a large part of the congregation assemble between the east end of the choir and the high altar, which is again inclosed within its own cancellus. The space around the altar—called the holy place, the sanctuary, the presbytery, and by other names—was also called the chancel, being inclosed by its own cancelli. This was the case in the pagan basilicas, where the tribune was so inclosed, and where the cancellarius sat; and the same custom was continued in the early Christian churches, the Christian altar being placed on the chord of the apse, on the same spot as the pagan altar had stood before, and being inclosed in the same manner with its own cancellus, the place of which is supplied by the altar-rails in the English church. The custom of inclosing the high altar and the chorus within the same solid screen only came into use in the twelfth century, and more commonly in the thirteenth, along with the procession-path and the lady-chapel, in consequence of a change in the Roman ritual at that period.

By the law of England, the chancel, in the sense of the eastern limb of the church, is distinct from the church, each having to be kept in repair by different parties; and at the time of the Reformation the word "church" did not include the chancel. The order that the two tables of the commandments should be placed at the east end of the church, meant at the east end of the nave, against the chancel-arch, where a partition was commonly erected for that purpose. The order that "chancels shall remain as they have done in times past," means that they shall not be destroyed to save the expense of keeping them in repair, as hundreds were at the time of the Reformation, many of which were rebuilt at the Restoration, under the direction of the great divines and bishops of the time of Charles II. The customs of the Church of England at that period, to which our present Book of Common Prayer and our present Act of Uniformity belong, are far more binding upon us than the customs of any earlier period. The word "table," both in the time of Elizabeth and in the time of Charles II., meant a slab or board only, and did not include the framework or other support on which it rested; and this slab was ordered to be moveable, and is actually found detached on all old communion-tables, when not fastened by modern nails or screws.

The custom of the orientation of churches in France and England appears to rest on ancient tradition, and is one of many ancient customs which seem to show the eastern origin of the ancient Gallican church, and through it of the ancient British church also. It never was a law of the church, nor a Roman custom, and never was a universal practice, though always the usual custom; and provided that the direction was eastward, that appears to have been sufficient, without any great exactness being necessary. The chancel was often rebuilt at a different time from the nave, and, the ground-plans being laid out carelessly, they do not both follow the same line.

THE GALVANISED IRON ROOFS AND THE STONE OF THE NEW HOUSES OF PARLIAMENT.

Sir Charles Barry has recently addressed the following letter to the *Times* on these subjects, in reference to the new Houses of Parliament:—

"Public attention having, by a recent discussion in Parliament, been directed to the condition of the iron roofs and the stone of the New Palace at Westminster, the following information respecting them may not be unacceptable to your readers, and may serve to remove any misapprehension that may exist on the subject.

"Metal roofs were not contemplated in the original design. They were resorted to upon the adoption by the government of Dr. Reid's plans for warming, ventilating, &c., by which they were required to contain, as they now do, the main smoke flues of the building, and therefore it became necessary that they should be constructed entirely of fireproof materials. A coating of zinc in preference to paint for the external plates was adopted upon the strongest testimonials from the French Government and other sources as to its long use and successful in France, where it still continues to be employed extensively, particularly in the dockyards of that country. Since its adoption at the New Palace at Westminster it has also been most extensively used both in public and private works in this country, and is still being used by the government in our own dockyards. Experience however, has proved that it is not capable of offering a long resistance to the deleterious effects of a smoky and impure atmosphere, and the roofs of the New Palace of Westminster have consequently become partially covered with an oxide of iron, or rust. As regards their stability and weather-proof qualities, however, they are none the worse on that account. No difficulty, moreover, exists in resisting all further oxidation, by covering them with one of the anti-oxide compositions now in use, which may be done at a very moderate cost. Several of these compositions have been in course of trial in various parts of the roofs for some time past, and I have reason to believe that I have discovered one that may be said to be almost imperishable.

"The choice of the stone adopted was the result of the labours of a commission consisting of two of the most eminent geologists of the day, an intelligent mason, and the architect, who, in the year 1838, visited every quarry and locality in the kingdom likely to furnish building stone. The stone at Anston in Yorkshire, was selected and adopted by the government, and every precaution has been taken to supply from the best beds in it. Upon the whole, it has turned out to be at least as good as any hitherto employed in London; portions of it, in particular situations, and under peculiar conditions, have doubtless yielded to the deleterious effects of a London atmosphere, but the proportion of the parts affected to those which are perfectly sound is infinitesimally small, and it is remarkable that the decomposition is almost exclusively confined to the plain faces, the moulded and carved portions of the work being generally as sharp and perfect as when first executed. To say, therefore, as has been recklessly asserted, that the stone is perishing in all directions, conveys a most unfair and exaggerated impression relative to its accurate condition. Various economical means, however, are available for arresting all further decomposition of the parts affected, and experiments have been in course of trial for years, with a view to determine upon the most effectual and unobjectionable process to be employed; and it is hoped, therefore, that ere long all further decomposition will be successfully arrested."

THE DESIGNS FOR THE WELLINGTON MONUMENT.

It will be remembered by many of our readers that government voted 100,000*l.* for the purpose of a public funeral for the late Duke of Wellington. Contrary to most precedents, this sum ––– actually found to exceed the expenditure by 23,000*l.* It was sequently first proposed that this large surplus should be re- . ,ed into the public exchequer; but eventually it was deter- ted, with the approval of the House of Commons, that it uld be applied to the erection of a monument in St. Paul's hedral worthy of one of England's greatest men. We gladly r the Chief Commissioner of Works all praise for the straightward and independent manner in which he has thrown open competition to the whole world, and we trust that the artist o receives the highest premium will be instructed to follow his design in all its integrity without government or other luence. We may perhaps be permitted to say that we do not ite admire the tone adopted by some of our contemporaries on this occasion, among whom some overlay their notices with most fulsome and injudicious praise, and in others there is a ne of acerbity which we cannot but regret. Must we or must not pronounce these antagonistic remarks as arising from norance of the subject, or that in one or two instances it arises om a feeling of personal ill-will against certain competitors; for r own part we grieve to know that "despair and genius are too oft nnected," and we entreat those to whom we are now referring not to hit so hard at struggling genius, but to be to its "faults a little blind," and endeavour to cheer it on its way instead of blighting its ardour by observations that may lead to despondency. We freely admit that in the collection now exhibited in Westminster Hall, there are many examples that do not reach beyond the direst mediocrity; but at the same time we are convinced—we know it to be an incontrovertible fact, that there are many specimens that do honour not only to our own nation, but also to our continental neighbours, notwithstanding the statement of some of our contemporaries that there is not a single design in the whole lot that deserves more than a 100*l.* prize, and that there are only one or two worthy of notice amongst a lot of rubbish. We estimate art at its true and intrinsic value, so far as it comes up to a certain standard of artistic excellence, as embodying sentiment, feeling, expression, and dramatic power. We confess that there are few such in the exhibition; and notwithstanding that we know that such men as McDowell and Foley have not competed, we yet are aware that there are some good men who have, and we trust they will be rewarded according to their deserts. We are proud to to say that if our native artists have a fair field and no favour, they can at the present period compete with any sculptors of Europe.

On entering Westminster Hall the *coup d'œil* of the models presents a most pleasing perspective, and will surprise the majority of general visitors. The models of course form a much more varied and interesting exhibition than the architectural subjects which have been so recently displayed for the new government offices. In the latter the visitor required a considerable amount of technical architectural knowledge before he could comprehend their comparative beauties. In the former the power of form and sentiment appeals to his senses, and he must be dull indeed who cannot comprehend the drift and aim of the artist who embodies his conceptions in palpable shape.

Of all the designs in the collection the most touching to the feelings is constructed by an artist who has as his motto the simple words, "Passed away." It represents a mausoleum, on the top of which is a beautifully executed statue of the duke, supported by two figures reclining, one holding a wreath of laurel. The mausoleum, within which is a marble sarcophagus, has brazen gates exquisitely designed and executed, on which, on medallions are depicted the principal epochs of the duke's life. On one side of the gate there is an angel, charmingly modelled, who with one hand is closing the gate, and with the other places a finger on her lips, as if hushing all to silence, and whispering the words, "Passed away;" outside and guarding the gate reclines a noble lion. The design truly portrays the words of the artist, "The angel of Death completes the tale. The gates are closed, the warrior and statesman has passed away, and History writes his deeds." A finer production has not been brought forth for many a day, and the author may well be proud of his work.

No. 19 is another great work. It is intended to despict the duke in a twofold character, viz., that of a warrior and a statesman. He is represented standing on a rock, with a sword in one hand, and a scroll in the other. On one side is a figure of Victory rising with her wreath to crown her favourite, and on the other a figure of Fame. In the centre are beautiful figures of Peace and Plenty. War is represented by two male figures; one, with a broken sword, looking upon another figure bowed down with fear and despair. At the foot of this extremely well-executed group are figures representing Legislation and History, and at the back of the group is a figure of Britannia mourning over her departed hero. This design will inevitably attract special notice.

No. 56. This model displays an extraordinary amount of talent, and is the work of a true artist; and what is of great consequence, it appears to be of the exact size and proportion to the site where the monument is intended to be placed. The figure of the duke at the summit of the pedestal, for individual likeness in his latter years, is without a rival in the exhibition, and four female statues at the corners of the pedestal for exquisite feeling and admirable modelling are beyond all praise. The work is truly monumental without an excess of architectural details, which in many instances mars the effect of a great number of the works, which ought essentially to partake of a sepulchral character.

No. 57 and 60 are very beautifully executed designs, and would appear to be the work of the same artist. They are very similar, the only marked difference being in the character of the bases. The front represents the duke in meditation, and reversing his baton in token of peace. Figures emblematical of Peace and War are on either side of the hero. Beneath is the Genius of History recording his "deeds of high emprize," and on either side are figures representing Belgium resting on her sword, and Spain wounded, holding a British sword, her own being broken. At the back are two gates opening into a mausoleum; above the gates is a figure of Britannia, mourning her departed hero, and on each side of her are figures representing India and Portugal.

We are fully aware that it may be considered invidious not to notice the whole of the works, or at any rate the greater part of the models, but we cannot do so where there are so many claiming especial attention. We will therefore for the present be content to name those those only which we conceive contain in themselves some superlatively excellent qualities, and which are appropriate, not only for the occasion, but also as adjuncts to a building that they ought to adorn. Amongst the models in which coloured materials are adopted, we may enumerate No. 6. The lower portion of this work is intended to be of porphyry, over which there is a basement of bronze, profusely ornamented in bas-reliefs with the arms of the conquered nations. Upon this is raised another base, of an oval form, of Cyproline marble, upon which is to be placed whatever inscription may ultimately be determined upon by the judges. Four figures, representing Strength, Justice, Temperance, and Prudence, are at the corners; on the second base there are bas-reliefs representing Ireland instructing Wellington in science; Victory crowning him as Sir Arthur Wellesley, on the taking of Mysore; the Peninsular campaign; and the entrance of Welington into Paris. Upon this last base a sarcophagus is placed, upon which the principal group stands, which represents Wellington giving back his sword to Britannia, who is in the act of crowning the spirit of the duke. On the left an Angel of Peace invites him to heaven, and History, on the right, is recording his various exploits. Altogether this is a work of great merit; but some, from the introduction of so much colour, may think it has somewhat of a meretricious appearance, an opinion in which we are disposed to concur.

In some of the specimens where polychromy is introduced, the result is entire failure, more particularly where gilding is also adopted in addition to bronze and coloured marble. We may however remark, that in this class there are several highly creditable examples. Many of the artists have essentially failed by making their works considerably too high; amongst these may be enumerated a huge architectural production, entirely bronzed, that assuredly would not go underneath the arch within which it is intended to place the monument. No. 68 is also preposterously high; this example is surmounted by a dome, and is as a whole much too architectural, independently of its being totally unfit for the situation where the monument is intended to be placed.

There are eighty-three models in all. There will be nine premiums awarded, viz. one of 700*l.*, a second of 500*l.*, one 300*l.*, another of 200*l.*, and five of 100*l.*, and the cost of the monument is not to exceed 20,000*l.*

DEODORISING AND UTILISING THE SEWAGE OF TOWNS.

Summary of the Report of the General Board of Health.

A REPORT has just been issued by the General Board of Health on the application and the deodorising of the sewage of towns. In the two or three hundred towns to which the Public Health Act has been applied, and in various other towns, works under private improvement acts have been carried out. A general system of main and house drainage has been effected. All cesspools in these places either have or are in course of being done away with. The refuse of the towns, instead of finding its way into those old-fashioned receptacles, is now discharged into the different watercourses and rivers; and the consequence is, that the waters in these rivers have become so foul and impure as to be unfit for human consumption or domestic use. What, then, to do with the sewage is a subject that cannot be put aside. Its value for agricultural purposes is variously estimated. One section of agriculturists and chemists give it almost a fabulous value, whilst others deem it all but useless.

Mr. Austin, the chief superintendent of the board, was deputed to examine and report on the subject. He visited all the principal farms where sewage manure, either in a solid or liquid form, has been adopted; and he has also directed his attention to the different methods in use in deodorising the sewage. The results of his labours are shown in some of the following conclusions. He says, "That, although from the earliest agitation of the question of sanitary reform and of the complete drainage of towns, the mischief from pollution of rivers, on the one hand, and the waste of valuable manure on the other, by the direct discharge of the sewage, was insisted upon, no conception was at any time formed of the *extent* of the evil which now so imperatively calls for a remedy."

After stating that the means of remedy by deodorisation are as yet imperfectly understood, he says:—"Chemical research has not yet arrived at any satisfactory method of economically arresting from solution the fertilising ingredients in sewage, while the analysis of solid sewage manures, manufactured under various patents, shows that, although for the most part possessing a low value, they do not justify the high prices at which they have been offered to the public; nor does there appear to be evidence of any agricultural results derived from their use which will support such a view of their value.

"The manufacture from excrement of a dry, portable manure, as practised at Paris, although realising results of greater value, is applicable only where the cesspool system prevails, and leads to an aggravation of that system which due regard for the public health would not tolerate.

"The separate system of drainage frequently proposed as a solution of the sanitary and agricultural difficulties of the sewage question would increase immensely the cost of drainage works, would add to the sources of danger to the public health, and would tend to a waste of fertilising power.

"The practical experience obtained during many years at Edinburgh and Milan has shown the great value of sewer water on grass lands, although applied in a state of great dilution; while valuable experiments have shown the power of soils to remove from solution, and retain for vegetation, the fertilising elements.

"Nothwithstanding the enormous quantities of sewage water which have been applied to the land at Edinburgh, the produce is said to be always in corresponding ratio to such quantity, and the limits of quantity to be applied, and of produce to be realised, have not yet been ascertained.

"The precise value of the manure in a given quantity of sewer water may be readily determined; and therefore the corresponding quantity of water which must be applied to convey a certain required quantity of such manuring elements on to land may be known. Although such immense agricultural results have been obtained with the irrigation from sewage water at Edinburgh, the method employed has given rise to much complaint of nuisance. This arises for the most part from foul deposits in wide ditches, and from the large evaporating surfaces of the sewage constantly exposed in the channels of irrigation. All such sources of nuisance and danger are preventible, and should not be tolerated; no ditches should be used, and the sewage should be exposed only during the act of irrigation of each portion of the land, when it would be immediately absorbed and deodorised by the soil.

"In order to avoid all further risk of injury to health, whether from the discharge of the sewage into the rivers and streams, or from its application to the land, it appears desirable that the solid matter should in every case be separated from the liquid sewage at the outfall, and a cheap portable manure should be manufactured therefrom for use in the immediate neighbourhood, as practised at Cheltenham. It should be mixed with the ashes of the town, or such othor deodorising material as may be most suitable for application to the surrounding land, and prepared, if desirable, with other ingredients for particular crops. It appears probable that such operation will in most places pay its own expense; but as some such measure is absolutely necessary for the public health, even though involving some expense, it should be the duty of local boards and other governing bodies to carry it out, just as much as the arrangements devolving upon them for removal of dust or other refuse of the town. It should form, in fact, part of such service, and might be combined in the same contract.

"The liquid portion of the sewage thus cleared of its solid matter, but still retaining its chief value as manure, might be applied with benefit to the neighbouring lands in any quantity; but all land upon which this method of application of the sewage is practised should, if not naturally porous, be artificially drained; as the liquid, if allowed to become stagnant, would, as in common irrigation, be likely to engender disease in the neighbouring inhabitants or in cattle exposed to its influence. The distribution of manures in the liquid state, by the hose and jet, from a system of underground pipes on the land, has been found, by the experience of several years upon farms in England and Scotland, most advantageous, and the outlay for such works is considered by eminent agriculturists who have had experience of their benefits as a very profitable outlay, irrespective altogether of the question of sewage distribution. Although the adoption of the same system at Rugby and other places for the distribution of liquid sewage has been found decidedly successful, the great Edinburgh results are not attainable by this method, unless conjoined with more ample and ready means for getting much larger sewage on a given area, in less time and with less labour and expense than can be done with the hose. Upon grass lands, for which its application is best adapted, these larger quantities of the liquid sewage, deprived of its grosser particles, may be economically distributed, especially upon the lower lands, by a combination of the underground pipe system with the subsidiary open irrigation by small contour gutters, practised by Mr. Beckford.

"This work being of a commercial or speculative nature, and not so much required for the safety of the public, would fall rather within the province of local companies or proprietors than of the local authorities, and to those parties all facilities should be granted for carrying it out.

"The solid *sewage* manure, prepared and deodorised as above proposed may be anywhere used, and any quantity of the liquid applied and absorbed on properly drained land, without any risk of injury to health, and without any of the offensiveness constantly experienced from farm-yard and other solid manure applied as top dressings. In any neighbourhood, however, where no opportunity exists for this beneficial irrigation, the liquid sewage before being discharged into rivers or streams, should, after separation of the solid matter, be treated with lime or other dedorising and precipitating agents, a duty which should devolve upon the local board or other governing body, as a precaution in which the public health is materially concerned.

"It is an object of immense public concern that the poisonous accumulations of our towns, now fast becoming the sources of pollution of our rivers and streams, should without delay be rendered powerless for further mischief, and applied as Nature's laws demand, for reproductive uses. By this means the greatest sanitary problem will be solved, and the greatest advancement of agricultural prosperity secured."

Such are the conclusions to which Mr. Austin has arrived after a most careful research. The report itself contains a mass of information which will prove of great value in aiding the solution of this very difficult but important subject.

MR. T. Hodgson, Brooklyn, (U.S.), has invented a plastic material, capable of making moulds for metal castings, which can be used over and over again. The repeating loam mould is capable of withstanding intense heat, and of concentrating it in a superior manner upon the metal to be smelted.

THE ATLANTIC TELEGRAPH.

Before this number of the *Journal* is published the two ships freighted with the insulated wire that is to establish telegraphic communication between the New and Old Worlds, will probably be on their way across the Atlantic, laying down the line; and before our next number is issued the news from America may be dated "*New York—this morning!*" It is scarcely possible to over-estimate the influence which so rapid a means of intercommunication may produce on the political, the social, and the commercial relations of the countries thus intimately connected, and yet the work which is intended to effect this important object has been proceeding during the last six months without having attracted much public attention.

The greatest length of line from station to station is about two thousand miles, from the south-east coast of Newfoundland to the west of Ireland. One half of the insulated wire has been manufactured by Messrs. Newall, at Birkenhead; the other half by Messrs. Glasse and Elliott, of East Greenwich; the length made by each being 1225 miles, so as to allow for unavoidable deviations from the direct course, and for the undulations of the bed of the Atlantic. The metallic conductor through which the electric current is to be transmitted consists of a copper wire cord, composed of seven strands of No. 25 wire, the diameter of the cord when twisted not being more than $\frac{1}{16}$ of an inch, which is about the same thickness as the copper wire used for the submarine telegraphs from England to Calais and Ostend. This copper cord is insulated by three coatings of gutta-percha, of the combined thickness of $\frac{1}{8}$ of an inch. Over the gutta-percha there is twisted a covering of tarred yarn, to serve the double purpose of protecting the gutta-percha from corrosion, and of improving the insulation. This insulating rope is again protected by a rope of thin iron wire. The wire of which this external covering is made is very thin, and it is twisted into a cord, eighteen of which cords form the strands that envelope the "cable." The object of this wire covering is to protect the insulating materials from abrasion during the operation of laying down the line into the sea; for it is too slight to afford protection from violent strains, such as those to which the submarine cables in the English Channel are exposed, it being considered that in the deep waters of the Atlantic the wire, when once safely deposited, will remain secure, for no anchors are cast so low, nor do living creatures exist under such pressure, and where no light can penetrate. The "cable" as it is called, thus constructed, is very flexible, nearly as much so indeed as a hempen rope of the same thickness. At each end however the insulated wire is protected with an external covering of much stronger iron wire, to the extent of 25 miles, to guard against the greater dangers to which it will be exposed near shore.

Of the London portion of the work the copper conducting cord was coated with its triple insulating shield at the Gutta Percha Works in the City-road, the other coatings of tarred yarn and of iron wire having been applied at the factory of Messrs. Glasse and Elliott, who have several machines where the operation was conducted at each at the rate of $2\frac{1}{2}$ miles per diem. As the cable was manufactured it was drawn out into the factory yard, and there deposited in several large coils, care being taken to lay it perfectly even. Each of these coils contained from two to three hundred miles of the insulated conductor, and in the course of its manufacture it was continually tested by a well-contrived electrical apparatus, to ascertain whether the current was unbroken, and whether the insulation remained perfect.

The *Agamemnon*, one of the finest ships in the British navy, was placed by the government at the command of the Atlantic Telegraph Company, to carry out that portion of the cable manufactured at East Greenwich; and the *Niagara*, the boast of the United States navy, was in like manner placed at their command by that government. The holds of both ships were cleared out, so that the cable might lie in one large continuous coil, of the diameter of the entire width of each ship. The *Agamemnon* lay in the river about 200 yards from Messrs. Glasse and Elliott's factory, with a public footpath intervening. The communication between the ship and the factory was maintained by moored barges, with planks laid from one to the other; and on the barges and on the bank of the river uprights were erected, on the tops of which large pulleys received the cable as it was drawn from the coils in the factory yard. The cable passed over an endless band, kept in action by a small steam-engine in the ship, and was received by men in the hold, who carefully laid the folds of the coil side by side, to prevent it from becoming twisted, and to facilitate the paying out. This operation of loading the ship went on incessantly at the rate of 50 miles a day, as indicated by a meter attached to the endless band, which showed the number of furlongs, of miles, and of hundreds of miles taken on board.

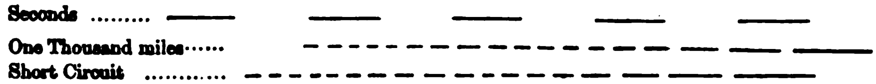
The *Agamemnon* completed her freight on the 21st ult., and on the 23rd she sailed to join the *Niagara* in Cork Harbour. It was originally arranged that the ships should depart in company, and when in mid-Atlantic, that the ends of the two halves of the cable should be joined; and then, one steaming east, and the other west, paying out the cable as fast as they could, that the *Agamemnon* should make the port of Valentia, on the west coast of Ireland, and that the *Niagara* should join the other end of the cable to the telegraph line at Newfoundland. It was afterwards thought best to commence paying out the cable from Valentia, and that both ships with two accompanying tenders should make the voyage together to Newfoundland. By this means the progress of the work will be known on this side the Atlantic from minute to minute.

On looking at the thin copper conductor which is intended to transmit electric signals through a length of 2000 miles, it seems, according to ordinary notions of the conducting properties of wires, to be sadly too small for the purpose. But such notions appear to be contradicted by the results of experiments. Mr. Whitehouse, to whom in conjunction with Mr. Bright, the electrical department of the undertaking has been entrusted, was for a long time engaged in endeavouring to ascertain the best methods to be adopted in transmitting an electric current under the sea to such a distance; and in the course of those investigations several new and curious facts were elicited respecting the conditions of electrical discharge. The principal difficulty which presented itself was the detention of electricity in the submarine wire; it having been found, even in the comparatively short distances of the submarine and subterranean telegraphs in Europe, that the conducting wire coated with gutta percha and surrounded by water, retains the electric charge for some seconds, and that to free the wire from electricity it is requisite to reverse the current. Thus, for instance, after each instantaneous transmission of a positive current through the wire, a negative current is sent through it, to discharge or neutralize the positive electricity, after which another positive current may be transmitted. It was feared, however, that that mode of discharging the wire would not be effective at greater distances; and calculations were made, founded on experiments, to show that it would be necessary to have a very thick conducting wire coated with a great thickness of gutta percha, to overcome the difficulty of the detention of the electricity across the Atlantic.

The results of Mr. Whitehouse's experiments tend to dispel this fear. In his experiments through 1000 miles of the Atlantic cable the positive current was completely discharged by the negative, and he was enabled by using a modification of Mr. Morse's telegraph, to transmit four distinct signals in one second. That rate of transmission would be sufficient for the sending of messages as quickly as in the ordinary working of the Morse telegraph.

Magneto-electricity is to be employed, but instead of a permanent magnet, electro-magnetism will be the immediate agent. For this purpose electrical apparatus of gigantic proportions has been constructed. The electro-magnet is five feet long, and it is to be actuated by ten or more cells of a Smee's voltaic battery, each of which is of prodigious size. The thin insulated copper wire, through which the induced magneto-electricity is transmitted, is made of No. 25 copper wire, and though many miles length of it are coiled round the electro-magnet, the number of convolutions is not so great proportionately to the length as in Ruhmkorff's induction coil. The apparatus for making and breaking contact is a ponderous machine, very different indeed from the small key used for that purpose in the Morse telegraph instrument. This enlarged size was found necessary, on account of the great heating power of the large cells of the voltaic battery, for an ordinary apparatus would have been melted on making contact.

The apparatus contrived by Mr. Whitehouse for his experiments through 1000 miles of the Atlantic cable indicated exactly the length of time occupied in the transmission of an electric current that distance. A strip of paper was moved by clockwork on an instrument which contained three indenting points, each one being actuated by a separate current of electricity. One



of these currents was brought into action by a second's pendulum, so that as the strip of paper was drawn through the instrument, alternate strokes and blanks were produced, each one being nearly half an inch long. These marks indicated seconds on the paper, and served to show how many marks in a second were made by the two other points, which were connected respectively with the 1000 miles of wire and with a circuit of but a few yards.

In the accompanying diagram, which is copied from one of the experimental strips, the marks in the top line show the seconds, those in the middle line are the marks made by the instrument after the electric current had passed through 1000 miles of wire, and the marks in the lowest line were made in the same intervals of time, but through a short circuit only.

The fact of most interest to be noted in this diagram is, that the marks in the middle line are about two-thirds of a second behind those in the lowest, though the signals in both were transmitted at the same instant. That interval therefore indicates the time occupied in the transmission of the electric current through the thousand miles of wire.

The results of Mr. Whitehouse's experiments seem to have satisfied him that he shall be able to transmit working signals through the Atlantic cable, should no serious damage be done to it in the laying down, and every possible precaution seems to have been taken to prevent such a calamity. We have on a former occasion * shown that no accurate conclusions can be drawn from experiments made with an insulated wire, both ends of which are connected with the voltaic apparatus; and that the excellent results obtained under such circumstances afford no proof that similar effects would be obtained when the telegraph instrument was placed in the middle of the circuit. We sincerely hope that the means adopted by Mr. Whitehouse will have removed that difficulty; and that we shall have in our next number to congratulate our readers on the complete success of the important undertaking.

* See *Journal*, Vol. XIX. (1856), page 364.

A discovery in electric science is said to have been made by Mr. Reid, of Gresham-house, by which the cost of telegraphic communication with distant stations will be diminished to an extent almost beyond belief. The Great Atlantic Telegraph Company had constructed at Greenwich a monster battery: it consisted of forty pairs of platinised silver and zinc plates, and presented an immense surface to the influence of the exciting fluid, and cost the company 2500*l.* It appears from a series of experiments made by Mr. Reid, that by a single pair of plates the same amount of work may be performed, he having transmitted currents of electricity with his simple battery through 1250 miles of the telegraph cable at Birkenhead, the cost of the battery being 3*d.*, which shows a wonderful contrast as compared with the company's apparatus. A battery of 504 plates had been in constant use for testing the cable, and the whole was found to be perfect; but Mr. Reid was desirous of making some further experiments to test the power of different batteries, and, amongst others, tried the effect of the mouth battery, with the result given. His assistant placed a plate of platina and one of zinc in his mouth, each being three-sixteenths of an inch square, and upon the current produced thereby being allowed to pass through the 1250 miles of cable, the galvanometer was deflected 8°; and although the experiment was made many times, the same result was invariably obtained, which is a most unusual occurrence.

LONDON AND NORTH-WESTERN RAILWAY GOODS STATION.

The operations for rebuilding the general goods station and warehouse of the London and North-Western Railway have been commenced by Mr. Jay, the contractor for the building, under the superintendence of Mr. Baker, C.E., and Mr. Stansby, the architect of the company. The new building will occupy precisely the same site as before, but will extend over a considerably enlarged area, and will cover, altogether, a superficies of 59,000 square feet. The part of the original basement that was vaulted, and which has not suffered from the late catastrophe, will be retained; and the basement of every part of the enlarged building will, in accordance with the new design, be vaulted. The ground-floor of the building, together with the platforms, will be clear of all obstruction throughout, for the better accommodation and management of the extensive goods traffic. The clerks' and managers' offices will be on the upper floor, and will be vaulted, and rendered fire-proof. On all sides of the building, which will be very nearly a square, the warehouses for storing of goods will be constructed, and the interior will be lighted from above by a glass roof. The walls will be of brickwork, and the girders of the floors of wrought and cast iron, supported by iron columns.

The stabling and smiths' shops that hitherto formed part of the building, will, to prevent as far as can be all possibility of future fire, be removed from the building altogether to the other side of the Gloucester-road, but communicating with the goods station by means of a tunnel; and the ground thus gained will be appropriated for store-rooms. The new stabling will be extensive enough to contain 270 horses, with all the requisite smiths' shops, harness-rooms, and machinery; water-pipes will be laid on throughout the new structure, and there will be rails all round, to bring up the goods trucks to the goods platform. It is expected that the building will be completed in about four months from this date.

New stations are being constructed at Watford, and at Harrow and Pinner, in consequence of the widening of the line out of London, which will ultimately extend, in quadruple rails, down to Bletchley, some forty-six miles from London. A new structure is now erecting in front of the Euston Station, for the shelter of vehicles and the public.

REVIEWS.

An Elementary Treatise on Orthographic Projection; being a new method of teaching the science of mechanical and engineering drawing. By William Binns. London: Spon. 1857. 8vo. pp. 138.

Suppose a shower of rain to fall vertically upon a solid fixed above a horizontal plane: the portion of the plane not wetted is an orthographic projection of the solid. Or if the sun shone vertically on the solid and plane, the shadow of the former would be its orthographic projection. The common geographical maps of the globe are familiar instances of these projections. If the curves of latitude and longitude were represented by wires bent to the convex shape of a hemisphere, the shadows of the wires alone would be their orthographical projections represented by the curves of latitude and longitude on the map.

This branch of geometry has numerous most interesting applications in various branches of science. To the engineer and architect it is the most important part of solid geometry. Many principles of statics and dynamics are most conveniently considered by reference to the theory of projections; and "the subject of orthographic projection" is, as Mr. Binns expresses it, "the A B C of that description of drawing which is universally adopted as a means of representing all kinds of engineering stuctures, as well as articles in the process of manufacture."

The present work comprises the author's course of instruction; formerly at the College of Civil Engineers at Putney, and now in the government Department of Science and Art. After some preliminary instructions, the methods of projecting points and straight lines in one plane upon another at right angles to it are treated of, and, as immediately connected with this topic, the determination of a Plan from an Elevation, and the converse process, are explained. A subsequent chapter treats of projection on inclined planes. The work then proceeds to the more difficult subjects of the projection of *curved* lines and surfaces. For instances of the former we have the projection of the meridians and parallels of the terrestrial globe, for various relative positions of its axis and the plane of projection. The chapter on "Penetration and Intersection of Solids," is one of the most interesting. It is often difficult to foresee by a merely mental effort what forms will result from the inter-penetration of solids

For example, if two equal cylinders inter-penetrate, their axes meeting perpendicularly, it is not every one who would see at once, without any aid of models or drawings, that the one cylinder cuts off from the other an angular four-sided solid. No one, probably, without understanding something of the principles of orthographic projections, or seeing a model, could delineate the lines of penetration of spheres penetrated by cones in various positions; but by means of plans and elevations of the two bodies the method of obtaining their lines of penetration is rendered easily intelligible.

The work being intended to be entirely practical, omits almost all reference to the theory of the subject. This we consider a mistake. A book which gives mere *receipts* for particular cases, is a guide for those cases only; a book which gives a general view of the theory of which those cases are examples, enables the reader to work out other examples of the same theory. In this view we think that books intended for "practical men"—which expression is a synonym for "uninstructed men"—should not exclude all theoretical knowledge. Our scientific readers, of course, know that the subject of orthographic projections is one of the most elegant branches of solid geometry, the subject of numerous celebrated mathematical researches. In the extent of their results and the power of their methods, those researches bear much the same relation to a "practical" work which a steam engine does to a fly. The "practical man," of course, objects that the higher results and more powerful methods are beyond his attainment. This is not quite true. A thorough master of solid geometry might, we believe, exhibit some of the most valuable of his methods and results in language which an intelligent workmen would understand. Besides, there is something far more attractive and readable in a treatise which contains enlarged views, than in one of narrow scope which teaches mere lessons like a spelling-book. We by no means, however, intend to disparage Mr. Binns' work by these observations, and should be glad to find that they suggest improvements in the treatise hereafter. It bears throughout evidences of that careful consideration of pupils' difficulties which results from experience in teaching. The examples are well chosen, clearly worked out, and the work generally shows that the writer has in a high degree that perceptive faculty which often serves instead of systematic study in giving insight into geometrical principles.

The Elements of Drawing, in Three Letters to Beginners. By JOHN RUSKIN, M.A., *with Illustrations drawn by the Author.* London: Smith, Elder, & Co. 1857.

There can be no mistake as to the authorship of this book. Every page is marked by the same current of feeling which pervades the 'Seven Lamps of Architecture,'—the 'Modern Painters,' and the 'Edinburgh Lectures.' There is the same exhaustless fancy and power of description which so frequently leads the writer beyond his mark into shallows and uncertainties, laying him open to the charge of false logic and inconsistency, and the same ingenuity in seizing on minute and subtle facts which are dexterously laid under tribute to serve the immediate object. This versatility and skill, joined with a highly attractive flow of language, makes all his productions most *readable* ones; and one is neither disposed nor, at first sight perhaps, willing to be convinced that so fair representations are to some extent illusory.

Mr. Ruskin is condemned as a theorizer, although a would-be-practical man; he is condemned as a meddler in matters where he has little pretensions; and he is open to the charge of uncompromising dogmatism. With these drawbacks it is not to be wondered at that he is not a general favourite among the painters and architects, whose abilities and works he so freely presumes not so much to criticise as to pronounce upon them judgment absolute. Mr. Ruskin must by this time be sensible of these faults, but he does not appear to care to remedy them; there is quite as much pertinacity in his new as in his former books, and he is quite as crotchetty. Still, no candid reader will deny to this volume the merit of earnest aim founded on intense observation, and though the author's schemes for education in drawing and painting clash mightily with time-honoured usage, and cannot therefore be expected to commend themselves to old-fashioned practitioners in art, the system proposed is one which can scarcely fail of a successful issue, if only the student will have patience to creep on in the anything but royal road prepared for him. This remark is, of course, irrespective of the discursive reasonings and questionable amplifications so abundantly interlarded.

The book is divided into three chapters in the form of letters, respectively treating of—First Practice, Sketching from Nature, and Colour and Composition. To these are added an appendix on Things to be Studied; and the reader is told in the opening sentence, that whether the book is to be of use to him or not depends wholly on his reason for wishing to learn to draw. This, therefore, is a key to the whole, and is thus explained: it is not intended to enable one merely to possess a graceful accomplishment, or to be able to converse in a fluent manner about drawing, or to amuse listlessly for a few hours; but to enable the inquirer to set down clearly and usefully records of what cannot be described in words, to assist the memory, or convey ideas of them, to obtain quicker perception of natural beauties, and to render him capable of understanding and appreciating the works of great painters.

Amid very much that is sound and sensible in this first chapter, we find much that is, to say the least, whimsical. Thus, in speaking of outlining, its value, and the proper mode of shading in line, he adds: "It is a good thing to accustom yourself to shape and hew your drawing out of a *dirty* piece of paper;" why, does not appear. "Stale bread" is objected to for obliterating false marks, "as it crumbles about the room and makes a mess; and besides you waste the good bread, which is wrong; and your drawing will not for a long time be worth the crumbs." Then, further on, he deprecates, and wisely too, the custom of making pretty drawings for presents. "If any one asks you for a present of a drawing, send them a couple of cakes of colour and a piece of Bristol board; those materials are, for the present, of more value in that form than if you had spread the one over the other." This is akin to an opinion broached in the 'Seven Lamps,' that in early stages half the canvas painters use is more valuable in its pure state than when their pictures are finished. What startling assertions are the following:—"I believe that a pupil never ought to be able to draw a straight line (!)......I do not believe a perfectly trained hand ever can draw a line without some curvature in it, or some variety of direction. Prout could draw a traight line, but I do not believe Raphael could, nor Tintoret. A great draughtsman can, as far as I have observed, draw every line *but* a straight one." Then again, when speaking of perspective: "Perspective is not of the slightest use, except in rudimentary work......No great painters ever trouble themselves about perspective, and very few of them know its laws; they draw everything by the eye......In modern days I doubt if any artist among us, except David Roberts, knows so much perspective as would enable him to draw a Gothic arch to scale at a given angle and distance." Turner—the revered Turner—*professor* of Perspective at the Academy, comes under the stigma of not knowing what he professed—"and never, as far as I remember, drew a single building in true perspective in all his life; he drew them only with as much perspective as suited him." Prout is quoted as another instance......"The aspects of things are so subtle and confused that they cannot in general be explained, and in the endeavour to explain some we lose sight of others......So that merely scientific draughtsmen caricature a third part of nature, and miss two thirds. The best scholar is he whose eye is so keen as to see at once how the thing looks, and who therefore need not trouble himself with any reasons why it look so."

The author's observations on light as varying the appearances of objects, are interesting and philosophical; a considerable space is allotted to the discussion of this subject, which is treated of both neutrally and in colour. The illustrations are at once familiar and excellent. A golden rule is ever and anon enforced, viz.: that a little bit perfected is worth more than many scrawls. There are many subtleties in nature which are difficult to be expresed by art, and Mr. Ruskin does not presume to teach any infallible rules; the great secret lies in observation, and in the study of the best works of etching and engraving. In order to find out what method can do, we must look to art as well as nature, and see what means painters and engravers have actually employed in imitating these subtleties. To further this scrutiny the author recommends the illustrated edition of Rogers' Italy, or Rogers' Poems, and a selected series (which he gives, noting the good qualities in each) of Turner's Landscapes and Sea Views. Still, these are prescribed more to look at and examine than to copy. But this is a point on which the reasoning in different parts of the book does not appear wholly to agree. When referring further on, to the mode of indicating the characteristics of foliage, he truly praises the unapproached skill of Harding, yet surely is soon betrayed into evident inconsistency. Compare the following passages:—

(1). "It is excellent, in so far as it fondly observes with more truth than any other work of the kind, the great laws of growth and action in trees: it fails,—and observe, not in a minor, but in the principal point, because it cannot rightly render any one incident or detail of foliage. And in this it fails not from mere carelessness or incompletion, but of necessity; the true drawing of detail being for evermore impossible to a hand which has contracted a habit of execution. The noble draughtsman draws a leaf, and stops, and says calmly,—That leaf is of such and such a character; I will give him a friend who will entirely suit him; he then considers what his friend ought to be, and having determined, he draws his friend."

(2). "Except now and then by chance the form of a complete leaf is never seen; but a marvellous and quaint confusion, very definite indeed in its evidence of growth, and unity of action, but wholly indefinable and inextricable, part by part, by any amount of patience. You cannot possibly work it out in fac-simile, though you took a twelvemonth's time to a tree; and you must therefore try to discover some mode of execution which will more or less imitate, by its own variety and mystery, the variety and mystery of nature, without absolute delineation of detail."

We have thus noted some of the crotchets and theorising in which our author is wont to indulge, to the great damage, we submit, of most of his writings, containing as they do so much that is valuable and inspiriting. What, for example, can be more suggestive or useful than the lesson on the study of shadows, on p. 146-7 in the work before us, or on the modes of representing water, on p. 178?

Some excellent practical advice is also tendered as to water-colours and their use, particularly the processes by which gradation in tone and change of hue are producible by successive layers of tints. The fewer colours that are employed the better. It is urged in a note that if colours were twenty times as costly as they are we should have many more good painters:

"If I were Chancellor of the Exchequer I would lay a tax of twenty shillings a cake on all colours except Black, Prussian blue, Vandyke brown, and Chinese white, which I would leave for students. I don't say this jestingly; I believe such a tax would do more to advance real art than a great many schools of design."

How is this to be reconciled with the note on page 208?—"It is, I think, a piece of affectation to try and work with few colours: it saves time to have enough tints prepared without mixing, and you may at once allow yourself these twenty-four:" —naming them, and the order of their arrangement in the colour-box.

Dry colours, moreover, are recommended in preference to moist, and practice with body colour is advised, as teaching the use of colour better than working with merely transparent tints; not because it is an easier process, but because it is a more *complete* one, and also because it involves *some* working with transparent tints in the best way. A golden rule for the test of colour tones is, whether the whites in the picture are made "precious" and the blacks conspicuous.

The rules of composition are treated of under eight heads, denominated "*laws*," viz., of *principality, repetition, continuity, curvature, radiation, contrast, interchange*, and *harmony*. In enforcing these an analogy is often drawn between the constituent parts of a musical composition, showing the dependance of one note upon another, and their combined influence in producing the desired harmony, and the several portions of a well wrought picture. For the latter (and indeed throughout the rest of the work), continual reference is made to Turner, and in the most unqualified terms of praise. In the productions of this great artist, for so he unquestionably was, Mr. Ruskin is prone to discover beauties which it may be doubted were ever contemplated; perchance he will allow some of these to have been casual, but he will trace them to the workings of a well-trained mind, and to a hand that could scarcely do amiss. But we cannot cede all the admiration which the author claims for some of Turner's pictures, nor assent to all the ingenious twistings with which he dissects them, as in the illustration of the "Old Bridge over the Moselle," where picturesqueness is challenged, not always consistently with common sense. (See p. 262 *et seq.*)

The appendix on "Things to be Studied," contains some important remarks, too numerous to borrow from here; but they embrace the study of (1) picture-galleries, with the distinguishing traits of the most eminent painters; (2) published or multiplied art, such as lithographs, etchings, &c.; (3) literature generally, as affecting the taste and judgment. All these are so many helps by the way, which it would be folly for either the student or the maturer mind to discard; but the great question of result hinges on the degree of individual observation, application, and energy; or, as it is tersely rendered in the preface—"the best answerer of questions is perseverance, and the best drawing-masters are the woods and hills.

Examples of Ancient Domestic Architecture. By F. T. DOLLMAN. Part III. Royal 4to. London: Bell and Daldy.

(*With an Engraving, Plate* XXII.)

On the appearance of the former Parts of this work we took occasion to call attention to its merits, and by permission of the author we are enabled to give in the present *Journal* a plate as a specimen of the illustrations in Part III., which is a sample of the eleven illustrations it contains.

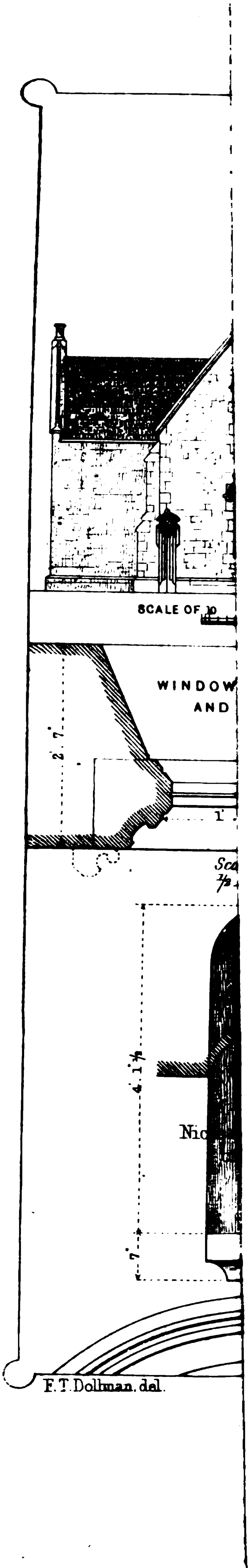
In this Part the ancient Benevolent Institution of St. Mary's Hospital, Chichester, for poor men and women, occupies three plates. They embrace a south-east view, a block plan, a general ground plan of the entire building and its chapel, with half-sections of the spacious refectory and chapel, and numerous details of the chapel wood work. The whole of these plates are remarkably interesting, and give with great accuracy every feature of the building. When St. Mary's became an hospital first there is some doubt: it is said to have been part of the nunnery founded by William, the fifth dean of the Cathedral, in 1173 or 1174; and the existing building is said to have been rebuilt about 1407. The government of the foundation is carried out by the Dean and Chapter of Chichester.

The Stamford Bede House (known as Browne's Hospital), Lincolnshire, forms the second subject, and is fully given in five plates, which embrace plans of the ground and first floors; a south elevation, and longitudinal section; a west elevation, and section of the porch; a transverse section looking west, this shows an elevation of the cloister; and details of windows, doorways, jambs, &c., with a perspective of the porch entrance, a striking feature of the building, worthy of attention, which completes the pictorial representations of this ancient charity. It stands on the north side of the Corn-market, and was founded in the reign of Richard the Third by an alderman and merchant of the Staple at Calais, named William Browne: it is endowed largely for the support of a warden, confrater, and twelve poor men, who are most comfortably provided for.

The third and concluding subject of the Part is the free Grammar School, known as Blundell's School, Tiverton, Devon, to which is devoted three plates. They consist of a front elevation and general ground plan (in this plan, what was once the entire building is carefully pointed out from later additions); a transverse section of the school showing the curious open screen of the inter-scholium, which separates the higher and lower schools, with details of the same and of the roof. The third plate shows the interior of the schools, with the timber roof of remarkable construction, and the garden front of the head master's house, with some interesting details. The Free Grammar School of Tiverton, where 150 boys are instructed, was founded in 1604, by a celebrated clothier of the name of Peter Blundell, who worked himself from a very low station up to a distinguished and wealthy position, and left for charitable purposes the great sum of 40,000*l*.; part of this erected and endowed the school.

Before dismissing this Part we must say, there are but few works of this character which come under our notice that are so well and ably carried out as this of Mr. Dollman: every Part has increased in value, and the utmost care has been bestowed throughout, so that whether it is regarded as an architectural or an antiquarian work, it must be considered as worthy of being placed beside the labours of Britton and the elder Pugin.

THE Brazilian empire is making numerous well-directed efforts to extend her maritime power, and is at present completing its first dry dock at Rio de Janeiro. It is situated on Snake Island, near the dockyard, and is being excavated out of the solid rock, convicts having been employed for several years in roughing it out. Mr. Henry Law, an English engineer, has contracted with the Brazilian government to complete it for 75,000*l*., including the cost of a 40-horse power engine to be employed in pumping the dock out, there being little or no tide in the harbour. The dimensions are—length, 300 feet; breadth, 92 feet; depth, 32 feet; but it is so situated that its length may be increased to any desired extent.



F. T. Dollman. del.

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GAUGINGS OF THE SEWERS OF THE CITY OF LONDON.

By William Haywood, C.E.,
Engineer to the Commissioners of Sewers of the City of London.

In the year 1853 I received permission from the Commissioners of Sewers of the City of London to take a series of gaugings of the whole of the sewers, which, either serving for the City alone, or passing through it, discharge their contents into the Thames within the limits of their jurisdiction. A general total of this discharge was obtained as quickly as possible, and held in readiness for any purpose for which it might be required; but as the extent to which I had the gaugings taken gave means of showing very accurate and detailed results, and deducing information of an interesting as well as useful nature, I delayed reporting to you upon the subject, until time was afforded me of collating the large mass of figures which record the actual observations, and their calculated equivalents; and I now have the honour of laying the results before you.

With a single exception, the whole of the outlets gauged are within the jurisdiction of the Commission; the exception is an outlet which, discharging upon the eastern side of the Tower, is without the present Corporation area, and is termed the Irongate. By arrangement with Mr. Bazalgette, the engineer to the then existing Metropolitan Commissioners of Sewers, I undertook the gauging of this also, inasmuch as it is almost entirely a City sewer, being in fact a portion of the Old City Ditch, and receiving but a very trifling addition of sewage after it leaves the City boundary; its gaugings are therefore incorporated with the others in the general tables; with it the list of outlets is as follows, commencing with that which is nearest to the south-eastern boundary of this jurisdiction :—

Name of sewer gauged.	Drainage area. Acres.
The Irongate	104·00
Tower Dock	3·25
Wool Quay	4·95
Custom House, east	14·59
Custom House, west	22·70
London Bridge	2250·00
Dowgate Dock	113·50
Hambro Wharf	10·00
Paul's Wharf	69·00
The Fleet	4220·00
Whitefriars Dock	55·50
Total area	6867·49

The Tower of London drains by its own sewers into the Thames; these were not gauged, and their area is excluded from the tables and computations, as well as an area of 24 A. 2 R. 11 P. within the City, which also drains by numerous small outlets directly into the river.

The discharges were taken by means of weirs fixed across the sewers, constructed so as to insure the whole of the sewage being discharged over them, and as near to the outlets as was practicable. The gaugings were carried on by night and day, whenever the state of the tides and the condition of the weather permitted; and when my assistants were driven out either by the tide or rain, the gaugings were resumed at the same minute or hour upon the next opportunity which a conjunction of dry weather and suitable level of the tidal waters allowed. Observations were recorded every fifteen minutes, and extended over the period between the months of June and December, 1853, during which time the weather was usually dry and warm. Observations were also frequently recorded during rain; but these, together with all subsequent gaugings until the flow had resumed its usual dry weather level, have been carefully excluded from the abstracts from which the tabulated results had been obtained. Those tables I have laid before the Commissioners, believing that every practicable care has been taken to insure their accuracy, and that with the diagrams they show as exactly as possible the dry weather discharge in the year 1853.

The sewers gauged comprise among them two of the most important in the metropolis—the Fleet, and London Bridge, the former of which drains nearly as large an area as any in London, and the latter, I apprehend, receives the drainage of a more densely populated district for its area than any of equal extent; the others run through districts where the consumption of water takes place under almost every variety of circumstance which can affect the rate and hours of discharge; and, taking the eleven sewers, representing as they do the drainage of an area of 6867 acres, or about 10¾ square miles, I believe they will furnish data as to periods and rates of discharge from areas, which will be applicable to nearly the whole of the sewers serving for the populated districts of the metropolis north of the Thames; and considered in relation to the known water supply at that or any future day, will enable the probable increments of sewage from the metropolis to be estimated with tolerable accuracy.

I will now direct attention to some of the results shown by these tables.

As to the Hours of Discharge.

In sewers draining the smaller areas the hours of minimum discharge are nearly the same as those of other districts, but local habits and circumstances directly affect the hours of maximum discharge; some results do not therefore accord with the larger and general results, but nevertheless with one or two exceptions it will be found that they agree in giving nearly one-half of the whole daily discharge as taking place during the eight hours which are between 9 a.m. and 5 p.m., a point of importance in its bearing upon the size of sewers and reservoirs for the scheme for the interception of sewage from the Thames.

The total average discharge in dry weather per diem during the six days of the week (Sunday being rejected), is 3,255,840 cubic feet, or 20,316,442 gallons.

The maximum discharge is between 11 a.m. and 12 a.m., when its average is 3497·50 cubic feet per minute.

The minimum discharge is between 2 a.m. and 3 a.m., when its average is 1033 cubic feet per minute.

The periods of mean discharge during the day are at 7·30 a.m. and 8·15 p.m., when it is 2264 cubic feet per minute.

The hour of least discharge is between 2 and 3 a.m.; but from 1 to 5 a.m. (4 hours) the discharge varies but 52 cubic feet per minute, which excess is between the hours of 4 and 5 a.m.: during these four hours but 7·78 per cent of the whole daily discharge takes place.

From 5 to 9 a.m. the discharge gradually but rapidly increases, and in the four hours ending 9 a.m. the total discharge is 14·42 per cent of the whole day's, or double that of the four preceding hours.

From 9 a.m the discharge increases less rapidly, it reaches its highest point at 11 a.m., at which moment it is 3501 cubic feet per minute; it continues nearly at that rate until 1 p.m., and then begins slowly to decrease. At 2 p.m. it is nearly the same as at 9 a.m., at 3 p.m. somewhat less; and it then falls off rapidly until 5 p.m. The eight hours of the greatest discharge are between 9 a.m. and 5 p.m., during which time 48·97 per cent., or nearly one-half of the whole daily discharge, takes place.

From 5 to 6 p.m. the discharge is nearly the same, it then declines slightly until 7, during that time 10·32 per cent. of the whole runs off; from 7 to 11 p.m. it falls off rapidly, and during those four hours 14·17 per cent. is discharged; from 11 p.m. to 1 a.m. but 4·44 per cent. runs off; and this completes the circle of twenty-four hours.

Selecting and arranging the hours into three distinct groups of eight hours each, it will be seen that from

1 a.m. to 9 a.m.	22·20	per cent. of the sewage is discharged
9 a.m. to 5 p.m.	48·97	" "
5 p.m. to 1 a.m.	28·83	" "
	100·00	

As to the Rate of Discharge per Acre.

The gaugings show the largest discharges from those districts which are the most closely populated, and the least from those where there is the most suburban and uncovered area. Thus, the Paul's Wharf Sewer, which runs through the heart of the City, and takes an area densely populated during twelve hours of the day, gives a discharge per acre for the twenty-four hours of 1765 cubic feet, which is the highest rate shown, and is five times that of the Fleet Sewer, which discharges but 347·8 cubic feet. It must be observed that a large portion of the Fleet area is yet field and purely suburban in character; between the Fleet and Paul's Wharf sewers, which are the extremes, the rates of discharge are various.

The mean discharge from the whole area is 0·3292 cubic feet per acre per minute, or 474·09 cubic feet per acre in the twenty-four hours.

EXPERIMENTAL CARRIAGE-WAY PAVEMENT, MOORGATE STREET. Laid in October 1848.

By William Haywood, Engineer to the Commissioners of Sewers of the City of London.

Table *showing the nature of the Pavings, with the first Costs, the Costs for Reparation and Maintenance incurred for the Eight Years ending 29th September*, 1856.

Description of Paving.					First Cost.		Reparation.						Interest and Cost of Reparation together.	
Name of Granite.	Area in Superficial Yards.	Depth of Stones.	Width or Thickness of Stone upon Surface.	Length of Stone upon Surface.	Per Square Yard, laid complete.	Total Cost.	Total Cost in 8 Years of whole Area.	Cost per Square Yard for 8 Years.	Total Cost per Annum of whole Area during 8 Years.	Cost per Square Yard per Annum during 8 Years.	Total of first Cost and Reparation for 8 Years.	Annual Interest upon first Cost at 5 per cent	Whole Area per Annum for 8 Years.	Per Yard per Annum for 8 Years.
		in.	in.	in. in.	s. d.	£ s. d.	£ s. d.	s.	£ s. d.	s.	£ s. d.	£ s. d.	£ s. d.	s.
Blue Aberdeen ..	565½	9	4	8 to 12	13 8	386 11 11	89 4 5	1·38	4 18 0½	0·173	425 16 4	19 6 7	24 4 7½	0·856
Mountsorrel	484¾	9	4	8 to 12	14 9	357 10 1	13 1 6½	0·64	1 12 8¾	0·08	370 11 7½	17 17 6	19 10 2¾	0·806
Blue Aberdeen ..	524¾	9	3	8 to 12	16 3	426 7 2	80 15 7¾	3·07	10 1 11½	0·385	507 2 9¾	21 6 4½	31 8 3¾	1·197
Mountsorrel	556¼	9	3	8 to 12	17 0	473 0 6	34 15 4	1·25	4 6 11	0·156	507 15 10	23 13 0½	27 19 11½	1·006
Blue Aberdeen ..	411½	5	3	5	10 9	221 3 7	91 16 4	4·46	11 9 6½	0·557	312 19 11	11 1 2	22 10 8½	1·095
Mountsorrel	468½	5	3	5	12 0	280 19 0	91 3 5½	3·89	11 7 11¼	0·487	372 2 5¼	14 0 11¼	25 8 10½	1·087
Aggregate area of Six Pavings ..	3011·50				Whole Cost	2145 12 3	350 16 8½		43 17 1		2496 8 11½		151 2 7¾	
					Average cost per Annum		58 9 5½	2·45		0·306	416 1 6	17 17 7		1·007

The Commissioners of Sewers having resolved that it be referred to the engineer "To report upon the different sorts of stone paving laid in Moorgate-street in 1848, and upon the comparative value of the stones for paving purposes in this city," I have accordingly carefully collated and arranged the whole of the charges which have been incurred upon this experimental pavement, as well as such other information as may aid in determining the points of reference, and beg now to submit the following report thereupon.

The circumstances which originated the laying down this pavement in Moorgate-street were as follows. In 1845 a piece of carriage-way paving, formed of very small stones, from Mountsorrel, in Leicestershire, was laid in Watling-street. This paving excited much interest; and on the 27th of June, 1848, I reported upon its condition, its probable duration, and cost, contrasting it with other pavements which had previously been in use. In my report I adverted to the difficulty of obtaining such a satisfactory test of the durabilities and cost of various descriptions of pavings as was desirable, and concluded with the following recommendation:—

"The only means of obtaining a practical test of the relative values of different kinds of pavings, is by laying certain varieties both in stone and construction in the same street, and at the same time, and in a situation where they will be as nearly as possible subject to the same amount of traffic and the usual disturbing and destructive influences. Their value would of course not be shown at once, but a few years will give ample opportunity of observing accurately their different degrees of safety, will show the precise amount of repairs upon each, and examination will then determine their losses by wear and tear; and the grand question of relative cost being thereby settled and shown, a basis of most valuable experience would exist for future guidance. This can be done without any additional outlay, whenever a street adapted for the experiment shall need repaving; such an opportunity now offers itself in Moorgate-street (which is ordered to be re-laid), and it is in my opinion a street eligible above most others for the purpose. In the first place, it is one having a fair amount of traffic, and not having any collateral streets of importance, the traffic does not diverge, but when it once enters upon it, ordinarily traverses its whole length; and you would thus obtain that which is most important to an experiment like that which I have the honour of submitting to you—an equalised amount of traffic over the whole of the varieties of paving which might be laid down."

This recommendation the Commission were pleased to agree to, and in October 1848 an experimental paving was laid down, of which the different descriptions and first cost will be seen in the above table.

The pavings had in October 1856 been down eight years, during that period they had had, I think, an average amount of disturbance by the openings of gas and water companies, and had been as nearly as possible subjected to the same amount of traffic, and the ordinary destructive agencies; the reparations were carefully made under my personal superintendence; and the table will show the expenditure incurred for them from the period they were laid down to Michaelmas 1856.

When I state my belief that each of the pavings has been subjected to about the same amount of destructive agencies, I must remark, that it is difficult to arrive at this precisely in respect of the pipe trenches; for the conditions under which pavings are taken up for the purposes of the various companies having mains beneath the streets differ materially; and not only is an opening made by them *per se* an injury, but the degree of injury that may result depends more or less upon the depth and width of the trench, the time a trench remains open, the state of weather during that time, the way in which the filling in of the earth and the blocking in of the stones is performed; and each of these conditions not only has a direct effect upon all pavings, but they vary in their degrees upon the different sorts of pavings. To this moreover may be added, that the extent of traffic in the street, and the actual condition of the paving at the time the openings are made, must also be taken into consideration when fairly estimating the damage done to them; and it will be at once seen how difficult it is either to ascertain or determine their relative effects upon different specimens laying many years upon the public ways. In the following conclusions therefore, if I have rejected what may in some cases appear to be obvious deductions from the tables, taking the figures as they stand, it is when those deductions differ largely from the results of my observations upon other pavements during the years I have had the superintendence of those within the City of London, or from that which experience has amply demonstrated to be the fact.

Making due allowance for accidental circumstances, which even when apparently trifling in their nature may considerably affect the result, three points appear to be shown by the experimental paving.

As regards Quality of Stone.

1stly. That, irrespective of size of stone, the Aberdeen granite generally required reparation earlier than the Mountsorrel.

2ndly. That the Aberdeen stone requires a larger area of repair than the Mountsorrel, that it has had more stones worn so as to be unfit for use, and consequently has required the insertion of more new stone, and has cost more per square yard per annum for repairs than the Mountsorrel.

As regards Size of Stone.

3rdly. That irrespective of the nature of the granite used, the pavings composed of the smaller stones have needed more reparation, and the insertion of a larger quantity of new stone, and have cost more for reparation, than those composed of the larger stones.

These results accord with my observations upon other pavements, but the precise relative value of the different pavements under the various columns of the table would be found to vary every year in some degree, if the costs incurred upon each were made up annually; yet, extending the observations over a series of years, and selecting a fair opportunity of contrasting them, I believe it would be found to be still more in favour of the larger stones than is now shown to be the case.

One conclusion only which is consonant with general experience can, in my opinion, as yet be safely deduced, viz., That within the limits of the sized stones which have been laid in Moorgate-street, the cost of repairs upon similar pavings will be inversely as the size of the stones.

But I must remark, that although in accordance with instructions I am now reporting upon these experimental pavements, I do not consider that in any respect such defined conclusions can be arrived at with respect to them as may be done when observations upon them have been extended over a longer time; nor, until that period has elapsed, that they will furnish sufficient information to enable me to report to you from the results which of them is the most suitable paving for general adoption. I therefore beg to be permitted to defer reporting upon that portion of the reference to me at present; but I may state that as yet I see no reason to doubt much that the description usually employed is (taking all the requisites of a paving into consideration) the most suitable of those which have been hitherto laid.

PROGRESS OF BATTERSEA PARK.

By James Pennethorne, Architect

On the 31st March, 1856, as shown by the general report of April 15, considerable progress had been made towards raising the ground and preparing for gravelling the Victoria-road, the Albert-road, and the Prince of Wales'-road, which are the three principal public roads outside the park; but at the same time nothing had been done within the area of the park, beyond bringing in earth for raising the esplanade road along the river bank, and for forming the footpaths and laying in the foundations of the carriage-way of that road. Since that date the works both outside and inside the park have progressed rapidly, especially the latter, as shown by the following statements :—

Works done outside the Park since 31st March, 1856.

The Victoria or Chelsea Bridge Road.—The filling in of earth to the height of 27 feet, for the formation of the octagon at the foot of the bridge, forming the principal entrance to the park, has been completed; the gravelling of the footways and of the carriage-way of all the road has also been completed; the fence on each side has been fixed, and for some months past the road has been fit for traffic, and has been subject to heavy cartage for the works of the bridge and of the park.

The Albert Road.—The south end of the Albert-road, for a length of 800 feet from the Lower Wandsworth-road to the park gate has been gravelled; an iron culvert, 3 feet diameter, has been laid for the public sewer, where it crossed under the road; the foundation of the road throughout has been completed; a length of about 600 feet has been capped with broken Kentish rag, and the footways have been raised and made good; but the gravelling for a length of 2300 feet, and the pipes and gratings for the drainage of about 1700 feet, remain to be done.

The Prince of Wales' Road.—The western portion of the Prince of Wales'-road, for a length of about 700 feet from the Battersea Bridge-road up to the park gate, and one footway the whole length of the road, had been formed and gravelled in March 1856; since that time the whole of the other footway has been formed and gravelled, and the carriage-way has also been completed the whole length, except about 1800 feet west of the Victoria-road.

The diagonal road from the south-west gate of the park towards Wandsworth, about 760 feet long, has been raised, formed, and gravelled complete; and the foundation of the diagonal road from the south-east gate has been in part formed.

Works done within the Park since 31st March, 1856.

The works done within the Park since March 1856 may be shortly stated as follows : viz.

1. The carriage drive round the park, which is about 2½ miles long, has been formed and completed fit for use.

2. The walks, in length together about 3 miles, comprising all those most required, and an avenue 40 feet wide from tree to tree, and nearly half a mile long (the walk being 20 feet wide), have all been raised to an uniform level of only 2 feet below Trinity datum, or to as high a level as the parade in St. James's Park, and are all gravelled and fit for use.

3. The plantations, covering together an area of about 22 acres, have all been raised as mounds, varying from 3 feet to 10 feet above the original level of the ground, and have been planted with about 45,000 choice trees and shrubs.

4. The ornamental water, which covers an area of about 19 acres, has been excavated, embanked, and filled with water; the puddle bank around it being about a mile and a quarter long, exclusive of a dam next the sewer 1600 feet long.

5. The boundary fence on the east side of the park has been fixed, with also watch-boxes to each of the five gates; and the park is now entirely enclosed, and perfectly secure from depredation or trespass.

In the report of 15th April, 1856, an opinion was expressed that the park might be completed within eighteen months from that time, "if the walks and plantations are to be formed upon the present level of the ground; but if the walks are to be formed on a higher level, and mounds are to be raised for the plantations (both of which are very desirable), it will be necessary to curtail the annual outlay, and spread the work over some years." At that time there did not appear much probability that earth, to the great extent required, could be obtained rapidly for filling in the lower ground, and raising the levels of the drives, walks, and mounds; but, expecting to obtain some earth from the river, and from the excavation for the ornamental water, and being fully sensible of the very great advantage to be derived from raising the levels, which I trusted might be accomplished within a few years, I proposed to complete within twelve months from that time, and on the raised levels, "the esplanade next the river, the drive round the park, and all the plantations between the drive and the boundary fence, with also two or three of the principal footpaths across the park."

It is therefore with the greatest pleasure that I can now report that circumstances have enabled me to complete, within the past eleven months, the drives and most of the walks and plantations upon the high level, so earnestly desired and so essential for the park. The excavations for the London Docks were continued by Messrs. Cubitt; and, taking advantage of so unlooked-for an opportunity, the earth was secured, for raising the levels rapidly, and was continued to be delivered there up to the 6th December, when apprehensions regarding the funds compelled me, with regret, to cease to receive it. Within that period, about 200,000 cubic yards of earth have been brought by the river (of which about 120,000 came from Messrs. Cubitt) and was conveyed from the river bank to the low ground and mounds by means of the railway plant, purchased in 1855 for raising the Bridge-road, assisted by a large plant which Messrs. Cubitt furnished without cost. This earth, with the addition of full 180,000 cubic yards more, excavated from the lake, from the gravel pits, and from the building ground within and around the park, together nearly 400,000, have enabled me to raise a large area, and in effect the whole area of the park, whereby the chief disadvantage of the site has been in great measure overcome.

The works have been carried out in conformity with the general principles upon which the plans of 1854 and of May 1856 were designed; but during their progress it became necessary to change the position of the water, on account chiefly of the subsoil, and the discovery of sand banks, &c. This alteration, together with the necessity for working the railways to advantage, occasioned considerable changes in the walks and plantations. The chief object of the design throughout has been to overcome the natural lowness of the site; for this purpose 19 acres of the lowest grounds have been covered with water, the top level of which will be only 3 feet below Trinity, or in many parts 3 feet above what the grass surface was before. About another 50 acres have been raised more or less, much of them 3 feet, and some mounds 8 and 10 feet above the original levels; and the plantations have been made very extensive, and treated more as ornamental gardens than as open park scenery. Thus by bringing in earth, those portions which before were the higher grounds of the site have become the lower, variety and undulation have been given to the surface; and the whole has been so divided, and the vistas have been so arranged, that when the plantations shall have grown, the comparative lowness of the site will pass unnoticed from the higher ground by the river side, and will not (as I believe) be objectionable even from the very high ground of the Chelsea Bridge-road, which has been raised near the bridge 27 feet above the original level.

Expenditure upon Works for the Formation of the Park.

The original estimate of the cost of forming the park, which I reported to the Commissioners of Woods and Works on the 22nd March, 1847, was 38,500*l.*, exclusive of the ornamental water, of the engineer's estimate of 25,000*l.* for the embankment, and of the contingent expenses; viz.—

		£
For forming public roads outside the park ...	10,000	15,000
For building such lengths of sewer as will not be built by the lessees	5,000	
For embanking the present shore, without raising the ground, or bringing out to a straight line	5,000	23,500
For drives, walks, drains, planting, levelling, boundary fences, lodges, and contingencies on the same	18,000	
		£38,500

The above estimate was increased in my report of 15th April, 1856, to about 53,267*l.* 8*s.* 7*d.*, to cover the cost of forming the Bridge-road and the park embankment up to it, the ornamental water, and the raising of the levels; the statement being as follows :—

"The expenditure upon the works up to the 31st March last, including the great embankment for the Bridge-road and the drive connected with it, has been 25,267*l.* 8*s.* 10*d.*; and the funds now applicable to works, including 25,000*l.* remaining to be voted, are, I believe, near 30,000*l.*

"The cost of the remaining works inside and outside of the park fence will depend upon what may be deemed essential, and upon the rate of carrying them forward, both of which subjects require great consideration; but the 30,000*l.* will probably be sufficient, except for the river embankment, the cost of which has been estimated by the engineer at 25,000*l.*"

The sum voted in the session of 1856 was only 21,262*l.*; but when making the above statement I had anticipated 25,000*l.*, according to the sum printed in the Votes for the year 1853-4.

The expenditure upon works for the park and for the public roads outside, from the commencement to the 28th February, 1857, has been as follows :—

		£	s.	d.
Expenditure to the 31st March, 1856, as before reported		23,267	8	10
Expenditure from the 31st March, 1856, to the 28th February, 1857—				
Cash paid for works	24,919 14	27,513	9	0
Liabilities incurred for trees, shrubs, grass, seeds, roadmaking, &c. ...	2,593 15			
		£50,780	17	10

The two preceding statements show an original estimate of 38,500*l.*, augmented in April 1856 to about 53,267*l.* 8*s.* 10*d.*, against an expenditure to the present time of 50,780*l.* 17*s.* 10*d.*; but the works, as estimated in 1847 for a park on the low level, differed so entirely from the works for the park on the higher level as contemplated in April 1856, and since executed (even much more rapidly than was then anticipated), that no just comparison can be made between these two estimates. The statements also show that against the estimate of 30,000*l.* in April last, there has been an expenditure (including liabilities incurred) of 27,513*l.* 9*s.*, the former having supposed the works to be carried on progressively, as earth could be procured from the building sites; and the latter being for the works as they have been executed rapidly, and at the cost of filling in the low grounds.

Expenditure upon the whole Undertaking.

The estimate of the expenditure upon the whole undertaking, as reported by me on the 22nd March, 1847, exclusive of interest on borrowed moneys, &c., and of the engineer's estimate of 25,000*l.* for the river embankment, was as follows : viz.—

		£	s.	d.
Purchases—				
Freeholders	143,724 18 0			
Leaseholders	43,708 17 11			
		187,433	15	11
Works		38,500	0	0
Expenses attending the undertaking		15,000	0	0
		£240,933	15	11

or a total of 265,933*l.* 15*s.* 11*d.*, with the embankment added.

The expenditure upon the whole undertaking, from the commencement to the 28th February, 1857 (including estimated liabilities to 31st March), has been as follows: viz.—

	£	s.	d.
Purchases (including 1816*l.* liabilities for Mrs. Arnold and others	231,776	19	0
Works (including 2593*l.* 15*s.* liabilities as before stated, and 600*l.* for works up to March 31) ...	51,380	17	10
Expenses (including 3900*l.* liabilities for rates, taxes, architect, and other contingencies	32,841	6	0
	£315,999	2	10

These two statements of general expenditure show, that up to the 31st instant the excess of expenditure upon the whole undertaking over the original estimate of 1847 will be (including liabilities) 75,065*l.* 6*s.* 11*d.*: viz.—

	£	s.	d.
Upon the Purchases	44,343	3	1
" Works	12,880	17	10
" Expenses	17,841	6	0
	£75,065	6	11

The causes of excess have arisen entirely from circumstances which could not be provided for in the estimate, and over which I could not have had the slightest control; they have been fully explained on several occasions, and especially in the general report of April 15th, 1856.

The excess upon the purchases alone has been 44,343*l.*, or about 25 per cent. on the estimate, and if they had been made within two years from the passing of the Act, as there was then reason to expect they would be, the estimates both for them and for the expenses would not have been exceeded. But the funds appropriated by the Act were not forthcoming; the Exchequer Bill Commissioners could only make their advances slowly, and in comparatively small sums; the whole of the properties were not acquired until eight years after the passing of the Act, during the whole of which time the lands were rising rapidly in value (as had been foretold), and businesses were established or increased which had little or no existence when the estimate was made, and the purchase of which became very expensive.

The excess upon the expenses has arisen also from the delays which occurred in making the purchases, and proceeding with the undertaking; these delays gave rise to the payment of interest on loans and purchases, which in 1847 had not been expected to arise, and was specially excluded from that estimate; for this alone there has been paid a sum of 10,775*l.* 18*s.* 1*d.* For the law expenses also, which have been very considerably increased by the same delays, 8,837*l.* 10*s.* 6*d.* has been paid. These two sums together make 19,613*l.* 8*s.* 7*d.*, for which, when the estimates were prepared, but a small provision was necessary.

The other incidental expenses for surveyors employed to value and give evidence before juries and arbitrators, for the costs of awards, for rates and taxes, &c., amount to 10,182*l.* 7*s.* 5*d.*; but this amount has, of course, been in like manner increased by the delays, but not to the same extent as the purchases, the interest, and the law expenses.

The expenses upon the works has exceeded the original estimate of March 1847 by 12,880*l.* 17*s.* 10*d.* The works then contemplated are, however, as before stated, so totally different from those executed, that no comparison can be made between the two estimates; but the total expenditure on works up to the present time (including liabilities), which has been, as before stated, 51,380*l.* 17s. 10*d.*, is below the sum of 53,267*l.* 8*s.* 10*d.*, which I stated in my report of April 1856, would probably be sufficient (except for the river embankment), depending, however, on what might be deemed essential, and upon the rate of carrying on the works; it is also to be observed, that the expenditure of the 51,380*l.* 17*s.* 10*d.* includes the payment, during at least the last six months, of gatekeepers, constables, repairs of walks and roads, and other works usually comprised under the term of maintenance.

Works remaining to be done, or which are recommended.

The works remaining to be done to complete the park, or which might be undertaken for its further improvement, are as follows, the same being exclusive of the works to be provided for by the vote for maintenance for the year 1857-58:—

Outside the Park.		£.
The completion of the Prince of Wales'-road, and the gravelling of the Albert-road and the Victoria-road, also forming and gravelling the road up to the south centre gate and the diagonal road to the south-east gate ...		2500
Inside the Park.		
Drives:		
Gravelling the loop road near the Albert Tavern		150
Walks:		
Gravelling the broad walk south of the ornamental water, the two proposed diagonal walks for the esplanade, and other unfinished connecting walks	£. 350	
Building a culvert for the public sewer under the west drive	150	
Levelling and forming ground:		
Forming slopes along the edges of the south drive and the west drive	250	
Forming ground along the south drive, the west drive, and towards the south-west gate	600	
		1350
Planting:		
Trenching and planting to the extent of twelve acres, including purchase of trees		1000
Filling up:		
Wheeling in slop, for one year		500
Raising the levels of walks, and of the low ground:		
Bringing in earth, by railway, from the building ground, to raise the surface between the Victoria-road and east drive	£. 1000	
Bringing in earth, by the river and railway, for the two diagonal walks, and for large mounds near them	2000	
Bringing in earth for a large mound near the old shooting-ground, and slope for east drive ...	1000	
		4000
Total		£9500

Respecting the several works estimated, I beg leave to offer the following remarks:

The estimate for the completion of the public roads applies to those which are, in my opinion, required for letting the building lands, or which I should recommend the Commissioners to form themselves; it supposes them completed in a proper manner with surface drainage, fit for traffic, and in a state to be surrendered to the district, but nothing is included for a second coat of gravel (the sum of 600*l.* having been provided for repairs in the estimate of the vote for maintenance), and there would not be a stone kerb to the footpaths.

When the continuation of the Battersea Bridge-road was surrendered to the district board, they called for such a kerb, but afterwards agreed to take to the road without it. There are not at present stone kerbs to the other roads in the district: the cost of them might be from 2000*l.* to 3000*l.* or more, depending on the scantling and material, and it would be an expenditure which would not benefit the Commissioners, which I believe they are not bound to undertake by the Battersea Park Act, and which under any circumstances cannot reasonably be required from them.

The works within the park for completing the drive, the walks, the forming of the ground, and the plantations, and estimated to cost 1350*l.*, are perhaps not all of them essentially necessary, or they might be done progressively out of the votes for maintenance; but I have suggested them to be done within the next twelve months, as they are required for the completion of the design, and it would be an advantage to bring the park soon into good condition.

The estimate of 1000*l.* for planting is intended to include all plantations except those few by the river side which depend upon the construction of the river wall.

The estimate of 500*l.* for wheeling in slop brought from the docks is submitted as an economical arrangement, particularly essential, and of the greatest service to the scenery of the park: the slop when dry becomes very fine earth. Probably not less than 40,000 cubic yards have already been brought, and applied to the formation of the long, gradual, and easy slopes from the esplanade road into the park; and the continuation of this process for at least another year I strongly recommend for completing the esplanade slopes, and more especially for the large central mound of the esplanade, which is calculated to produce great effect upon the scenery from every part of the park.

The last item of 4000*l.* is proposed for raising the levels of walks, for filling up the low grounds, and for forming additional mounds for plantations.

One of the lowest portions of the lands purchased was around the junction of the two main sewers, or, now, near to the south-east gate of the park. This has occasioned great difficulties; but they have been in great measure overcome by converting one large portion into ornamental water, and by filling up another with earth brought in by railway or excavated from the lake, which latter portion is now occupied by the east drive, with the avenue, and by the broad walk at the water-side. But there still remains to be raised a considerable area of low ground between the east drive and the Victoria-road. In the course of years this perhaps might be done with rubbish and earth brought from the building ground and other places; but it forms so important and conspicuous a part of the park, that, in my opinion, the proposed outlay of 1000*l.* would be fully justified, and would be repaid by the immediate effect it would produce. If, however, it be done at all, it should be done in the present year, before the bridge is opened, and while the railway works are in progress; for the means I propose to adopt are, a line of rails laid from the building ground, with waggons, &c. to bring from there the earth which the builders would eventually have to excavate for the basements of the houses.

The cost is stated to be estimated at 1000*l.*, and I believe it may be limited to that sum, but it would of course depend on the extent to which it might be deemed advisable to continue the filling up.

The cost of raising the ground along the lines of two diagonal walks yet remaining to be formed, including mounds for plantations connected with them, is set down in the estimate at 2000*l.*, depending, like the last, upon the extent to which the work may be carried. These walks are intended to lead direct from the river pier, and other central attractions, to the south-east and south-west gates of the park; they are essential to the park communications, and ought to be formed on the raised levels of the other walks. The mounds connected with them are proposed for large plantations, to curtail in each case the views over the lower land, to give variety to those portions, and to connect the plantations adjoining the river esplanade with the plantations in the interior of the park.

The raising a mound for a large plantation in the open space or low ground between the east drive and the embankment of the Victoria-road, estimated to cost 1000*l.*, is proposed entirely as an addition to the scenery, and to break the long line of embankment which forms the Victoria-road; and in my opinion it is very desirable from almost every point of view, but especially so from the very high embankment which forms the approach to the park from Chelsea Bridge.

Respecting the two last subjects I beg leave to observe, that if these works should be done this season I should expect to obtain much of the earth from Messrs. Cubitt's; but whether done this year or next, they must be done while the river bank remains in its present state, or not at all; the barges can now lay up close to the shore, on beds which have been expressly made for them; but after the river wall has been built, there will be no means of landing from them.

Hitherto the works of the park have been carried forward on the principle that according to the levels and forms now adopted for the walks and plantations, so they must remain for the future. On this principle it was that the high levels were adopted, and the walks formed upon a healthy level, with good views, and with varied and undulating scenery, instead of on the low level, which would have perpetuated all the evils of the site. By the adoption of the high level the park has become agreeable and enjoyable; and it is submitted, that as the two items last referred to would only cost 3000*l.*, the great principle on which the works have hitherto been carried forward ought not for that sum to be abandoned.

Works which are not at present required.

The works to which I have not yet alluded are the main sewers and branch roads for the lands outside the boundary fence, and the lodges and the river wall (with pier) for the park itself.

Outside the Park.—In the report of last year I stated that the public sewer or open ditch, which now traverses the whole length of the south side of the park, and cannot be filled up until the new main sewer has been constructed, is a public nuisance, and will, so long as it continues, be a great drawback and hindrance to the enjoyment of the park; the experience of the past year induces me to repeat this opinion even more strenuously. This sewer (independent of the nuisance and unsightliness) has created very great difficulties and expense, and is likely to interfere greatly with the letting of the building lands; nevertheless, I fear that no steps can be taken respecting it until the main drainage scheme for the south side of the river has been determined, and the works thereof have been commenced, or at least provided for.

According to the plans proposed by Mr. Bazalgette for the south side drainage, the large main sewer for Battersea would be carried under the whole length of the Prince of Wales'-road; this, with a branch from it up the Albert-road, to intercept the present open ditch, would provide all the drainage required for the building lands, except the small sewers for the branch roads. There is probably little doubt but that this great sewer will be built, though four or five years hence, and as the cost would be defrayed by the rates, it has not appeared to me necessary to make provision for it in these estimates. Nor have I made provision for the smaller sewers under the branch roads, because the Metropolis Local Management Act provides for all sewers to be built by the district board at their own expense, the cost to be afterwards recovered by them, wholly or in part, by an increased rate upon the properties improved. And as these smaller sewers could not be built until after the main sewer, and would not be required until the land has been let, their cost would fall upon the lessees, as was before contemplated.

When the new main sewer has been built, the present open ditch will, of course, be abandoned as a public sewer, and will require to be filled up, which would be a considerable expense; and I would take the liberty to submit to you, whether—in consideration of the sewers being a public work as well as the park, and of the advantage of both works to the parish of Battersea especially—it would not be reasonable to require the Metropolitan Board, when they build the new main sewer, to fill up the present open ditch with the earth to be excavated for the sewer, and also to form proper outlets for the surface drainage of the park and of the ornamental water.

The roads which have been formed, or the completion of which is included in the estimate herewith submitted, are all those which, in my opinion, would be necessary for the public, or for the letting of the building lands; and the more so as they will probably remain uncovered and almost unproductive for some years. I have therefore not made provision in the estimate for the cost of the branch roads; they will not be required until the lands are let for building purposes, and should then be constructed by the lessees.

Inside the Park.—The cost of building lodges at the four principal entrances of the park might be 4000*l.* or 5000*l.*, depending on the size deemed necessary; but I have not included any sum in the estimate, considering such an expenditure unnecessary for at least some years hence. Convenient iron huts, with fireplaces, have been erected at each of the gates, for the day and night watchmen and constables. The west lodge, which is now occupied by the head gatekeeper, and as offices for Mr. Farrow and Mr. Gibson, is a very convenient house, though its exterior appearance needs improvement. There are some small houses in the neighbourhood which the gatekeepers are now permitted to occupy, and the house in which Mr. Farrow, the superintendent, now lives is very suitable for his purposes. Victoria Park has remained now for above ten years without lodges (except the house occupied by the superintendent); and as they are not essential for Battersea Park, and might possibly rather detract from than add to the scenery, I submit that the cost of building them may be postponed for some years.

The river wall or embankment was proposed, I believe, more for the improvement of the river than for the advantage of the park, but I have always considered it an integral part of the park; the esplanade (a leading feature of the park) would be formed almost entirely on land recovered from the river, and the omission of this part of the design would be greatly to be regretted. The construction of this embankment was contemplated in 1853, and was provided for in the estimate upon which application was made to Parliament for votes to complete the undertaking; but the money so voted (which also, as I believe, included 50,000*l.* for the outlay of the park) have been absorbed by the greatly increased cost of the purchases, and no means now remain available for the embankment.

The cost of this embankment (estimated by Mr. Page at 25,000*l.*) has not been included in my estimates, because the work belongs to Mr. Page; and though the scenery of the park very much depends upon it, and the work must appear unfinished till it is done, it is not advisable in my opinion to make application for funds for at least two years hence; because so long as the river shore remains in its present state, the barges can lie up to land earth and slop, and it is of much more importance to continue that supply for one year, if not for two, than to build the river wall.

Another subject hereafter to be considered will be the construction of a pier, which, as connected with the embankment, belongs to Mr. Page's department. The cost of this work has not, I believe, yet been included in any estimate, and the amount will depend upon the mode in which it may be built, and the extent of river wall that may be included with it. The construction of a pier as a free access to the park would not benefit the public, but only the steamboat companies, who would charge the same passage-money whether this one pier be free or not; and therefore it should, I think, be built, and let to the companies for a rent (in the first instance) that would return a proper per-centage on the outlay, to be increased afterwards as the traffic will justify; or a frontage might be let to the companies on lease at a small rent, for them to construct the pier. I apprehend, however, you will prefer the former course.

During the next ten years many expenses must be incurred for the management and letting of the estate outside the park, of which no estimate can well be submitted; but these expenses, it is presumed, will be paid for out of the annual rent produced by the estate, which after the 25th instant will be about 3000*l.* per annum; and that amount will be augmented year by year, though the increase may not during the first years be rapid.

Returns from Building Lands, &c.

The total quantity of land applicable to building purposes is 125 acres, and I believe it is correct to state that about 21½ acres of the land (including the rights of landing attached to one pier) have been disposed of to the West London and Crystal Palace Railway Company, in perpetuity, at a rent of 2464*l.* per annum, with power to them to purchase the same within six years, at the sum of 61,600*l.* Of the land so let, a great portion is the least valuable of that which belongs to the Commissioners round the park, being very low, but part of it is good high ground; and the pier alone was estimated as worth 1000*l.* per annum.

At a general meeting of the company lately held, Sir S. M. Peto stated that "a very large plot of land near their intended station had since been purchased at more than double the price the company had paid for their land;" and though this might be explained by circumstances, it shows the company are well satisfied with the terms accorded them.

Probably no correct inferences can be deduced from the above letting, but I think it justifies me in assuming that the total rental to be eventually derived from letting the whole 1[illegible] will not be less than 10,000*l.* per annum.

It would be difficult to hazard an opinion respecting the [illegible] or letting value of the lands at the present time, and it wo[illegible] improper to make it public; they would for the next few [illegible] be valued low, and I would recommend that no attempt be [illegible] for some time to let or sell, except some wharfs, houses, an[illegible] lying portions of land.

The Chelsea Bridge will not be open for traffic till towar[illegible] end of this year; the approach to the lands from Nine Eln[illegible] be interrupted for a yet longer period by the works of t[illegible] way; the locality cannot assume an aspect very differen[illegible] that which it at present bears, nor become much know[illegible] some time after those periods; the main sewer for the d[illegible] the lands may not be built for four or five years; and [illegible] I am of opinion that it would not be advisable to e[illegible] let the lands by forcing them prematurely into the [illegible] that it would be advantageous to leave them to acquire increased value by the progressive improvement of the locality.

The River Wall and Embankment.

Estimate.

	£
The wall, built of brick, with stone coping and with concrete backing	25,000
The piling, for which only a provision can be made, say ...	6,000
The filling in, also as a provision, say	4,000
Total estimated cost	£35,000

Some parts of this wall would be built close to the present shore, but others would extend into the river nearly to low-water mark, consequently the height, thickness, and general strength of the wall will differ in the several parts; but the above estimate has been framed on the supposition that the coping would be level throughout at a height of 5 feet above Trinity datum, or 1 ft. 6 in. higher than was proposed by Mr. Page in June 1845. The estimate supposes that a length of 1210 feet would be 17 feet high, that 2200 feet would be 22 feet high, and that 400 feet would be 25 feet high.

It is proposed to disguise the appearance of a parapet by forming a seat, which would extend for about 1500 feet in front of the esplanade, and would add greatly to the appearance of that part of the park.

A sum of 6000*l.* has been set down in the estimate for piling; but the quantity that may be required will depend entirely upon the sub-soil, respecting which I am uninformed, and the sum stated may be too low.

A sum of 4000*l.* has also been set down in the estimate for filling in the ground behind the wall; the total quantity required will be about 120,000 cubic yards, which at 8*d.* would cost 4000*l.*; but the actual cost will depend upon the speed with which the work shall be carried on, and if it proceed rapidly the estimate will be exceeded.

The total length of the river wall from the termination of the abutment wall of Chelsea Bridge to the west side of the Prince Albert-road will be about 3810 feet; and the total cost, according to the above estimate of 35,000*l.*, would be, taking one part with another, an average of about 2*l.* 4*s.* per foot lineal above the estimate made by Mr. Page in 1845, arising chiefly I presume from the following causes:—1st. The increased length of 380 feet. 2nd. The increased height of 1 ft. 6 in. above Trinity datum. 3d. The increased quantity of stonework for the parapet.

As this work is in the hands of Mr. Page, I would respectfully submit the propriety of requesting his present opinion upon it, twelve years having elapsed since his estimate was made, during which period he has derived experience from the works he has already done, and has obtained information as to the foundation which may be expected for this portion of the wall, neither of which I possess.

Surface Drainage.

Surface drains have been laid down for the low clay lands, and for some walks, at a cost of about 200*l.*; the outlet into the open public ditch or sewer being about 100 yards west of the west-end of the lake. A great part of the park land is of a very absorbent nature, and the walks have all been formed high above the adjoining surface; both are therefore at all times dry, and it is not proposed to undertake any further surface-drainage.

The drainage of the low clay lands is the deepest that the present open ditch will permit; but possibly it may be deemed advisable to deepen and to extend this drainage, whenever, by the construction of the new sewer, such a work may become practicable.

Fencing Plantations.

The amount set down by me for wire and other fencing in my estimate for maintenance, dated 3d December, 1856, was 1500*l.* In the other parks the practice has been to inclose the plantations with wooden fences, to be superseded progressively by iron hurdles, and most of the plantations in Victoria Park are now fenced with wood; but, presuming you might deem it advisable to adopt immediately iron fencing for Battersea Park, I included the sum named in the estimate for maintenance, and apprehend it will cover all required within the coming year. The total quantity necessary to inclose the plantations which have been completed is 10,000 yards lineal, which, at 3*s.* a yard, would cost 1500*l.* As all the fence will require to be fixed on curved lines, and as the park will be grazed by sheep only, I believe light iron hurdles would be preferable to wire, and that they might be fixed sufficiently strong for the purpose at the price named.

The Cross Roads.

The two cross roads not formed are, the road up to the south centre gate, and the diagonal road to the south-east gate; the cost of these two roads is included in the sum of 2500*l.* set down as the estimated cost of road-making outside the park.

Enfranchisement.

The total quantity of the lands to be enfranchised will not be ascertained until the admissions have been completed; but I believe the surveyor to the lord of the manor expects it will not be less than 50 acres, and that the total cost of enfranchisement will not be less than 5000*l.*

Having now given explanations and details, and reported fully upon all subjects connected with the purchase and formation of Battersea Park, I take the liberty very respectfully to observe that the objects which the first promoters of the park had in view have now been accomplished. In 1843, when the Metropolitan Improvement Commissioners turned their attention to the subject as connected with the embankment of the river, to which their first report referred, the lands known as Battersea Fields were a low marsh, intersected in every direction by broad black streams or ditches; the river shore was occupied by old timber docks, little better than receptacles for mud; and the river was only divided from the marsh by a narrow raised causeway. The marsh had been sold some few years before in many small allotments, at 50*l.*, 60*l.*, or 70*l.* an acre, and the several proprietors were about to commence building houses of the smallest description, considerably below the level of high-water, and without any possibility of drainage. It was chiefly for the purpose of preventing so great an evil as this, and to stop the objectionable purposes for which the locality was made available, that the Improvement Commissioners advised the purchase of the lands; and though circumstances have rendered the cost much more than was at first contemplated, and though the park will not be obtained and formed at a profit without cost, yet the cost will be comparatively small, and the recommendation of the Commissioners will have been fully justified by the result. The approach to the park by land will be good; the steamers on the river will bring people easily from all the dense parts of the City and of Southwark; the esplanade by the river side will be peculiarly attractive. The scenery will be diversified, assisted as it is by Chelsea Hospital, the Suspension Bridge, the Crystal Palace, the high grounds of Clapham, Wandsworth, &c.; and in a few years, after the plantations shall have grown, and the river embankment shall have been formed, there will probably not be a park near London presenting more attractions of scenery, or more sources for the enjoyment and recreation of the public, than Battersea Park; and the locality altogether, instead of being (as would have been the case) a hot-bed of malaria, fever, and crime, will be, as I firmly believe, a suburb worthy in every respect of the west end of London.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

The twenty-seventh meeting of the British Association for the Advancement of Science will commence in Dublin, on the 26th inst., with the delivery, by the President, the Rev. H. Lloyd, of the inaugural address. The concluding meeting will be held on Wednesday, the 2nd September, at 3 p.m., when the Association will be adjourned to its next place of meeting.

The committees of sections will meet daily, from the 27th inst. to the 2nd Sept. inclusive, at 10 a.m. The sections will meet daily, from the 27th inst. to the 1st Sept. inclusive, at 11 a.m.

Communications may be presented to the following sections:—Section A, mathematics and physics; B, chemistry and mineralogy; C, geology; D, zoology and botany, including physiology; E, geography and ethnology; F, economic science and statistics; G, mechanical science.

Notices of communications intended to be read to the Association, accompanied by a statement whether the author will be present at the meeting, may be addressed to John Phillips, Esq., assistant-general secretary, Magdalen Bridge, Oxford; or to Lundy E. Foote, Esq., Rev. Professor Jellett, and Dr. Hancock, local secretaries, Dublin.

DOVER HARBOUR OF REFUGE.

QUARTERLY REPORTS OF Messrs. WALKER, BURGES, & COOPER, *to the Secretary to the Admiralty.*

July 1, 1856.—The foundations of the pier have been extended 14 feet during the past quarter. The soft nature of the bottom still retards the progress of the work. An average length of 34 feet of the pier has been raised a height of 20 feet from the level of 36 feet below low water, and 43 feet of the pier have been raised from 1 foot below to 5 feet above low water. One thousand tons of granite have been delivered, and 2500 cube yards of concrete blocks have been made upon the works. The staging has been extended 90 feet. The daily average number of men upon the works has been 154. Certificates amounting to 24,000*l.* have been granted to Messrs. Lee, the contractors, during the quarter; making the total sum certified on the first and second contracts 246,000*l.*

October 8, 1856.—The foundations of the pier have been extended 35 feet, and raised 14 feet high during the past quarter. In addition to this, the masonry for an average length of 49 feet of pier has been raised from 36 feet below low water to 3 feet above low water, and for an average length of 41 feet it has been raised from the level of low water to 27 feet above that level. The foundations are now being laid upon the same description of bottom as described in former reports, 45 feet below low water. One thousand seven hundred tons of granite and Portland stone have been delivered, and 3300 cubic yards of concrete blocks have been made upon the works. The daily average number of men employed upon the works during the quarter has been 173. A severe storm on the 21st August, and another on the 27th and 28th September, disturbed small portions of the work in progress, but did no damage to that which was completed. Certificates to the amount of 10,000*l.* have been granted to the contractors during the past quarter, making the total sum certified for the first and second contracts 256,000*l.*

January 9, 1857.—The staging for erecting the pier has been carried out 43 feet; an average length of 35 feet of the pier previously founded has been raised to within 25 feet of low water, and a length of 49 feet has been raised from 3 feet above low water to the underside of the coping of the harbour wall. Six hundred and forty tons of granite and Portland stone have been delivered on the works, and 2600 cubic yards of concrete blocks have been made. Several storms have occurred during the quarter; that from the 6th to the 13th December was the most severe, but with the exception of washing off ten stones from the unfinished portion of the pier, no damage was done to either the temporary or permanent works. Average number of men employed upon the works, 160. Certificates amounting to 8500*l.* have been granted to the contractors, making the total amount certified for the first and second contracts 264,500*l.* We have to report the loss of two lives by accident.

April 8, 1857.—The staging for erecting the pier has been extended 47 feet. The advance made with the foundations of the pier has been 46 lineal feet. The masonry of this length has been raised on the average a height of 14 feet from the foundation, and a further length of 37 feet of the upper work has been raised from 23 feet below low-water spring tides to 7 ft. 6 in. below the same level. The walls are now placed at 46 feet below low-water spring tides, upon a foundation of broken flints and sand. This, though not so satisfactory as the solid chalk, has shown no symptom of insufficiency. Eight hundred and forty tons of granite have been delivered on the works, and 3140 cube yards of concrete blocks have been made. Average number of men employed upon the works, 152. Certificates amounting to 8500*l.* have been granted to the contractors, making the total sum certified for the first and second contracts 273,000*l.*

HARWICH HARBOUR OF REFUGE.

QUARTERLY REPORTS OF Messrs. WALKER, BURGES, & COOPER, *to the Secretary to the Admiralty.*

July 1, 1856.—The continuance of rough weather delayed the commencement of the dredging at the Outer Shoal until the 27th May. The dredging of the Guard Shoal has, with the exception of a few small patches, been completed to the extent ordered. The quantity of material raised from the Outer and Guard shoals during the quarter has been 15,000 cubic yards. Daily average number of men employed, 28. The total amount certified since the commencement of the works is 8500*l.* There has been no extension of Landguard Point above the level of low water since last report.

October 8, 1856.—With the exception of some small lumps, the removal of which has been delayed by boisterous weather, the dredging of the Outer Shoal has been completed to the extent ordered. The quantity of material raised from the Outer and Guard shoals during the past quarter has been 12,000 cube yards. Daily average number of men employed, 29. No certificates have been granted to Messrs. Lee, the contractors, since last report. There has been no extension of Landguard Point above the level of low water since last report.

January 9, 1857.—The whole of the dredging ordered has been completed. Total quantity raised from the Outer Shoal during the past quarter 3000 cube yards. The contractors have received a final payment on account of their contract for the removal of the Outer and Guard shoals; the total amount being 9738*l.* 4*s.* 6*d.*, which, with the amount of their first contract, makes a total of 71,627*l.* 18*s.* 11*d.* paid to them for dredging. There has been no extension of Languard Point, either above or below low water, since last report. On comparing its present state with what it was in 1845, when our first survey was made, there has been a total extension of 560 feet, or on the average 50 feet per annum. As the length of the point has increased, its width has diminished, and it is now 70 feet less in width than in 1845.

No further Report on this harbour has been made.

ALDERNEY HARBOUR OF REFUGE.

QUARTERLY REPORTS OF Messrs. WALKER, BURGES, & COOPER, *to the Secretary to the Admiralty.*

July 1, 1856.—A commencement was made with the foundation of the walls of the western breakwater on the 22nd April, since which time 110 lineal yards of staging have been erected, beyond the end of last season's work. The sea-wall has been founded 97 yards in length; of this, 77 yards are raised 4 feet above high water, and 20 yards to the level of low water of spring tides. The foundation of the harbour wall has been extended 96 yards during the past quarter; of this, 75 yards have been raised to the level of the coping, and the remainder to the level of low-water spring tides. The hearting between the sea and harbour walls has been extended along with the walls, and for 75 yards in length is raised 4 feet above high water. In addition to the stone used in the works above described, 85,000 tons have been deposited in the base of the breakwater during the past quarter. The daily average number of workmen employed has been 1039 during the quarter, and 52 horses. The amount of certificates granted to Messrs. Jackson and Bean, contractors, has been 27,000*l.*, making a total of 398,554*l.* since the commencement of the works.

October 8, 1856.—The foundation of the walls of the western breakwater has been extended 49 yards eastwards during the past quarter; their extreme outer ends are now 947 yards from the shore. The total length of the sea and harbour walls founded this season has been 146 yards; of this, 72 yards of the sea wall have been brought up to the level of 18 feet above high water, and the remaining 74 yards to the level of 4 feet above high water. The harbour wall for the whole length has been raised 4 feet above high water, and is ready for the coping. The hearting between the sea and harbour walls, for the same length as the walls, is ready for the pitching. The promenade wall has been carried forward for a length of 70 yards, and is raised to a level of 10 feet above the plinth. The base of the breakwater under low water has been extended seawards. A sufficient quantity of stone is deposited for the foundation of the walls, for a length of 90 yards in advance of the masonry. The total quantity of stone delivered on the works during the quarter has been about 120,000 tons. The average number of men employed has been 996, and of horses 60. The amount of certificates granted to the contractors during the quarter has been 28,500*l.*, making a total of 427,054*l.* since the commencement of the works. Two workmen have lost their lives during the quarter by accident.

January 9, 1857.—The sea and harbour walls of the western breakwater have not been extended further eastward since last report; their outer ends are 947 yards from the shore; 117 yards of sea wall have been raised to the level of 20 feet above high water during the past quarter, and the remaining 29 yards to the level of 16 feet above high water; 911 yards of sea wall and 941 yards of harbour wall are complete, except the coping. The promenade wall is ready for the coping for a length of 883 yards from the shore. The base of the western breakwater has been extended seawards, and a portion of the stone has been laid down below the level of low water for a distance of 150 yards eastward of the extreme end of the walls. The total quantity of stone deposited in the western breakwater during the quarter has been 72,000 tons. The railway from the Mannez quarries to the east breakwater, and the junction railway from the present railway to the same point are in progress. A considerable supply of concrete blocks and dressed stone has been prepared for the next season's work. The weather has been stormy during the quarter; on the 15th October the sea carried away the contractor's staging, and displaced a small portion of the masonry. The daily average number of men employed during the quarter has been 748, and 49 horses. The amount of certificates granted to Messrs. Jackson and Bean during the quarter has been 16,000*l.*, making a total of 443,054*l.* since the commencement of the works.

April 8, 1857.—The distance of the sea and harbour walls from the shore remains as stated in our last report, viz. 947 yards, the length ready for the coping being 911 yards of sea wall, and 941 yards of harbour wall. The promenade wall is ready for the coping for a length of 883 yards from the shore. The total quanquantity of stone deposited in the base and foreshores below low water, during the last quarter, has been 99,000 tons. A large quantity of stone has been dressed at the quarries, and a number of concrete blocks have been made for this season's work. The railway from the Mannez quarries to the east breakwater, and the junction railway from the present railway to the same point, are in progress. The rails and chairs have been delivered at the works. The daily average number of workmen employed during the quarter has been 818, and of horses 48. In the month of January there were several gales, accompanied by heavy seas, which caused damage at the outer end of the work, and to the sea wall at 500 yards from the shore. The amount of certificates granted to the contractors during the quarter has been 14,500*l.*, making 457,554*l.* since the commencement of the works.

JERSEY HARBOUR OF REFUGE.

QUARTERLY REPORTS OF Messrs. WALKER, BURGES, & COOPER, *to the Secretary to the Admiralty.*

July 1, 1856.—The foundation for the lighthouse at the head of the Verclut Breakwater is completed. The castings are being made by Mr. Wilkins. Messrs. Jackson and Bean, contractors, have received a certificate for 2520*l.* 18*s.* 2*d.* during the past quarter, being the balance of their account, and making a total of 197,020*l.* 18*s.* 2*d.* since the commencement of the works.

Note.—The works at Jersey have been suspended by order of the Board of Admiralty.

PORTLAND HARBOUR OF REFUGE.

QUARTERLY REPORTS OF Messrs. J. M. RENDEL and J. COODE, *to the Secretary to the Admiralty.*

June 30, 1856.—During the quarter now ended, 113,756 tons of stone have been deposited in the breakwater, and a length of 150 feet of timber staging has been constructed. A contract has been entered into for the construction of a coaling and watering establishment, in connection with the inner breakwater, and for the construction of so much of its superstructure as is necessary for such establishment, which will be suitable at all times for the largest ships of Her Majesty's Navy. These works are now being proceeded with, upwards of 200 feet lineal of the foundations of the superstructure of the inner breakwater having been put in, and the foundations of the jetty commenced. The average number of workmen employed has been 354; convicts in quarries, 893; horses, 30. Amount expended during the quarter, 17,731*l.*

September 30, 1856.—In the quarter now ended there have been deposited in the breakwater 123,000 tons of stone, the length of stage constructed in the same period being 180 feet. Upwards of 730 lineal feet of the foundation courses of masonry for the superstructure of the inner breakwater have now been put in, and of this masonry 550 feet in length have been raised above the level of high water of spring tides. The excavations for the foundations to the coaling and watering jetty are in a forward state, so that the first courses of masonry for this part of the work will be commenced forthwith. Average number of workmen employed, 423; convicts in quarries, 927; horses, 30. The amount expended during quarter, 21,942*l.*

QUARTERLY REPORTS OF Mr. J. COODE, Engineer-in-Chief.

December 31, 1856.—The quantity of rough stone deposited in the breakwater during the past quarter amounts to 111,032 tons, making the total since the commencement 2,545,837 tons. The length of stage from the shore is now 4940 feet, and the depth of water at the outer end 9¼ fathoms. Of the superstructure of the inner breakwater, 760 lineal feet have now been raised to the level of 8 ft. 6 in. above high-water of spring tides. The bottom or foundation course has been laid for nearly one-half the length of the coaling and watering jetty; the setting of three other courses has been commenced, and the divers are still employed thereon, but the season of the year is now such as to render it more than probable that the diving operations will very shortly have to be suspended for about three months; the preparation of the stone for this jetty will, however, be proceeded with in the meantime, so that this part of the work may be resumed and carried on with expedition as soon as the fine weather may admit. Average number of workmen employed, 391; convicts in quarries, 949; horses, 32. Amount expended during the quarter, 18,702*l.*

March 31, 1857.—The breakwater has been advanced 205 feet, the total length executed during the past year being 745 feet. The total length of the breakwater now affording shelter to the harbour is 5145 feet, the outer end being in 9¼ fathoms at low-water of spring tides. The quantity of rough stone deposited during the quarter has been 122,070 tons, and for the year 469,907 tons; making the total quantity deposited from the commencement up to this time, 2,667,907 tons. Owing to the unusual mildness of the weather during the last three months, and the amount of shelter afforded by the outer portion of the works, the divers have been enabled to continue their operations in setting the courses of the coaling jetty under low water with but little interruption, and the two footing courses and three courses above the footings have now been set. The masonry for the superstructure of the inner breakwater will be resumed forthwith. The average number of workmen employed was 396; of convicts in quarries, 923. The amount expended during the past quarter was 21,982*l.*

ON ASCENDING ATMOSPHERIC CURRENTS IN TROPICAL REGIONS.

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

THE fact, that the barometer stands lower over the Atlantic and the Pacific Oceans near to the equator than in parts about the latitudes of 30° north and south, is generally acknowledged by meteorologists, and therefore may be admitted to be established.* It is accounted for by most writers on the subject in the same way. They say, that in accordance with the Hadleian theory of winds, atmospheric currents flow from the polar regions towards the equator, where the air becomes warmer, rises and flows over in the higher regions north and south, to return towards the poles; but the mass near the equator, being warmed, it is said to be made lighter, as shown by the average lowness of the barometer. The rising of the air is therefore required to be viewed as a necessary part of the Hadleian theory of winds, that theory resting upon it as a known and admitted truth, which serves as a foundation. Sir J. C. Ross says in Vol. I., p. 12 of his 'Voyage to the Antarctic Ocean,' that he "commenced hourly observations for the purpose of marking the progress of barometric *depression* in approaching, and *re-ascension* in receding from, the equator, a phenomenon represented as being of the greatest and most universal influence, as it is, in fact, no other than a direct measure of the moving force, by which the great currents of the trade winds are produced; so that the measure of its amount and the laws of its geographical distribution lie at the root of the theory of the trade winds."

I have formerly pointed out that no ascertained facts have been brought forward as proofs of the correctness of this theory of ascent of air. Indeed, the atmospheric phenomena which are

* See "On the Atmospheric Changes that produce Rain and Wind." London: Weale, Holborn. p. 289.

observable over the two oceans that have been named, give no countenance to it. In no part of the equatorial region over these oceans can such rising of the atmosphere be traced as is assumed in order to furnish a support for this theory.* It is true, there is an area, of comparative calm on the north side of the equator between the south-east and the north-east trade winds which blow over both these oceans, and more particularly over the Atlantic; and these areas of calm have meteorological peculiarities, being remarkably hazy and misty. The air in these parts is generally moist and stagnant, or there are fluctuationg light breezes, and occasionally tornadoes; but no such regular ascent of heated air near the equator can be traced, as has been gratuitously assumed to take place. Even the direct influence of the sun in heating the equator at any one time is known to be less than it is in other parts at a certain distance on each side of it, because that luminary passes directly over the equator twice in the year at equally distant intervals of time, whilst it crosses other parts of the tropics the same number of times within short periods, and therefore heats them, at those times, to a higher degree. If, therefore, the direct heating power of the sun caused air to ascend, the ascent should be within the belts that are the most heated, and at the times when the sun exerted the greatest heating power upon each of them in each tropic. But supposing for the present, for the sake of simplicity, that the equator is the part most heated by the sun, have we reason to infer that atmospheric pressures between the equatorial and polar regions would be thereby made such as they are actually found to be by the heights of the barometer?

The difference in the direct heating power of the sun over the equator, and over other parts immediately adjoining, is very small, but that difference may for the present be admitted to be a certain quantity, and to become greater in proportion to increase of distance from the equator. And when the air at the equatorial belt became a little more warmed than the adjoining masses of air, it would expand, be forced to rise, and to overflow to the north or the south. But as it overflowed, heavier air from each side would begin to press in below to restore an equilibrium of pressure; and it would be only to the extent that the warmed air overflowed beyond the influx of cooler air below that the whole column would be rendered lighter. For the first effect of heating the air near the surface to produce the overflow, must be a heaping of it up in the higher regions; and it would be only when that heaping had been sufficiently great to cause a considerable overflow to other parts that the total pressure of the equatorial column would be diminished. But when that diminution had taken place to an extent sufficient to admit air to flow in below from north and south, we should begin to have streams of air flowing inward on the surface from the polar regions, and outward above from the equator; and the diminution of atmospheric pressure in the equatorial belt would be to the extent that the latter preserved its superiority over the former, and this difference of pressure would be shown by the reduced height of the barometer. It would, however, be necessary that the overflow should be so great as to admit the cooler air from north and south to press and flow towards the equator, and therefore to leave the barometer standing proportionately higher at the poles than at the equator. At the poles the pressure must be as much greater than at the parts about the equator as to give motion to the mass of air that was moving on the surface between the equatorial and the polar regions, notwithstanding the friction and other obstructions it has to encounter. What this difference must necessarily amount to is not easy to determine in a satisfactory way, but it is evident it must be very great as compared with the amount of difference known to exist. The barometer stands at a certain height at the equator—say it is, according to Kaemtz, 758 millimetres for the whole atmospheric pressure, and that up to 40° of latitude it rises to 762 or 764, say 763; but at Iceland in 64° of north latitude it stands at only 752 millimetres, and at Cape Horn in 54° of south latitude it is no higher than about 742 millimetres. Capt. Ross found the pressure to be—

	inches.
At the equator	29·974
In 13° of south latitude	30·016
22° 17′ ditto	30·085
34° 48′ ditto	30·023

The last two of these registrations were however made in the dry parts of the south-east trade wind of the Atlantic. But in latitude 66° south he found the barometric pressure in January a mean of only 29·196 inches, and in February, 28·8507 inches; the former being ·778 *less* than equatorial pressure, and the latter 1·123 inch less. How, then, can it be supposed that *superior* atmospheric pressure of cool air near the polar regions can force the air over the surface of the globe from those regions of really inferior pressure, into the belt of warmer and lighter air at the equator? What prevents friction from stopping the flow of the cooler air until the difference between equatorial and polar atmospheric pressures is rendered greater than it is at present?

But is there, *in fact*, such an ascending current along an equatorial belt of calms as that assumed to exist in the Hadleian hypothesis? No such current is ever described as having been observed. It has been supposed to exist but apparently, because it was necessary to the building up of a theory; and certain facts have been alleged to justify the supposition. North-east and south-east winds blow over large extents of both the Atlantic and Pacific Oceans, and these winds have been said to meet about the equator, and ascend there to the higher regions, as already stated. But these winds, instead of ascending near the equator, as asserted, pass forward westward over the oceans to certain countries, where they are known to produce important results. In the wide Indian Ocean near to the equator there is no belt of calms, and therefore no air can be there presumed to ascend in one; but the monsoons of the Indian Ocean, like the trade winds of the Atlantic and Pacific, blow towards certain areas *over land*, similar in their character to those where the Atlantic and Pacific trade winds terminate; and in such areas *over land* all the winds —the trades and the monsoons—are found to terminate, instead of ascending in an equatorial belt over the ocean.

If we search for a tropical belt of heated air, we find indications of its existence, such as it is, only in a small part of the equatorial circle. On the western side of the Atlantic a certain kind of belt exists mostly north of the equator, which is the nearest in character to that described generally as the belt of calms and of ascending air. But in the central and more eastern part of this ocean the belt enlarges until it expands into a tolerably wide region of calm, having the name also of the Rainy Sea, in which hurricanes and tornadoes occasionally occur. The upper region in this locality is generally misty, and the air below is often still, making it then a true region of calm. But in time the atmosphere in the part, by evaporation, becomes saturated with vapour, some of which is freely condensed, and a storm is produced, and winds blow in all directions towards the locality where the principal condensation of vapour takes place. It is probable that the whole of the atmosphere in these generally calm regions is warmed above their natural temperatures by condensation of the vapour that produces the mist up to a considerable height—this warming more or less affecting the weight and pressure of the air; and it may account for the low average level of the barometer that is found in those parts about the equator. But as in these regions where the surface is so much heated by the sun, and evaporation is therefore so energetic, condensation takes place with considerable constancy, and the more important of its processes appear to occur at a considerable height in the atmosphere; it lowers the barometer less during storms than it would if the same amount of condensation occurred in cooler latitudes or at lower levels.

We have seen that north-east and south-east winds blow over the wide expanses of the Atlantic and Pacific Oceans, and these winds are known to pass on to certain parts over elevated land, where—and not over the equator—they must be presumed to ascend; and the air comes almost entirely from the north and the south, because to the east mountains intervene and cut off a supply of air from that quarter. But other elevated land may also be instrumental in producing such a vacuum in the atmosphere as to cause air to flow to it also from the *west*, *north-west*, or *south-west*, instead of coming from opposite quarters. I have elsewhere shown that a cause evidently exists in the unknown parts of Central Africa, which determines winds to blow from the Gulf of Guinea and the neighbouring sea to the interior of the continent of Africa* from north-west, west, and south-west; and these winds are presumed to be produced by lofty mountains in the interior parts of the continent. These westerly winds assist in determining the form of the Rainy Sea, or region of calm of which we have spoken. The line from which the western wind starts forms one side of the region of calm; the two other sides to form an irregular triangle, being constituted of the south-east and north-east winds already named. But the existence of the

* See "On Atmospheric Changes," &c. p. 20.

* See "On Atmospheric Changes," &c. p. 379.

westerly wind blowing from the whole of the Gulf of Guinea is formidable evidence against the notion of there being constant north-easterly winds approaching the equator, and ascending there, as assumed in the Hadleian theory; the westerly winds in these parts being in direct contradiction to that theory.

On the eastern side of the Pacific Ocean also, near the Bay of Panama, a region is found which furnishes evidence not less strong against that theory. From about 8° of north to 5° of south latitudes in America a range of elevated land exists, which appears to produce similar atmospheric phenomena to those which have been found in the Gulf of Guinea. Towards these lands winds blow from the west and north-west, and of course from the Pacific equatorial ocean across the Bay of Panama, and the whole of that part which is situated between the Galapagos Islands and the coast of Mexico, extending to California. This large area has also frequent calms, heavy rains, and tornadoes, like the Rainy Sea of the Atlantic Ocean. The trade winds of the Pacific, like those of the Atlantic, blow, not towards the equator, but over the wide expanse of ocean towards the Australasian and East Indian Islands; because there is generally a comparative vacuum in the atmosphere produced by condensing vapour over the elevated lands of these islands. But the mountains of equatorial America will not permit air to pass from the east to furnish these winds, and it therefore comes in laterally from both the north and the south, and constitutes the north-east and south-east trade winds that blow over large extents of the eastern portion of this great ocean. The supply of air thus flows from the north-east and the south-east, and passes obliquely by the least obstructed—that is by the easiest—route to the vacuum in the west, and it leaves more or less of an intervening central line or belt in the middle and western part of the ocean little disturbed.

The winds in the open Pacific having north and south in them as well as east, is therefore a consequence of a direct supply of air from the east being cut off by elevated land; those from the north and south approaching each other and becoming more parallel as they proceed to the place of their termination. On the southern side of the equator a supply of air comes apparently from the south near to the American coast, and in due time it approaches the equator, and appears, as it proceeds, to occupy nearly the whole of the southern tropic, and even part of the northern. The air which flows from the north does not come from a part so far east, because, as already stated, there are counteracting influences in operation from the Bay of Panama up to California, which influences there produce atmospheric disturbances and currents in the opposite direction. But from about 120° of west longitude the north-east trade wind may be found at a certain distance from the equator, soon, however, becoming more eastern as it proceeds towards the Philippine and other islands, the places of its termination. On the south side of the equator, the tendency of the wind as it proceeds is to become less south and more east, but the general current is more broken in upon and disturbed by islands than on the north side; it, however, extends to the northern tropic. The distance between these two trade winds is the greatest in the eartern part of the ocean, and it diminishes as they proceed westward, until at last there does not appear to be much space between them. But in the whole of this belt of calm, as it is called—though the term wedge or triangle would be more appropriate, particularly in the eastern portion—in no part can an ascending current of air be traced as a result of south and north winds pressing against each other, and ascending to the upper regions, as is often plainly said and generally implied by writers on the subject. The statement, therefore, that such a belt of ascending air exists in this ocean, may be taken as a necessity which has been imposed on those who have adopted the Hadleian theory of winds; and the obscurity of the subject has permitted the assertion to be repeated, until, by the mere force of repetition, it is received as an established fact.

The north-east and south-east trade winds of the Atlantic, it has been shown, blown towards the mountains of South America, being at first supplied by air from the Atlantic Ocean; but Africa intervening, it comes afterwards from near Madeira on the north, and from near the Cape of Good Hope on the south, by oblique winds. The area towards which these winds are proceding is in tropical America, and as the supply from each side comes from, say 30° of latitude, and from the eastern part of the ocean, and is proceeding to a part that is far west, they converge more or less towards each other as they proceed westward, leaving a space between them. No heated air, however, appears to ascend in this space, allowing other air from the north and south to flow towards it as described in the theory that has been named. But in due time evaporation from the stagnant and heated part of the ocean fills the atmosphere with vapour, some of which is at last condensed, and a local ascending current is produced. This region of calm is then changed into one of tornado and hurricane —rain descends in torrents worthy of the Rainy Sea, thunder and lightning seem to rend the sky, and the wind blows *from every quarter towards the tornado* with a fury that nothing appears able to resist; even the dry Harmattan wind from the great African desert then rushes into the vortex that has been created. Yet these formidable disturbances appear to be local, or at least unconnected with the trade wind; seeming in each instance to commence spontaneously in their own locality, and drawing air from every part around them, and after going through their own course of action in a moderate number of days they cease, and the part becomes again a region of calm, until evaporation makes it once more a Rainy Sea. The whole of the belt of calm that extends across the Atlantic to the coast of America partakes to a certain extent of the character of the Rainy Sea, and has its rain and local storms in proportion to its breadth.

We thus see good reason to believe that the north-east and south-east winds of the Atlantic and Pacific Oceans do not ascend in an equatorial belt over the oceans, as is assumed in the Hadleian theory, but proceed forward nearly parallel with each other to their places of termination overland; the winds of the Atlantic going to America; the southern passing over Brazil, up the valleys of the Amazon and Orinoco, and along the shores of the Caribbean Sea into the Gulf of Mexico, the principal place of its termination appearing to be against the elevated cordillera of the Andes, extending from 12° north to 20° south. The northern wind from Madeira proceeds westward, and appears to join the southern near the coast of Guiana, extending in its breadth northward over the West Indian Islands, passing over the Caribbean Sea to the Northern Andes, and by the Gulf of Mexico up the valley of the Mississippi. Decided winds are found over the ocean along these tracts, and although disturbed when approaching land, they may be traced over the parts named. Up the broad valley of the Amazon an east wind is said to be always blowing, and it even increases in strength as it approaches the mountains which form its terminus. The same eastern aerial current is found in ascending the Orinoco; and a moderate wind is stated to blow up the Mississippi during ten months of the year. Here then we see where the trade winds of the Atlantic really go; and some of the effects they produce may be traced along the eastern side of the cordillera of the Andes, from 20° south latitude to 40° north, the whole line of which is supplied by these winds with the vapour that produces the great rains of these parts. The winds of the Pacific pass to Australasia and the East Indian Archipelago, extending in the southern hemisphere to the Feejee Islands, and in the Northern to the Philippine Islands; and the overflow of air may be from these areas of condensation of vapour, and not from the equatorial belt.

Not only may the winds be traced through their western course, but the waters of the ocean also which they put into motion may be followed. The wind of the Southern Atlantic sends an oceanic current against the Brazilian coast, which, split by Cape St. Roque, goes in part southward, even to the Straits of Magellan; whilst another portion enters the Caribbean Sea, and, joined by the ocean stream of the northern winds, the two oceanic currents pass through the Caribbean Sea to the Gulf of Mexico, the waters of which they raise above the oceanic level so much as to produce by statical pressure the great Florida current that flows into the Northern Atlantic. In like manner, the two trade winds of the Pacific Ocean send the waters of that ocean westward (after the average rate, it is said, of two miles in the twenty-fours) over the tropics. And among the various islands, extending to the Feejee on the south and to the Philippines on the north, these immense currents show themselves in the various channels between the islands, going southward almost to New Caledonia and Australia, and northward towards Japan, to feed other currents set in motion by other winds. The machinery of the prime moving power which produces all this transfer of air and water is to be found over certain lands where condensation of vapour creates a partial vacuum in the atmosphere, that gives birth to the movements first of air, and then of water. And the greatest force operates from east to west, where elevated land exists, and not from north and south towards the line of the equator, as has been asserted without sufficient authority.

But it may possibly be asked, why should this great force move large quantities of fluid matter so decidedly from east to west, and not in other directions? And to this question the present state of our knowledge does not furnish the means of giving what all persons may consider a satisfactory reply. It may however be the fact, that the American and the Indian mountains are better situated geographically than any others for receiving and condensing the vapour which the sun is constantly raising from the surfaces of the tropical Atlantic and Pacific Oceans. This it is presumed must be substantially true, though it may not be possible to adduce evidence beyond the circumstance that a great portion of the vapour that passes from these oceans is condensed among those mountains. It is not, however, all condensed there, as we have seen that some of it is converted into rain in the Atlantic Rainy Sea, and in the belt of calms, certain disturbances being thereby produced in these parts. But some Atlantic vapour also goes to Central Africa, in the winds that blow from the Gulf of Guinea; and here again an oceanic current is created by and follows these winds, running from west to east with great velocity. Thus on the north side of the equator in the Atlantic Ocean, whilst we find both an atmospheric and an oceanic current passing westward to the Caribbean Sea, two other similar currents are running eastward into the Gulf of Guinea, but all moving towards elevated land. Now the two atmospheric currents thus moving with the oceanic may be considered quite sufficient to prevent air flowing from north and south to an equatorial belt, to ascend there into the higher regions.

It is singular that we should find a state of things so similar in the eastern part of the Pacific Ocean, in the northern hemisphere, to that which has been traced in the eastern part of the Atlantic. But a north-west wind does in fact blow from California, over the ocean off Mexico, and into the gulf of Panama, apparently produced by a condensation of vapour among the elevated lands of Central America and of New Granada. And thus we see that while a north-east wind is blowing in the open Pacific northward of the equator, a north-west wind prevails from California to the gulf of Panama, the two winds at the same time taking the air in opposite directions, that is, westward and eastward, instead of allowing it to go to the imaginary equatorial belt, where it has been said to ascend.

But this is not all the singularity that is found in this part of the world, or rather, it does not exhibit all the facts which here militate against the Hadleian theory, that air ascends to the upper regions from an equatorial belt. The so-called Pacific region of calm extends far westward from the bay of Panama as another similar region does in the Rainy Sea off Africa; but in the Pacific, in the southern hemisphere, winds sometimes blow from the west towards the mountains of America, passing as a regular monsoon in the summer of that hemisphere from the Society Islands, across the ocean to equatorial America, instead of going as a south-east wind to the equator. Mr. A. G. Findley has also found, from the records of navigators, that a belt of the ocean near to, but on the north side of the equator, extends across nearly its whole breadth, from the islands in the west to the bay of Panama, in which belt a wind blows *from* the west. We thus see that a west wind blows across this wide ocean just where it has been said that north-east and south-east winds meet and ascend to the higher regions of the atmosphere. Now if it be true that a westerly wind near to and on the northerly side of the equator generally blows across the whole Pacific, north and south winds cannot meet and ascend there. Both the statements cannot be true.

The state of things in the Pacific Ocean presented to our view by the discovery of this prevalent equatorial west wind, is curious. It appears as if the various elevated lands in the western and southern part of that ocean condensed sufficient vapour to produce a flow of air from the east and south to Australasia, constituting the south-east wind of the Pacific; and that the elevated lands to the north of the equator up to the Philippine Islands, brought winds in the same way from the northern Pacific; the two parallel winds almost touching each other near the termini. But, at the same time, it would seem that very copious condensation of vapour against the lofty ridge of the Andes of New Granada, created such an atmospheric vacuum as caused air to flow towardsit, not only from the neighbouring gulf of Panama, but in addition from parts beyond it, near the north side of the equator, stretching across the whole ocean. This west wind would thus appear to show not only that north and south winds in the Pacific do not ascend in an equatorial belt of calm, but that the whole Hadleian theory of north and south easterly winds meeting in open oceans near the equator is utterly destitute of foundation, and contrary to known facts. Here we have, in the very part where these winds should join and ascend to upper regions, an extensive and continuous west wind! And what can at the same time cause an east wind to blow in each tropical region, while a west wind is blowing near the equator between them? Two winds blowing one way, and a third between blowing the opposite way! It appears that it can only be a vacuum at the termination of each wind—the elevated land,—the forms of the elevations, the extent of vacuum created, and the ocean paths for the air to flow in, determining the direction in which the supply of air comes in each case, and the distance from which it is drawn.

The mountains of New Granada may possibly, by the vacua which they create, be able to draw air from the whole equatorial extent of the Pacific, whilst those of Australasia and the East Indian Archipelago may produce vacua into which air passes on the one side from the southern, and on the other from the northern tropical regions of that ocean.

It may possibly be said, that in the Atlantic and Pacific tropical oceans, winds blow both from east and the west, but to a much larger extent from the former than the latter, seeing that the south-east and north-east trade winds are of very superior magnitude to the western winds that blow towards the gulfs of Guinea and Panama; and as it is admitted that no palpable cause can be pointed out to account for the superiority of eastern winds, this circumstance may by some persons be held to give countenance to the Hadleian theory. But supposing, as we have seen reason to believe, that condensation of vapour is really the prime mover of the atmosphere and the originator of winds, it is not likely that that condensation would be precisely equal on both the west and the east sides of the two oceans; but it might be much greater on the one side or on the other. Yet as eastern winds predominate in both the oceans, some persons may still imagine that this indicates the existence of the cause recognised in the Hadleian theory. In opposition to this surmise, however, we have the well-known fact, that in the wide Indian Ocean western winds greatly preponderate, as none but such are found north of the 15th degree of southern latitude. And this preponderance of western winds in the Indian Ocean may be admitted to restore the balance of probabilities between the chances of winds from the two opposite quarters in the tropical regions of the three oceans. But the strongest argument against the truth of the Hadleian theory is its absolute incompatibility with these western winds! If that theory was true, the western winds could not exist: their existence consequently proves its falsehood; and, in the present state of our knowledge, obliges us to have recource to the condensation theory to account for the phenomena that are constantly occurring.

In treating on our present subject, it is necessary in the first instance to fix upon the main general features of each case, and not to suffer the attention to be too much directed to partial or temporary disturbances. Both air and water, when impelled in certain directions by adequate forces, are liable to be interfered with by disturbing causes, acting in various kinds of ways. But if we are to obtain a tolerably clear perception of the principal phenomena that are in operation, we must distinguish between them and the occasional interferences of disturbing causes. In this way alone does it appear practicable to deal with such a subject with clearness and brevity; and it appears to be highly desirable, if not absolutely necessary, that the primary motive power that is in operation should be distinctly recognised, in order that the successive phenomena may be connected with it as effects resulting from an adequate cause.

Mr. John Steell, of Edinburgh, is employed in the sculpture of a statue of Allan Ramsay, in freestone, to be erected on the new terrace at Ramsay-gardens, Edinburgh. The block is 11 feet long by 4 feet square, weighing between 15 and 16 tons. The figure will be 10 feet high, and the pedestal 18 feet.—The statue of O'Connell, by Hogan, has arrived at Limerick, and has been placed on its pedestal at the Crescent, where it will be boarded up and enclosed pending the day of inauguration.

VENTILATING FAN.

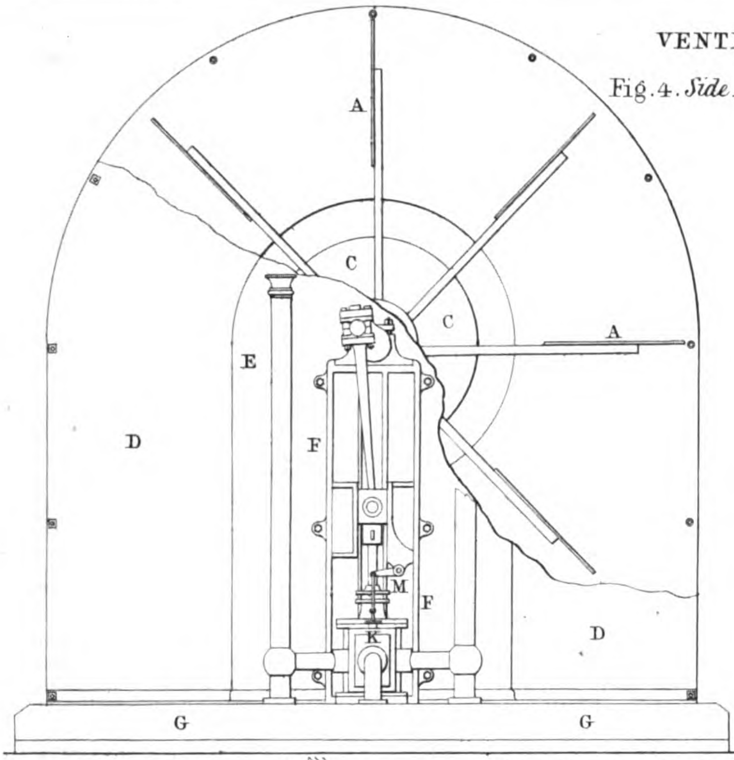

Fig. 4. *Side Elevation*

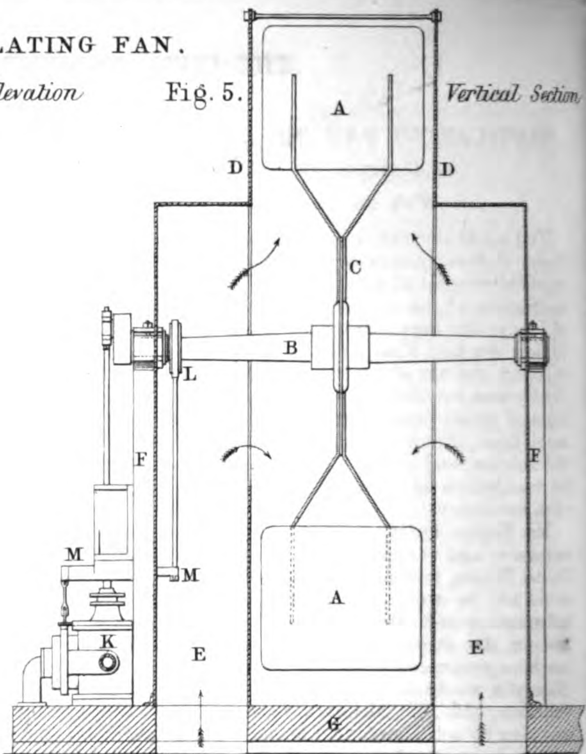

Fig. 5. *Vertical Section*

Scale 1/48th

Ins 12 6 0 1 2 3 4 5 10 15 Ft

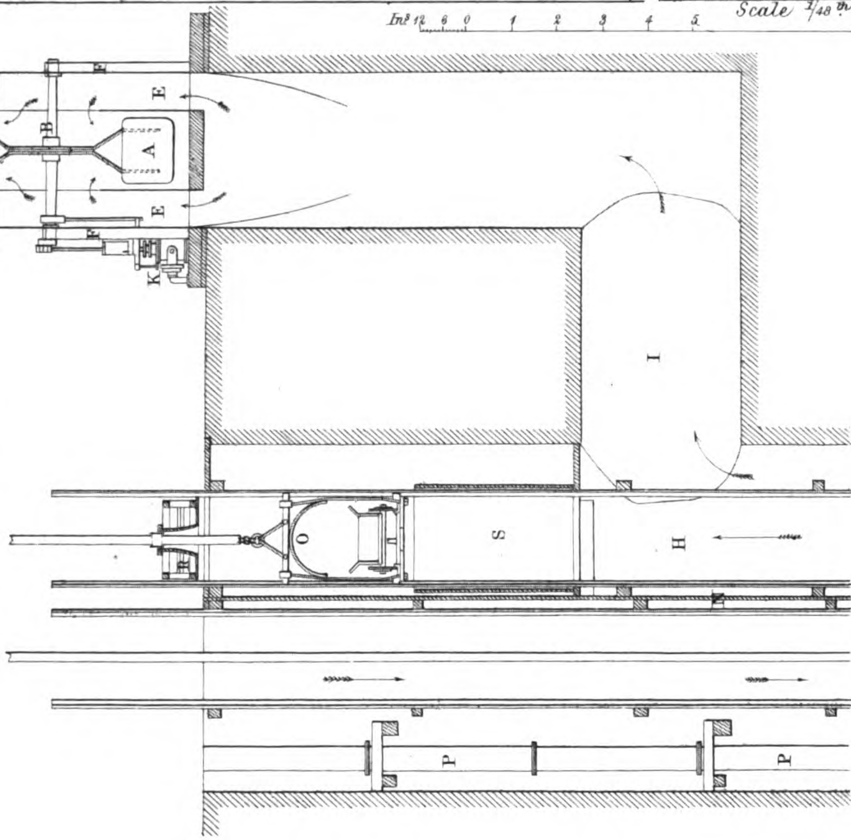

Fig. 1. *General Section*

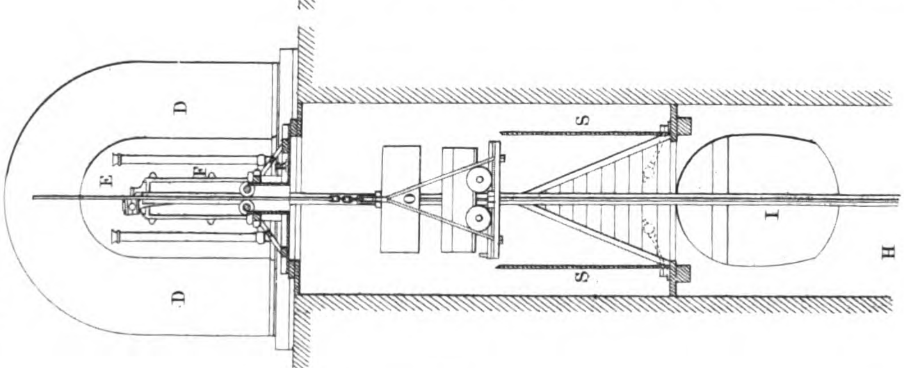

Fig. 2. *Section of Pit*

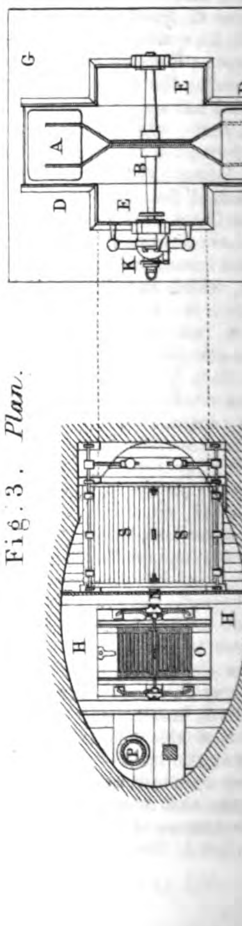

Fig. 3. *Plan*

Scale 1/120th

VENTILATING FAN AT ABERCARN COLLIERIES.

Designed by Ebenezer Rogers.

(*With an Engraving, Plate* XXIII.)

The mode of ventilation that is still generally used in the collieries of this country is the old furnace ventilation, where the required current of air through the mine is maintained by the rarefaction of the column of air in the ascending shaft, by means of a large fire kept constantly burning at the bottom of the shaft. In Belgium and France, on the contrary, this plan is almost superseded by the use of machinery to maintain the current of air; as the furnace ventilation, although possessing the important advantages of great simplicity and freedom from liability to derangement from disturbing causes, has some serious objections and deficiencies, and in some cases becomes so imperfect a provision for ventilation as to render a better system highly desirable and even necessary.

Mr. Rogers having occasion to ventilate the workings in some extensive and very fiery coal seams recently won at Abercarn in South Wales, under circumstances where the furnace ventilation could not be applied, after carefully collecting every accessible information as to the ventilating machines used in Great Britain and on the continent, came to the conclusion that a plan of machine proposed for the purpose some years since by Mr. James Nasmyth would be the most suitable and effective. After consultation with Mr. Nasmyth, it was resolved to test the principle and plan by actual practice; and the ventilating fan now described was made at Patricroft by Mr. Nasmyth, and is erected and now working at the Abercarn collieries.

The general arrangements of the top of the shaft and the ventilating fan are shown in figs. 1 to 3. Figs. 1 and 2 are vertical sections, showing the air valves at the mouth of the pit, and the passage connecting the fan with the pit; fig. 3 is a sectional plan of the pit and fan; fig. 4, a side elevation of the fan and engine, to a larger scale; and fig. 5, a vertical section of the fan.

The fan A, A, fig. 5, is 13½ feet diameter, with eight vanes, each 3 ft. 6 in. wide and 3 feet long. It is fixed on a horizontal shaft B, 8 ft. 7 in. in length from centre to centre of the bearings, which are 9 inches long by 4½ inches diameter. The vanes are of thin plate iron, and carried by forked wrought-iron arms secured to a centre disc C, fixed upon the shaft B. The fan works within a casing D, D, consisting of two fixed sides of thin wrought-iron plate, open all round the circumference, and connected together by stay-rods; the sides are 3 inches clear from the edges of the vanes, and have a circular opening 6 feet diameter in the centre of each, from which rectangular wrought-iron trunks E, E, are carried down for the entrance of the air, the bearings for the fan shaft B, being fixed in the outer sides of these trunks, which are strengthened for the purpose by vertical cast-iron standards F, bolted to them and resting upon the bottom foundation-stone G. The two air-trunks E, E, join together below the fan, as shown in fig. 1, and communicate with the pit H, by means of a horizontal tunnel I, which enters the pit at 21 feet depth from the top.

The fan is driven by a small direct-acting non-condensing engine K, which is fixed upon the face of one of the vertical cast-iron standards F, and is connected to a crank on the end of the fan-shaft B. The steam cylinder is 12 inches diameter, and 12 inches stroke, and is worked by steam from the boilers of the winding engine of the pit, at a pressure of about 13 lb. per square inch. The eccentric L, for the slide-valve is placed just inside the air trunk E, and works the valve through a short weigh-shaft M, with a lever on the outside.

The pit H, fig. 3, is of an oval form, 10 feet by 18 feet, and divided near the centre by a timber brattice N, the one side forming the upcast shaft and the other the downcast. Both of these are used for winding, and the cages O, in which the trucks, &c. are brought up, work between guides fixed to the timbering of the pit. The pumps P, are placed in the downcast shaft.

In order to allow of the upcast shaft being used for winding, the top is closed by an air-valve R, which is formed by simply boarding up the underside of the ordinary guard upon the mouth of the shaft, leaving only the hole in the centre through which the chain works. This air-valve is carried up by the cage O, on arriving at the top of the shaft, and then drops down again flat upon the opening when the cage is again lowered, as in fig. 2. During the time that the valve is lifted, its place is occupied by the close bottom of the cage O, which nearly fills the rectangular opening left at the top of the shaft. By this simple means it is found practically that a complete provision is made for keeping the top of the upcast shaft closed, and maintaining a uniform current of air up the shaft; for the leakage of air downwards through the top whilst the cage is in the act of opening or closing the air-valve, and through the small area that always remains open, is found to be quite immaterial, and the surplus ventilating power of the fan is amply sufficient to provide against it.

In the original construction a more perfect air valve was supposed to be requisite, and was provided by the inclined flaps S, S, which are fixed just above the horizontal tunnel I. These are fitted closely together, leaving only a small opening in the centre for the chain to pass through, and were intended to be opened by the ascending cage coming in contact with them, closing again directly by means of balance weights before the air valve R at the top of the shaft was opened, so as to preserve a thorough closing of the top of the shaft. The flaps were to be opened again by a lever from the top to allow the cage to descend. However, it was found on trial that the valve R at the top was amply sufficient; and consequently, although the other valves S were also provided, they have never been put into use.

The total depth of the pit is nearly 300 yards, and at a depth of 120 yards a split of air is taken off, and coursed through workings from which coal and fire clay are got; the larger portion of the air descends to the bottom of the pit, and is there split into many courses, to work two separate seams of coal and a vein of ironstone. The total length of road laid with plates or rails in the workings is about 7 miles, and the working faces amount to nearly double that distance. The longest distance that is traversed by any single course or split of air in passing from the downcast to the upcast shaft is nearly 2 miles. The quantity of materials raised from the pit is about 500 tons daily.

The speed at which the ventilating fan is usually worked is about 60 revolutions per minute, giving a velocity at the circumference of the fan of 2545 feet per minute; 45,000 cubic feet of air per minute are then drawn through the mine, nearly one-third of which ventilates the upper workings, and the rest passes through the lower workings.

Table I. (appended) gives the results of a series of experiments made with this ventilating fan, under the direction of Mr. Rogers, showing that the total quantity of air delivered at the velocities of 60 and 80 revolutions of the fan per minute, is 45,000 and 56,000 cubic feet per minute, with a velocity of current of 782 and 1037 lineal feet per minute respectively, or about 9 and 12 miles per hour; and the degree of vacuum or exhaustion in the upcast shaft is ·5 and ·9 inch of water respectively.

In these experiments the mode adopted for ascertaining the velocity of air currents was by calculation from the difference of pressure, as observed by means of a carefully constructed vacuum gauge, the result being checked by the anemometer, and by the time of passage of the smoke of powder fired at fixed distances by means of wires from a voltaic battery at the top of the shaft.

The working velocity of the fan is readily and instantly regulated by means of a throttle valve in the steam pipe of the engine, which is under the control of the man in charge of the working of the pit, and is adjusted according to the requirements of the ventilation arising from changes in the atmospheric pressure and in the quantity of gas in the workings. It has been found that a velocity of about 50 to 60 revolutions per minute gives the best amount of ventilation, and that beyond 80 revolutions the current of air is too strong to allow of the lamps being kept alight in the workings.

This ventilating fan has been now in constant work for two years, night and day, without once stopping for repairs of any kind, and is in as good working order as when first started; there appears to be nothing to get out of order about the machine on account of the simplicity of its construction, and no reason to anticipate any failure. The engine is made very simple in construction, with large and durable wearing surfaces, and the steam cylinder is fitted with a solid metal piston to prevent any occasion for stopping to adjust the packing. The whole cost of the steam power for working the fan is so insignificant that a little leakage of steam is quite immaterial. The complete arrangement would be to have a second duplicate fan fixed complete, and ready to be set to work at any moment if the first was stopped, or to work in conjunction with it on any emergency requiring greatly increased ventilation; though from the experience of the present fan it has not appeared requisite to take any such precaution.

TABLE I.—*Synopsis of Experiments on Fan Ventilation.*

	Height of Barometer.		Temperature by Fahrenheit's Thermometer.				Revolutions of Fan per minute.	Water Gauge.	Velocity of Air in feet per minute.	Cubic feet of Air per minute.	Steam Gauge on Fan.	Theoretical Consumption of Coal per hour.
	At the Surface.	At the Bottom.	Top of Downcast	Bottom of Downcast	Bottom of Upcast.	Ten yards from top of Upcast.						
	inches.	inches.	degrees.	degrees.	degrees.	degrees.		inches.			lbs.	lbs.
Mean of twelve experiments Natural Ventilation	29·61	30·60	41·10	51·73	55·56	48·00	...	·15	446·0	24325	—	—
Mean of four experiments Fan Ventilation	29·85	30·85	38·10	50·10	53·93	47·30	60	·50	781·8	45187	13·0	17·4
Mean of five experiments Fan Ventilation	29·65	30·61	41·40	50·70	55·10	48·70	80	·90	1037·0	56555	19·3	23·2

In case of putting up another fan for a similar purpose, the author would adopt one of still larger diameter, probably 21 feet, and running at a slow speed, which he considers would be preferable, and still more economical in power. The construction of the casing of the fan he would propose to make of a simpler and less expensive description, using only thin brick walls for the sides and the air trunks. The whole expense would then be very inconsiderable even for a complete pair of the ventilating fans.

The ventilating fan has a very important advantage over the furnace ventilation, in the power it affords of suddenly increasing the current of air to a great extent in any emergency; whilst with the furnace any increase is very slow in action and limited in extent, and cannot be effected from the surface of the ground.

Another advantage is the coolness and freshness of the upcast shaft, which can be used for the passage of the men as freely as the downcast shaft, being free from the heat and smoke of the furnace ventilation.

There is also no risk of explosion from the access of gas to the furnace fire; and in the first opening of a fiery seam, as in the present case at Abercarn, a furnace could not have been safely lighted until after a long delay for drainage of the gas, owing to the sudden and extensive liberation of gas, and even then it would have been attended with considerable difficulty and danger; but with the help of the fan, all delay and danger was avoided, and the workings commenced immediately on reaching the seam.

A bratticed shaft was the only plan practicable in the present case, on account of the great difficulty of sinking deep through the rock, which was of remarkable hardness; and in such cases the furnace ventilation is very objectionable, on account of the constant leakage caused by the drying of the timber of the brattice from the effects of the heat of the fire, and the corroding action of the sulphurous vapours of the furnace smoke.

By employing the suction in place of the blowing action, and having a fan of large diameter, great exhausting power is obtained without requiring a high velocity of rotation. The circumference of the fan case being left open allows the air to be expelled all round wilh perfect freedom; and the central diaphragm plate on the fan spindle prevents the opposite currents of air entering at each side from impeding each other. The simple manner of driving, by an engine acting direct by a crank on the fan spindle, saves the necessity for intermediate gearing; and by having the fan on the surface of the ground exposed to sight, its action and rate can be seen at all times to be effective, whilst it is safe from the chance of any damage arising from an explosion, were one to occur.

In the pit at Abercarn the quantity of gas is so serious that safety lamps are now used exclusively throughout the workings, and not a single naked light is allowed, except at the two stations near the shaft, where the safety lamps are lighted and locked up. Several very slight explosions have occurred, but not any at all serious in their consequences, except one, which may be mentioned as a useful example of the great practical value of a means of suddenly producing a greatly increased current of ventilation, in preventing loss of life from the result of explosion. In this instance, which occurred about October 1855, one of the men took a naked candle into a stall in which fire-damp had accumulated in the lower workings, at about 150 yards distance from the shaft. An explosion ensued, which being heard by Mr. Rogers, who was at the top of the shaft at the time, he instantly turned the steam full on to the engine of the fan, which immediately increased the speed of the fan to nearly double its rate, and caused such a sudden increase in the velocity of the current of ventilation, that the after-damp resulting from the explosion was carried past the men in the workings so quickly that they escaped all serious injury, so momentary was their exposure to its effects. But if the ordinary velocity of current only had been maintained, some of these men could not have escaped with their lives. The man who caused the explosion was severely burnt, but recovered from the injury.

Almost immediately after turning on the steam to the fan, a shower of black particles was thrown out of the fan, which would be the result of the explosion, being the fine particles of carbon, liberated as light flaky soot from the decomposition of the carburetted hydrogen by the explosion. This is commonly but incorrectly called coal dust, and is always the result of an explosion; and in the author's opinion this is the cause of the fatal effect of the after-damp, from the accumulation of the minute solid particles upon the lungs, and not the exposure to the carbonic acid and nitrogen resulting from the combustion of the gas and air. This opinion is confirmed by the result of examination of the lungs of men killed by mine explosions, which are found to be loaded with these black solid particles. It has been observed frequently that men can live for some time in the after-damp following a mine explosion, if they take the precaution to cover their mouths and nostrils completely with a handkerchief, so as to sift the air they breathe and prevent these floating particles of carbon from entering the lungs; and this precaution is enjoined in the rules of several mines, to prevent breathing the coal-dust, as it is termed. Mr. Rogers gives a case, where a miner, named John Hall, now living at Abercarn, got through a distance of half-a-mile filled with the after-damp, by taking this precaution, and escaped with safety to the shaft.

One of the most explosive mixtures of gases that can be produced in a coal mine is in the proportion of 5 volumes of carburetted hydrogen and 40 volumes of atmospheric air. When this mixture is exploded the results are 2 volumes of vapour of carbon, 3 volumes of carbonic acid gas, 10 volumes of vapour of water, and 32 volumes of nitrogen gas. After the explosion the carbon assumes the form of light flaky soot, which is very finely distributed throughout the air. Table II. illustrates the manner in which Mr. Rogers believes that the decomposition and combinations accompanying the explosion take place.

A similar ventilating fan to that above described has been since erected by Mr. Nasmyth at Skiar Spring Colliery, near Elsecar, which is working with complete success; it is of rather larger size than the one at Abercarn, being 15 feet diameter, and 4 ft. 3 in. wide in the vanes, and is worked at 80 revolutions per minute by the steam from a pumping-engine boiler at 15 lb. per square inch. The result is a thoroughly efficient ventilation of the workings, completely under control at the surface of the ground, and maintained at an expenditure of fuel extremely small as compared with that required for the ordinary furnace ventilation.

TABLE II.—*Table illustrating a Mine Explosion.*

BEFORE EXPLOSION.		AFTER EXPLOSION.			
5 vols. of Carburet'd Hydrogen. 5 CH_2	40 vols. of Atmospheric Air. 8 O + 32 N	2 vols. of Vapour of Carbon. 2 C	3 vols. of Carbonic Acid Gas. 3 CO_2	10 vols. of Vapour of Water. 10 HO	32 vols. of Nitrogen Gas. 32 N
C 1 vol.		C 1 vol.			
C 1 vol.		C 1 vol.			
C 1 vol.	O ½ vol. O ½ vol.		CO_2 1 vol.		
C 1 vol.	O ½ vol. O ½ vol.		CO_2 1 vol.		
C 1 vol.	O ½ vol. O ½ vol.		CO_2 1 vol.		
H 1 vol.	O ½ vol.			HO 1 vol.	
H 1 vol.	O ½ vol.			HO 1 vol.	
H 1 vol.	O ½ vol.			HO 1 vol.	
H 1 vol.	O ½ vol.			HO 1 vol.	
H 1 vol.	O ½ vol.			HO 1 vol.	
H 1 vol.	O ½ vol.			HO 1 vol.	
H 1 vol.	O ½ vol.			HO 1 vol.	
H 1 vol.	O ½ vol.			HO 1 vol.	
H 1 vol.	O ½ vol.			HO 1 vol.	
H 1 vol.	O ½ vol.			HO 1 vol.	
	N 32 vols.				N 32 vols.

Note.—The chemical equivalent of oxygen by volume, or the combining volume of oxygen, being a half-vol., the 8 vols. of oxygen which are in mechanical mixture in the air before explosion represent the 16 equivalents (or 16 half-vols.) which are in chemical combination with the carbon and hydrogen after explosion.

Discussion upon the above Paper at the Institution of Mechanical Engineers.

Mr. LLOYD (the Chairman) said that a more interesting and important paper could not have been brought before the Institution, for every one acquainted with the working of collieries must be aware of the great value of thoroughly efficient ventilation, and the danger and serious risk of life attending any imperfection in the system. Only a few months previously an explosion had occurred in Wales, by which more than a hundred persons had been killed in one pit, showing the necessity of adopting some efficient system of ventilation, that would not be liable to be deranged* from accidental causes; and the method now described was certainly a very simple and mechanical way of accomplishing this object. Several attempts at mechanical ventilation had been made previously, but did not appear to have met with much success in actual adoption. Mechanical means had been tried, he believed, more in Wales than elsewhere, because the coal in that district contained such a large proportion of explosive compounds. He inquired what were the essential points of difference in the previous methods from the one now described?

Mr. ROGERS said there was nothing new in the principle of ventilation by purely mechanical means; the same principle had been in use centuries ago on the continent, although of comparatively recent introduction into this country. The old German miners had used an inverted tub, placed in water, and worked up and down by a lever, with an air valve at the top opening inwards, the fresh air being alternately drawn into the tub and expelled along an air main conducting it into the workings. This rude contrivance had been recently improved and the plan carried out on a large scale in Struvé's ventilator, in which the inverted air vessels were like large gasometers; but the apparatus was expensive, and proved troublesome in working. Rotary ventilators, acting on the principle of the screw, had been tried in some cases; and the fan had also been applied, but without success, in consequence he considered of a want of mechanical knowledge on the part of those who had sought to adopt this method of ventilation. The need of sound mechanical applications in carrying out improvements of this nature formed his principal reason for bringing the present subject before the Institution, with the view of drawing attention to its importance. The fan at Abercarn had proved completely successful, and he was not aware that any really effective machine had been produced previously; but the subsequent one at Skiar Spring Colliery was still better, and experience would no doubt lead to yet further improvements, particularly in a still further increase of the diameter of the fan. In some of the early attempts the air was forced down the pit by a blowing fan, which was beginning at the wrong end of the process; and another mistake that had been made was that the area of the branch air-passages was too small at the point of taking off the air, causing a serious waste of power and a check to the current in passing the contracted parts. In Mr. Nasmyth's fan the simple direct-acting engine was an important feature, together with the compact arrangement of the machinery, requiring no foundation but the fan-case itself, and giving no trouble in keeping it in repair. The engine was capable of driving the fan at 100 to 120 revolutions per minute, if requisite in an emergency, but the ordinary speed was 50 or 60 revolutions per minute. This fan had been two years in constant work, without requiring any repair, and appeared in as good order now as at first starting. The cost of working, as compared with the old imperfect furnace ventilation, was remarkably small, the fan saving certainly nine-tenths of the fuel consumed by the ordinary ventilating furnace. The efficiency of the air-valve covering the top of the pit was an unexpected result, and simplified the construction of the apparatus considerably. It had been thought originally that two air-valves would be required, to prevent loss by drawing in air direct from the top of the pit, and double valves had consequently been provided; but this provision was found unnecessary, as it appeared that a column of air of so great length, extending over 12 or 15 miles through the mine, when once set in motion was not perceptibly affected by a slight check at the end of its course, and was not disturbed by the passage of the cage in and out of the mouth of the pit; the simple flat door at the top accordingly answered the purpose completely. In the erection of subsequent fans the construction might be further simplified by the substitution of thin stone or brick walls on each side of the fan in place of the present iron casing, with the advantage of cheapness and facility for renewal or repair.

Mr. LLOYD observed that the plan now described appeared to be far superior to the ordinary system of furnace ventilation, in which a large furnace was kept burning at the bottom of the shaft, so as to rarefy the air and make the requisite draught up the shaft to draw the current of air through the mine. Such a method was unavoidably attended with continual variations in the current of air through the workings, as the fires fluctuated according to the brightness or dulness of burning at different times, and the ventilation was directly affected by irregularities in keeping up the fires and variations in the state of the atmosphere. The use of jets of steam for ventilation, proposed by Mr. Gurney, had recently been in favour, the steam acting in the same manner as the blast in the chimney of a locomotive engine; he inquired what was the general result of this plan, and whether it was now in regular work?

Mr. ROGERS thought the employment of steam jets must always be an imperfect and expensive mode of applying steam power for ventilation; it was much preferable to apply the steam direct to work a fan, by which means a low pressure of steam could be made fully available. He did not think the plan of steam jets was continued in practical use; one serious objection to it that was experienced when tried on a large scale, was the constant shower of water caused by condensation, from the large quantity of steam thrown into the air-shaft.

In reply to a question as to what degree of vacuum in inches of water was obtained by the fan ventilation, and how the velocity of the air had been estimated, Mr. Rogers stated that in his own experiments he had found from ½-inch to 1 inch of water pressure, according to the speed of the fan; he had tried the vacuum by means of a water gauge, and had also estimated the velocity of the air by Dr. Hutton's theoretical calculations. The results had been checked by Biram's and other anemometers, and had been found to agree very well. A third test had been tried by firing powder at measured distances in the workings by means of a voltaic battery at the surface, the time of passage of the powder smoke to the surface being noted by a watch.

Mr. LLOYD said with reference to the amount of vacuum obtained in the ordinary furnace ventilation of collieries, the information possessed was very imperfect, from the uncertainty about the experiments; he supposed the vacuum was generally below 1 inch of water, perhaps considerably less: but in large deep mines a vacuum of as much as 2 inches of water was sometimes required to overcome the resistance to the current in the workings.

Mr. ROGERS remarked that there were several disturbing causes to be taken into consideration, and great precautions were necessary in ascertaining the vacuum correctly. The barometer showed 1 inch difference of height at the top and bottom of a deep shaft, such as that at Abercarn of nearly 900 feet depth, where it stood at 29 inches at the top, while it showed 30 inches at the bottom. The particulars of the height of the barometer and difference of temperature had been noticed in his experiments, and were given in the table appended to the paper, together with the degree of vacuum arising from the natural ventilation due to the difference of temperature, which amounted to about ¼-inch of water.

In reply to a question whether the distance of the fan from the pit mouth and its relative position were material for its good working, Mr. Rogers said that the distance of the fan from the shaft was immaterial, provided that the air passage from the pit to the fan was of the full size, free from contractions or obstructions. All that appeared requisite was to make the fan large enough to have an ample margin of surplus power of ventilation, without requiring a high speed of working; and from the results of his experience he should certainly recommend in future a considerably larger size of fan, probably as large as 21 feet in diameter.

Mr. HAWKES mentioned that a species of fan for ventilation had been tried many years ago by Mr. Brunton, acting somewhat on the principle of a screw, to which allusion had been made; but he was not aware what results had been obtained with it. He remembered that Mr. Nasmyth had read a paper on the subject of ventilating fans at the meeting of the British Association at Ipswich, several years ago, but thought the arrangement then proposed was different from that now described.

Mr. ROGERS stated that the fan on Mr. Brunton's plan at Mr. Powell's colliery in South Wales, was first put to work about nine years ago. It was a horizontal wheel about 9 feet diameter covering the top of the air shaft, with a large number of vanes set inclined like the vanes of a windmill or the blades of a screw; the air had access to the vanes on the underside, and was expelled from the upper side of the fan. The plan was found to be imperfect and unsatisfactory as a means of ventilation, and he believed it had been entirely abandoned. In the paper read before the British Association that had been referred to, Mr. Nasmyth proposed a fan only about 4½ or 4½ feet diameter, which was so small a size that it would not have at all answered the purpose. The large size of the present fan was the most important feature in the improvement, by which indeed the practical difficulties had been overcome. The whole credit of the calculations and arrangements in the form of the present fan was due to Mr. Nasmyth, and they were founded on the results of his experience; there might no doubt be many modifications of the form and proportions of the different parts of the fan, but these did not appear to be material points, and the simple construction that had been described appeared practically as good as any. He might mention that the plan had been thrown open by Mr. Nasmyth for general use, without reserving any exclusive right in it.

Mr. COCHRANE thought a great feature in the plan of fan ventilation was the simplicity of the apparatus, and the smallness of cost, and also the applicability to deep mines; the great freedom from risk of derangement was an essential point, removing the objection ordinarily urged against ventilation by mechanical means. Any plan which tended to preserve life was of great value, and the fan ventilation was certainly an important step in the right direction. Great credit was due to Mr. Rogers for investigating the subject so completely, and making such a thorough practical trial of the plan. There was no doubt this fan was doing the work of ventilation admirably, and he thought surpassing all other plans, and it required only to be better known to be extensively adopted; they were greatly indebted to Mr. Nasmyth for effecting this valuable improvement in the mode of ventilating mines.

Mr. ROGERS observed that the power of suddenly increasing the current of air through the workings in any emergency was a great advantage over the ordinary furnace ventilation, in which no such change was practicable. He was convinced that the majority of deaths from explosions resulted from the suffocating effects of the after-damp, and not from injuries occasioned by the explosion itself; and in cases where men recovered after an explosion, it was observed that a quantity of black carbonaceous matter, or "coal dust" as it was termed by the miners, was first thrown off the lungs; this was the result of the deposition of carbon in the atmosphere that had been inhaled; for every 45 volumes of fire-damp, which was a mixture of carburetted hydrogen and air, produced in the explosion 2 volumes of vapour of carbon, which was precipitated in the form of minute black flakes filling the air. In the case mentioned in the paper, the result of suddenly turning the steam full on to the engine of the fan was remarkable; an immense volume of air, probably 70,000 or 80,000 cubic feet per minute, instantly swept through the works like a hurricane, and carried off with it all the particles of carbon precipitated in the air. With the furnace, however, the ventilation might have been deranged by the explosion, and thus made worse instead of better at the very moment when most needed.

Mr. LLOYD remarked that another advantage in the fan, that had not been directly alluded to, would be the uniformity with which the ventilation was constantly maintained; he had no hesitation in saying that the loss of life from bad ventilation was much greater than that from explosions, as the men working in the pit were exposed to bad air constantly, and the effects must tell seriously on their health when the ventilation was defective for any length of time, which was liable to be the case frequently with the ordinary mode of ventilation.

Mr. RAMSBOTTOM thought the fan an exceedingly perfect machine; the leading feature in the mechanical arrangement appeared to be the enlargement of the fan to a size admitting of direct action of the small steam-engine by which it was driven, the engine working at the same speed as the fan, thus dispensing with any intermediate gearing, and reducing the whole to the simplest form of machine, which could be readily kept in good working order. A second cylinder might easily be applied if desired at the other end of the same shaft, which would render any stoppage from the failure of the working parts next to impossible.

INSTITUTION OF MECHANICAL ENGINEERS.

MANCHESTER MEETING.

THE annual session of members of this society, for the reading and discussion of papers upon engineering topics, commenced in the lecture theatre of the Mechanics' Institution, Manchester, on June 24, under the presidency of Mr. Joseph Whitworth, when the following communications were laid before the meeting:

Description of a large Tubular Wrought-Iron Crane, recently erected at Keyham Dockyard, Devonport. By WILLIAM FAIRBAIRN.—The crane is built on the principle of a tubular bridge, and the advantages of this mode of construction are, the security and facility with which the greatest weight can be raised to the top of the jib without the slightest risk of failure. It would require a weight of 63 tons to break it, and with a weight of 20 tons the deflexion of the jib is only 3·73 inches; its actual strength is thus much greater than is ever required to be used. The government has taken the initiative in adopting these cranes, by having six erected in the New Keyham Docks at Devonport; two more have been ordered for Devonport, and one of colossal dimensions for Keyham. This last-named sweeps a circle with a radius of 53 feet: it will lift the heaviest load perpendicularly 37 feet from the quay wall, to a height of 85 feet above low-water mark, and will land it 68 feet from the edge of the quay. It can raise boilers from the holds of vessels of the line, lift the heaviest piece of ordnance from the decks, and ship and unship masts with the greatest ease. [This paper will be given in full, with engravings.]

A New Mode of Connecting the Feed Pipes between Locomotive Engines and Tenders. By JAMES FENTON, of Low Moor, Bradford.—It consists of two cylinders, one of which is bolted to the feed pipe of the engine, and the other to that of the tender; the connecting tube, of brass or iron, works in the cylinders upon four india-rubber rings, which are prevented from running out by small iron collars or hoops round the tube, between which each of the rings works. The advantages of this construction are its simplicity and consequent cheapness, and its durability—the motion of the elastic rings being a rolling instead of a rubbing one. The rings cost 6*d.* each.—Mr. Ramsbottom, of the London and North-Western Railway, said he had had this mode of connecting the feed pipes in operation on one of the company's engines for more than two months, and up to this time it had worked very satisfactory; it was simple and effective.—Mr. Craig said he had applied this invention to a force pump, and one or two engines, with very great success. It was far superior to the old connections, and cost much less to keep it in repair. The india-rubber would last on an average about six months.—Mr. Thomas Forsyth expressed a doubt as to the durability of the india-rubber under the action of hot water.—Mr Fenton said he had a ring sent to him which had been in operation in an engine while it ran 8834 miles, and there was no great apparent injury of the india-rubber.

A New Arrangement of Furnaces, by Mr. WILLIAM SIEMENS, which is particularly applicable where great heat is required, the object being to utilise a large proportion of the heat which is commonly allowed to escape into the chimney. The products of combustion are made to pass through a mass of perforated brick-work, termed a "regenerator," which presents an extended heat-retaining surface; the portion of the brick-work which is first acted upon is heated to the highest degree, and the succeeding portions to a less and less degree, so that the products of combustion are thoroughly deprived of their heat before they reach the chimney. The direction of the air current is reversed at intervals of about an hour, by means of a valve in the bottom of the chimney, and the heat previously deposited in the first regenerator is taken up by the fresh air, which reaches the place of combustion in a highly heated condition, and produces a flame of much greater intensity than could have been obtained by means of cold atmospheric air. The intense heat of the flame so produced is communicated to the second regenerator in the same manner as before described, the products of combustion reaching the chimney comparatively cool. By the repetition of this process of reversing the direction of the draught through the furnace, an unlimited degree of temperature may be obtained, and the saving effected is in proportion to the increased degree of heat required. One furnace upon this principle has been working for the last three months at Messrs. Marriott and Atkinson's works, Sheffield, for heating ingots of steel and iron; it has so far worked most satisfactorily, and realised a saving of 79 per cent. of fuel over the ordinary heating furnace, in doing the same amount of work. The regenerative principle has lately been applied to other purposes. A puddling furnace was put into operation recently at Bolton; its results in the saving of fuel are the same as in the case at Sheffield, and it is also expected to exercise a very favourable influence upon the purity of the iron produced. The new furnace effectually prevents the emission of smoke from the slag.—The application of this regenerative principle to furnaces was suggested by Mr. F. Siemens, brother to the writer of the paper, and has been carried out by the two brothers conjointly.—Mr. Atkinson said the result of his experiments with the new furnace was, that during six days, commencing with the 13th ult., it consumed 1 ton 10 cwt., while the consumption by the old furnace was 7 tons, each furnace doing the same kind of work. With the new furnace steel had been melted with a consumption of less than 1 ton of coal. He considered that this furnace was admirably adapted for every heating operation, and that its result in the saving of fuel was gigantic. The furnace was also calculated to last three times as long as an ordinary one.—Mr. Cochrane, of Dudley, remarked that it would be a great boon if the results of the working of this furnace for puddling iron could be furnished to the Institution.

Large Blast Engine and New Rolling Mill at Dowlais Ironworks. By WILLIAM MENELAUS, of Merthyr Tydvil.—He stated that the engine supplies blast to six furnaces, some of which make 235 tons of forge iron per week with cold blast and raw coal. The beam of this engine and its appendages weigh upwards of 40 tons, and the fly-wheel weighs 35 tons. The engine was designed and erected by Mr. Truran, the Dowlais Company's engineer. The rolling mill is now in course of erection: the driving-wheel is 25 feet in diameter, and with the shaft weighs 42 tons; the fly-wheel, 21 feet in diameter, makes 110 revolutions per minute, which is the speed of the roll trains. The engines will drive one rail-mill capable of making 1000 tons of rails per week; one rail or roughed-down mill capable of making 700 tons a week; and one bar-mill making 200 tons a week; besides two blowing-mills and two hammers. The large rail-mill is arranged to roll in both directions when necessary, at a speed of 110 per minute. The mill will be capable of rolling bars of lengths and sections never before attempted. [This paper will be given in full hereafter.]

On the comparative Evaporating Power of Brass and Iron Plates. By GEORGE TOSH, of Maryport.—Mr. Tosh's attention having been called to the subject by an article in the *American Railroad Journal*, he made a series of experiments. He had constructed two vertical boilers of equal dimensions, each having a tube of brass and iron respectively of 2 inches external diameter; the fuel used was gas. The boilers were filled with water of the same quality and temperature, and were exposed to the action of the gas an equal length of time; the height of the water in each boiler was then carefully gauged as soon as ebullition had ceased. Eight experiments were made, an equal number by day and night; and the result was that 16½ lb. of fuel with brass tubes evaporated the same quantity of water as 21 lb. with iron tubes. Further experiments with copper and brass tubes showed copper to be as much superior to brass as brass to iron. The copper evaporated about 56 per cent. more water than the iron.—A discussion ensued upon this subject; and in answer to a question, Mr. Tosh said no account was taken of the supply of gas, to see if it was the same upon each experiment. The results detailed in the paper were therefore regarded as inconclusive, and Mr. Tosh said he would make further observations.

Plan for the Prevention of Smoke in Steam-Boiler and other Furnaces. By W. B. JOHNSON.—The improvement consists in introducing air in a downward direction immediately over the furnace bridge. The apparatus which regulates the supply of air is self-acting, and requires no extra duties from the fireman. It is so regulated that the greatest quantity of air is admitted immediately after the furnace is supplied with fuel, and the quantity admitted gradually decreases until it ceases altogether, when the air admitted through the fire-bars in the ordinary manner is sufficient for combustion. Experiments with a pyrometer were made to test the efficiency of this arrangement, which showed that an increase of heat was obtained by admitting air in the manner described; and to that extent economy in fuel, as well as the prevention of smoke, was effected.

A Vertical Steam Boiler, of a new construction. By T. DUNN, of Manchester.

A Decimal Measure of Length for Mechanical Engineering Work. By J. WHITWORTH.—Instead of our engineers thinking in 8ths, 16ths, and 32nds, he considered it very desirable that they should speak and think in 10ths, 100ths, and 1000ths. The change to the decimal measure was easy of attainment, and when attained its use and convenience would amply repay any trouble in acquiring it. If we had a better system of notation for our measures, in which small differences of size were expressed in terms conveying their value to the mind, the importance of minute and accurate measurements would become more familiar, and more generally applicable. Many operations would by that means be more easily performed, and in some instances greater safety would be the result. After careful thought, and a comparison of different scales, he had come to the conclusion that the scale which he had prepared and exhibited on the diagrams was a good one, although he did not assume that it was absolutely the best that could be suggested. The scale he had proposed combined the greatest possible advantages with the least possible change. The system was in operation at his works, and the workmen were enabled to work to the 10,000th of an inch. He exhibited the internal and external gauges to which the Enfield rifle was manufactured, and showed that the internal gauge, which was $\frac{1}{5000}$-inch larger than the external gauge, would not pass through the external gauge. In the introduction of this system, it would be necessary for the workmen's rules to be divided into tenths instead of eighths of an inch.—Mr. Fairbairn said such a system would simplify our operations considerably. He had no doubt that if employers of mechanics would adopt this system, the other parts of the kingdom, and probably other nations, would follow the example.—Mr. M'Connell approved of the president's suggestion, but remarked that it was desirable that our decimal system should, if possible, be brought into unison with that already in use in France.—Sir C. Fox approved of the system suggested by Mr. Whitworth, and stated that in it ⅛-inch was represented by ·125, and that every number representing eighths would terminate with 5. He believed that it would be found impracticable to bring our system and the French into unison, but there was a simple mode of remembering the difference between the English yard and the French metre, which would be sufficient for all practical purposes—the French metre was represented by three English measures, 3 ft. 3⅜ in.; within the thickness of a bit of silver paper this was theoretically correct. He regretted that instead of the decimal we should have the duodecimal system.—Mr. M'Connell suggested that the Institution should adopt Mr. Whitworth's system, and unite in endeavouring to have it brought into general use.—Mr. Dyer said he thought it was very desirable that the Institution should declare its approval of the decimal system, and it was peculiarly suitable that this approval should be decided upon in Manchester.—Col. Kennedy said he hoped the Institution would declare its adoption of the principle.—After some discussion, the resolution was unanimously carried—"That this meeting pledges itself to the adoption of the decimal scale, the inch being divided into a thousand parts."

Saving the Dead Weight in Passenger Trains. By C. FAY.—This plan is in operation upon the Lancashire and Yorkshire Railway between Manchester, Oldham, and Ashton. The mode consists in building longer carriages.—Mr. Fairbairn said that if the principle were carried out on the London and North-Western the reduction of weight would cause a saving of 2000*l.* a-year; but it was remarked that the necessity which would exist for making larger turntables and new workshops, in order to accommodate the large carriages, would prevent their adoption.—Mr. Fay also suggested that there should be regular periodical meetings of railway carriage builders, and exhibitions of rolling stock.

Improvements in Iron and Steel, and their application to Railway and other purposes. By THOMAS W. DODDS, of Rotherham.—Several specimens of iron converted into steel were exhibited, and the paper stated that the process which produced them was as follows:—The iron in the furnace is covered with charcoal mixed with a small portion of lime and alkaline matter, and exposed to the strong heat of an ordinary coal fire for 75 hours. The iron is then drawn from the furnace, the temperature of which is somewhat reduced, and the conversion into steel is complete. The superiority of this process to that generally adopted lies in a great saving of time, which is effected by a new arrangement of the furnace, and an economy of coal amounting to fifty per cent., without detracting in any degree from the quality of the material. The more rapid conversion is effected by a modification of the chemical materials ordinarily used. Rails made by this process will last twenty-one years, whereas an ordinary line of rails requires renewal once every seven years. The same principle can be applied to the production of tyres of wheels, and of all kinds of tools, which are thus vastly improved as to their usefulness, at a very slight additional cost; a file, for instance, might be converted in this way for one-eighth of a penny. Rails manufactured on this principle had been in use at the London bridge station for eighteen months, and they were not perceptibly worn; the old rails had to be renewed every three months.

Recent Improvements in Water Meters. By B. FOTHERGILL.—He described a number of meters, which he said were objectionable on account of the bulk and weight of the machines. Kennedy's was the best as yet brought into actual use; but it was defective in consequence of its great weight and size; it was liable to stoppage, and so to allow the water to pass unregistered; and it required frequent lubrication. Chadwick and Frost seemed to have remedied these defects. Their meter was but half the bulk and weight of Kennedy's; it had fewer parts and less wearing surface; it required no lubrication, but worked smoothly, without any offensive noise, and was not liable to allow any leakage. It had been found to register with a nearer approach to absolute correctness than any other meter.

Routledge's Safety Escape Pipe for Steam Boilers. By J. RAMSBOTTOM, Manchester.—The furnace is connected with the side flue by an elbow pipe or flue, 4 inches in diameter. In the upper part of this elbow flue, and above the elbow, a number of fusible plugs are inserted. As soon as the water falls below its proper level the action of the heated gases in the flue melts the plugs, which are made of tin and bismuth, and no possible accident can occur. Experiments have been tried with this safety pipe with complete success.—Mr. Tomlinson said that his experience taught him that in locomotive engines a lead plug wore away to the copper in a few days; it then became oxidised and encrusted at the top, so as to become perfectly useless in a short time.—Mr. Craig said his experience was to the same effect, and he had consequently given instructions to his foreman never to use a lead plug more than six months; since this had been done he had had no more trouble.

Mr. DAVID JOY, of Leeds, described *an Engine to be moved by Water Power, for working the Bellows of an Organ.*—It is upon this principle, and by one of these engines, that the organ at the Art Treasures Exhibition is supplied with wind.

A paper, by Mr. WILSON, of Patricroft, was read, upon *Balancing the Valves of Steam Engines*; it was illustrated by diagrams.

An Apparatus for Economising Fuel. By W. G. CRAIG, of Manchester.—The apparatus is the invention of Mr. Green, of Wakefield, and its object is to economise fuel, and increase the evaporative power of the boiler. It consists of a series of upright pipes or tubes introduced between the boilers and the chimney, through which the feed water is made to pass on its way to the boiler. The water is heated above the boiling point, and a considerable quantity of steam is generated before entering the boiler. The formation of a coating of soot on the pipes is prevented by an apparatus of scrapers, which consists of a number of connected rings that are made to encircle the pipes, and are kept constantly but slowly in motion, traversing the whole length of the pipes. The apparatus is at work at Messrs. Hoyle and Sons' printworks, Mayfield, where it has been applied to eight large boilers. The heat of the boiler entering the economiser is 40°, and by the action of the economiser it is raised to an average temperature of 249°. There are in this apparatus 200 four-inch pipes, each 9 feet long, which present a total heating surface of 2000 square feet. The economiser has been very extensively adopted in this country, in Ireland, and on the Continent. The saving in the consumption of coal is from 17 to 25 per cent., and the apparatus will last longer than the boiler, as it is not liable to get out of repair. It can be applied to old and new boilers of every description without stopping the works.—Mr. Leese, of the firm of Kershaw, Leese, and Sidebottom, said the economiser had been in use for several years at their Stockport mills, and so economical was its working found to be, that he recommended all his friends to adopt it. It had saved them a consumption of 32 tons a week.

ON STAMPED OR INCISED STUCCO.*

By B. FERREY.

I WISH to call the attention of the members of the Institute to some specimens of stamped stucco, from which I think it may be seen that it is possible to obtain large surface decorations at a small expense, and that a common material, which has hitherto in modern practice been only used for perfectly plain purposes, may be made the means of much successful enrichment. My mind was first directed to this matter by a desire to obtain some sort of suitable ornamentation for the interior of churches built at small outlay; for it appeared to me that when every effort was making to render churches both solid in construction and beautiful in material, by the use of costly marbles for walls and polychromatic devices for internal wall surfaces, there should be some attempt (where economy in cost was obligatory) to employ common products in such manner that in their natural use they should conduce to church-like effect, without adopting those surface embellishments which in their application become necessarily expensive.

Much attention has properly been given to a better use of bricks for ecclesiastical buildings, and good effect has been produced by them with stone and flint; naked brickwork, however, for the internal facing of walls is less successful; and the usual way of obtaining durable surface decorations is by painting upon metal plates and affixing them to the walls. With many people, however, there is a strong dislike to polychromy; they will sanction any extent of neutral tint or bi-colour, but object to having coloured decorations, however well executed. This may be, and probably is, a mistaken view; but the prevalence of the opinion is a "great fact," and must be dealt with accordingly. Any kind of enrichment therefore which can be produced in the plaster, and is consistent with "true principles of medieval art," is worthy of notice. Anything affecting to be what in reality it is not should be excluded from use in churches, where truthfulness ought to prevail. Plaster is therefore very properly forbidden to be used for columns and arches, or any constructive members which ought to be of stone or some other rigid substance.

In former times the plastered walls of our churches were covered with coloured devices and texts, or illustrations of scrip-

* Communicated to the Royal Institute of British Architects, June 15, 1857.

tural subjects—entirely plain surfaces were seldom to be found; but in later periods a puritanical spirit prevailed, which led to the concealment of all these decorations by repeated coatings of whitewash. Happily a more enlightened feeling now exists, and there is a general desire that our churches should be suitably ornamented; indeed, nothing hinders decoration but the want of funds, and in all modern churches there is a seeking for some economical mode of enriching the internal wall surfaces. A very cheap and simple mode of ornamentation seems hitherto to have remained unattempted. It is well known that the external rough casting on old wooden buildings was stamped or wrought in small devices, known by the term "pargetting," but it never assumed the importance of extensive wall decorations, as when stone and brick entirely superseded the use of quartered oak framing the system of pargetting also ceased. There seems no reason however why this principle of design should not be largely used in another way. The plan now proposed is to impress the common stucco with geometrical and other forms: they may be applied according to the taste of the architect, either under string-courses, around arches in spandrils, soffites, or in large masses of diapering; and texts may be imprinted on the plaster instead of being simply painted on the walls. If colour is wanted, it can be effected by mixing the desired colour with the coat forming the groundwork, then by laying the stencilled pattern against it, and filling in the solid portions of the device with the ordinary stucco or plaster.

It will be observed that I have used the word stucco in this description, and not plaster; it is not however to be supposed that this process cannot be used with fine plaster or any cement which does not set too rapidly. My object is to show that the commonest material is capable of being employed, and that it may be impressed *in situ*. If common stucco, therefore, may be thus treated, it shows what opportunities are open to us for giving interest to large wall surfaces which are generally left plain.

My bringing this matter before the members of the Institute is simply with a suggestive view; each person will judge for himself as to the particular way in which it may be applied. The cost of making the brass patterns is not expensive, and there is no reason why fresh designs should not be made to suit any building, thus the frequent repetition of the same ornaments would be avoided. This should not aim at superseding any higher mode of decoration; but that it may be made conducive to good effect in the interior of buildings I can entertain no doubt.

ON SCOTT'S PATENT CEMENT.*

By Capt. H. Y. D. Scott, R.E.

Whilst experimenting in the spring of 1854 on a lime possessing feeble hydraulic properties, I on one occasion placed a piece of the limestone in a dining-room fire, and then left it for a few hours to calcine it. In the meantime some economically disposed person smothered the fire with cinders and dust from the hearth; and on my testing the lime with acid, to ascertain if it was properly burned, it effervesced so violently, that I again returned it to the grate. But now the fire could not be made to burn brightly, and on a second trial it effervesced as much as before. Somewhat impatiently I rubbed the lime to a powder, to assist the slaking, mixed it with water, and waited in expectation of seeing the cake I had made crumble to powder; but much to my astonishment it gradually solidified, and at the end of twenty-four hours would not yield under the nail.

After many attempts with coke and coal to produce similar results on a manufacturing scale, I ascertained that the phenomenon was in some manner or other caused by the sulphurous acid generated from the fuel; and this led to the process now adopted.

This process consists in subjecting quick-lime, which has been raised to incipient redness by the combustion of ordinary fuel, to the fumes arising from sulphur burned with a limited access of air. A small amount of sulphate of lime is thus formed, and to this cause apparently the extraordinary change produced in the lime is to be attributed. It now no longer slakes, in the ordinary sense of the term, and when ground to powder and used as a cement, it not only forms a very cementitious mortar, but affords a very cheap, beautiful, and durable coating for walls, whether used internally or externally.

The ordinary method of coating walls internally is open to many objections.

1. Lime and hair plaster often blisters from the use of imperfectly slaked lime.

2. It always opens in unseemly cracks, from unequal contraction in drying.

3. A long period, varying with the season of the year, must elapse between the application of the several coatings, involving serious loss of time and inconvenience in moving scaffolding.

4. A very long period must be allowed before the walls are papered and painted.

5. It never becomes sufficiently hard to resist a moderately heavy blow, such as may be given in moving furniture, &c.

From all these objections the new cement is free. It neither blisters nor cracks. It sets with sufficient rapidity to allow the plasterer to follow on with the finishing coat without loss of time, and therefore the expense of moving scaffolding is avoided. A room can be papered and painted as soon as finished, except in the winter time, and then as soon as the walls can be made sufficiently warm to prevent the deposition on them of the moisture of the atmosphere. And to all these advantages is to be added that of costing, if laid on half-an-inch thick, 20 per cent. less than the ordinary material.

For exterior coatings the Portland cement is now generally used, and if well made and properly treated this cement leaves nothing to be desired in point of hardness. But objection is constantly made to the great variations in its colour, and indeed it is impossible to get two supplies, or even two casks, of precisely the same tint. Very frequently one portion of a house shows of a blueish white, and the remainder, by a well marked line of separation, of a leaden blue or dirty brown. Scott's cement, on the other hand, is always of the same colour—the agreeable light buff of the magnesian limestone, and any variation of tint that shows itself after application is of a nature to increase its resemblance to it. At the same time, at the expiration of a week it can compete with the Portland cement in hardness, and the saving effected in the materials used in stucco work is not less than 30 per cent.

The only precaution necessary to impress on workmen in its use is that which is necessary with all cements, and the neglect of which so often brings undeserved expense and abuse on the cement manufacturer. I mean a thoroughly wetted wall for the rendering-coat, and still more a thoroughly wetted rendering-coat (if the setting-coat is not brought on at once, as it should be) for the finishing work. A cement cannot set properly, if the water necessary for its solidification is strained from it before the chemical action with the water is complete.

In summer time, I would further recommend that two days after the coating has been applied the finished wall should be again wetted with a syringe or watering-pot—an operation requiring a few moments only, but greatly assisting the due action of the cement.

* Communicated to the Royal Institute of British Architects, June 15, 1857.

SMEATONIAN SOCIETY OF CIVIL ENGINEERS.

This society, founded in 1771 by Mr. Smeaton, for the purpose of encouraging civil engineers, and introducing, through social meetings, a friendly intercourse among the profession and men of science, had an entertainment, on the 11th ult., at Greenwich. Most of the leading members of the profession assembled, and several guests partook of the evening's hospitality. The party during the afternoon visited, under special arrangements, the *Great Eastern* steamship, the Atlantic cable on board H.M.S. *Agamemnon*, and the Nautilus diving bell at the Victoria Docks. At the dinner the chair was taken by Mr. Hawkshaw, the president for the year; about forty gentlemen were present, among them Mr. Stephenson, M.P., Mr. Locke, M.P., Sir J. Rennie, Sir J. Macneil, Mr. Mylne, the treasurer, Messrs. Walker, Lindley, J. Simpson, &c., while some few members were unavoidably absent on account of professional engagements in the country. Among the visitors were Col. Dawson, R.E., Capt. Claxton, Capt. Moorsom, Capt. Galton, R.E., &c. The usual loyal and ancient toasts of the society were given, and much friendly intercourse and discussion on the engineering and scientific topics of the day took place, and the festive proceedings terminated at a late hour.

SAFETY CAN AND LAMP FOR SPIRIT-GAS.

The Committee constituted by the Franklin Institute of Pennsylvania, to whom was referred for examination a Safety Can and Lamp for Spirit-gas, invented by Mr. Seth E. Winslow, of Philadelphia,—Report: That the improvement consists in the use of a wire gauze diaphragm of conical form extending from the mouth inward like a bag. The gauze for the can is double for greater safety; the gauze in the lamp is single only, and is perforated below, the lamp-wick passing through the orifice. The can has, moreover, an air-tube passing from the spout near its mouth to the body of the can just under the cork, so that the fluid may be poured steadily without removing the cork. This is not, however, claimed as new.

Diaphragms of wire gauze, so well known and so long used for the purpose of preventing the propagation of explosions, have been heretofore employed in burning fluid lamps and cans in one of two forms—either as plane transverse diaphragms stretching across the neck below the stopper, which present a very small surface for the passage of the fluid, and are liable to be clogged by sediment, and to be broken by thrusting the cork too far in, or by other violence; or in lamps, as cylinders extending from the top to the bottom of the lamp, within which the lamp-wick is contained. The latter form allows too much space for the fluid within it, and an explosion may be sufficiently violent to tear the gauze, or, although not extending to the liquid in the body of the lamp, may yet lead to serious damage.

This cannot be the case with the conical diaphragms, which, although simple, yet appear to be a new and valuable improvement, adding materially to the safety of these useful utensils.

NON-WASTING AND NON-FREEZING HYDRANT.

The Committee constituted by the Franklin Institute of Pennsylvania, to whom was referred for examination, a non-wasting and non freezing Hydrant, invented by Mr. James Cochran, of New York,—Report: That they have examined the above-named hydrant, and find it constructed with a hollow cast-iron body into which the feed-pipe enters near the bottom, containing an immoveable concave iron plate, and to which is attached a disc of gum elastic, acting as a moveable bottom: under this is a convex piece of cast-iron, also moveable, which is attached by means of an iron yoke and cranks to a vertical rod, and it to a lever handle at the top of cast-iron frame.

The supply and exit pipes enter through the immoveable concave plate into the box, formed by the plate and gum disc, so that all the water passes through this box. Upon the supply is constructed a conical cap, so arranged that the water enters at one end in the direction of the taper, and is discharged through a rectangular port in the side, ¾-inch long and ¼-inch wide, so that a very small motion of the tap will open or close it entirely. The water acting in a longitudinal direction of the tap, as the tap wears by use, it is intended to be kept tight by the pressure of the water. This tap is attached by a combination of links and pinions to the yoke and rod before named. The handle is a lever of the second order with fulcrum at end, and the vertical rod is attached by means of a small rock shaft, so that by raising the handle the rod moves in the same direction. By raising the handle, the rod raises the convex plate, and it the gum; and after moving about one inch, the tap is opened and the water commences to flow. By letting go the handle, the weight of the rod, yoke, &c., together with the pressure of the column of water, draws it down and closes the hydrant.

The pressure of the cast-iron plate being taken from the bottom of the gum disc, the weight of the water from disc to point of exit is intended to press it down; and the capacity of the box being twice as great as the exit pipe, it empties the pipe, and the water returns again into the box.

Upon opening the hydrant by raising the handle, the convex plate is caused to ascend and press against the gum disc, forcing the water contained in the box into the exit pipe, and a continuous stream follows. The tap is so arranged that it does not open until the disc has nearly reached its height, so that the water in the box is thrown into the pipe before more is admitted.

It is claimed, that this hydrant can be repaired without digging it up, which, if so, is certainly a very desirable object gained. The iron post or hydrant is encased in a wooden box, which will not require repair oftener than an ordinary hydrant.

When the supply pipe and gum box is placed a sufficient depth below the surface (say, about five feet, which is the depth the ground has sometimes frozen), as there is no waste above the box, it is impossible to freeze.

ON THE DRAINAGE OF WORTHING.

By Dr. Collett.

There are some now living in Worthing, who remember it a small fishing village. It became a popular place of resort, and consequently increasing and prosperous, from the advantages of its position on the coast, its wide-spread sands, and the varied beauty of the surrounding neighbourhood. As the population increased, however, the drainage, which was from the beginning without arrangement, and based upon the old polluting system of cesspools, proved defective. These poured their fluid contents by several trunks on the shore, a short distance from the beautiful esplanade, which at times therefrom, especially during the ebb of the tide, could no longer be resorted to. Who then can be surprised that the town became injured in reputation as a watering place? But this was not all. The wells in many places became contaminated by soakage from the cesspools with which they were in close proximity, so that the water became thereby unfit for use.

The requirements to remove these evils were—a new system of drainage carried *from* the shore, and a general and sufficient supply of pure water. How these wants have been met, the following description of the works will show. And first, as to the drainage. The cesspools in the town (and there was one to almost every house) have been filled up, and waterclosets have been substituted. The pernicious system of discharging the sewage into the sea in front of the town, has been entirely abandoned. The drainage has been wholly remodelled. A main brick sewer or culvert, of an egg-shape form, 3 ft. 2 in. by 2 ft. 3 in., has been carried through the principal streets, at a depth, in some parts, of 23 feet, and is connected with the other streets and with every house by branch drains of stoneware, varying in diameter from 15 inch to 6 inch. The main sewer terminates in a sump 6 ft. 2 in. by 2 ft. 10 in., and a sewage well 30 feet deep, and 10 feet in diameter at the top, reduced to 6 feet at the bottom. This well is situated considerably to the north-east of the town, and an artificial fall obtained into it from every direction. In it is placed a sewage pump, consisting of three 15-inch barrels, worked by steam power, and connected with the engine in the water-tower (shortly to be mentioned), by an iron shafting and driving gear, by which it is pumped through an outfall sewer, emptying itself into the sea at a place, two miles eastward of the town, called Sea Mills Bridge. There the sewage mixes with a stream of pure water from the kilns and with the general drainage of the district; and it is worthy of remark that the abundant supply of pure water to the town, mixed as it now is with the sewage, so completely by its antiseptic properties counteracts the putrefactive fermentation, that neither at the works, nor in the immediate neighbourhood of the outfall, is there any disagreeable smell. Thus the beach and sands are wholly freed from the sewage which formerly damaged both them and the esplanade. The sands are rapidly improving and will, it is expected, before long, recover their former firm and dry condition.

The water-tower at the north-east of the town, with the engine house and chimney-shaft adjoining, have been erected under the superintendence of W. Rawlinson, C.E. It has a total elevation of about 110 feet, and is 40 feet square on plan. There is a central pier of brick, and a spiral staircase of cast-iron. The foundation is of concrete. Within the adjoining engine-house a well has been sunk in the chalk to a depth of 70 feet, which is lined with iron cylinders to exclude the surface water. Below this depth a bore has been driven into the chalk 295 feet further, and making a total depth of 365 feet. From it gushes an abundant supply of the purest water, 15° of hardness, which is lifted by the engine into a water-tank at the top of the tower, and thence distributed into all the houses in the town. The tank is of cast-iron, 40 feet square, 13 feet deep, and will contain 110,000 gallons. Its bottom is 70 feet from the ground. The thickest plates are ½-inch and the thinnest ⅜-inch in substance. The engine, which also works the sewage-pump in the sewage-well, is high-pressure, made by Messrs. Headley and Manning, of Cambridge; it commenced work at the end of last year.

The public sewers are all completed, the whole of that part of the town in which visitors reside is effectively drained and supplied with water, and the remaining works in the smaller streets are rapidly approaching completion. All the works have been performed under the superintendence of Mr. Charles Hide, surveyor, of Worthing.

It is well known to visitors who have frequented the town, that a quantity of sea-weed is apt to be thrown upon the beach in the autumn. Except in combination with other substances which create chemical decomposition, it cannot be considered unhealthy, but remedial. The late Dr. Golding Bird was wont to remark, that, "but for the sewage mixing with the sea-weed thrown on the shore, it would be an additional inducement to send patients to Worthing." The whole drainage having been now removed, no deleterious action can again occur from this source.

REGISTER OF NEW PATENTS.

EQUILIBRIUM VALVES.

P. Gaskell, Kingston-upon-Hull, *Patentee*, November 10, 1856.

This equilibrium valve is composed of two plates of bell-metal or other suitable metal, made either to revolve on a metal shaft in the case of a rotary valve, or to slide in the case of a sliding valve, at a distance of about two or three inches apart from each other, within a metal valve-box of a circular or square form, the valve plates and box being all ground smooth and fitted so as to be perfectly steam-tight, except at the apertures in the lower plate, hereafter mentioned. The steam intended to pass into the cylinder is first admitted into the valve-box in the intermediate space between such two plates. The pressure of the steam in the valve-box on the upper or outer plate thus counterbalances (or nearly so) its pressure in a contrary direction on the lower or inner plate and produces an equilibrium, thereby obviating in a great degree the friction of the valve as it revolves or slides. The upper or outer of such two plates is without any hole or aperture for the passage of steam. The lower or inner of the two plates is perforated with holes or apertures proper for the passage of steam from the valve-box into the cylinders as the valve slides or revolves.

The diameter or the area of the surface of the upper or outer plate is somewhat less than that of the lower or inner plate, and thus the pressure of the steam, though very nearly at an equilibrium, is somewhat greater on the latter plate on account of its greater surface than the other, and by this means the moving part of the valve is maintained in its proper place with sufficient tightness to secure its efficient working, but without any such pressure on its seat as to cause disadvantageous friction.

Relieving the moving part of the valve from nearly the whole of the pressure of the steam upon it, by the means described, must lessen the friction in a very considerable degree, and thereby effect a corresponding saving in the consumption of fuel required for working the engine as compared with the quantity consumed in working engines constructed with the ordinary valves.

CHIMNEYS.

John Billing, Abingdon-street, Westminster, *Patentee*, November 15, 1856.

In constructing a stack of chimneys, the patentee makes the top of each chimney of a conical or pyramidal form, of straight or curved contour, with or without a level or inclined base or surface on each side of the top of the stack. A vertical partition is placed between each chimney top to prevent the smoke from one chimney descending into an adjoining one.

The conical tops are made flat at the sides where they come in contact with the vertical partitions or screens. When the partitions can be placed sufficiently far apart the sides of the cones are not flattened, or are only slightly flattened. The sides of the screens may be flat or hollowed. The cones are made hollow of terra-cotta or baked clay, or they may consist of a solid block with a vertical perforation; they are made with openings of different sizes to adapt them to different sizes of fireplace; but in all cases they are so proportioned and arranged that the opening or outlet is below the level of the top of the partitions or screens. The conical top may be simply placed or set over the flue; or the flue, if of the ordinary square or rectangular form, may be brought into a circular or octagonal form at the upper part, or may have a piece of earthenware or other pipe built into the top. The partitions are separate pieces or tiles of terra-cotta, but they and the conical tops may be made of stone or other suitable material, and the partitions may be made in one piece with the cone, and other similar modifications in the details of construction may be made. In lieu of a cone, a square or quadrangular or polygonal pyramid may be employed, although the former is preferable. A single chimney top may be constructed in a similar manner by placing one of the conical or pyramidal tops on the termination of the flue, with a vertical screen or partition on each side. One or more hollow conical or pyramidal caps may be placed above the conical or pyramidal chimney tops, so as the more effectually to prevent gusts of wind from blowing down the chimney; these additional caps are, however, seldom required. The conical or pyramidal form of the tops, in combination with the more lofty partitions or screens, causes the currents of air or gusts of wind to be so deflected and directed as to prevent them from blowing down the chimney or impeding the ascent of the smoke or air, and the smoke from one flue is also prevented from descending the adjoining flues. These chimney tops are applicable to chimneys used for fires, and also to chimneys or flues used for ventilation.

Claim.—Constructing chimneys with conical or pyramidal tops in combination with partitions or screens rising above them, as described.

ARTIFICIAL GRANITE.

J. H. Headley, Walpole, Canada, *Patentee*, December 12, 1856.

This invention relates to a process of manufacturing artificial stone by moulding and pressure, whereby the moulded block or article may be made to present an exterior of marble, while its interior is composed of a coarser material.

The patentee takes good clean sand, fine gravel, or any pulverable siliceous matter in any desired quantity, and to this adds a portion of fresh burnt lime (protoxide of calcium), reduced by grinding to an impalpable powder; these two substances are incorporated by mixing them together as intimately as possible. The natural dampness of the sand or gravel will slack the lime, which in heating will cauterize the silicon, and form a thin film or pellicle of lime over each grain of silica. The proportions of sand and lime vary, according to their purity and strength, from five parts of siliceous matter for every one of lime, to forty parts of the former for every one of the latter; a good proportion is ten or twelve parts of sand to one of lime. When the composition has become cold, and is thoroughly amalgamated, it is to be then moistened with water until it is sufficiently damp to pack. This composition is used to form the granite, or coarse base of the articles to be moulded.

Or he takes granulated marble (pulverized carbonate of lime) and mixes it with ground unslacked lime in the same proportions, way, and manner, as the siliceous matter above described, and moistens it until sufficiently damp for packing.

When it is desired to employ these two compositions in moulding any article, they are placed in a smooth metal mould in such a way as to leave the sand and lime in the interior of the block, and a thin lamina of the marble and lime on the outside, from a quarter to half an inch thick. The mass thus prepared is then subjected to a great pressure, say, from one to three tons per square inch of surface, after which it is removed from the press; the moulded block will then gradually harden by the absorption of carbonic acid gas from the atmosphere.

To make pavements, tombstones, baths, &c., hydraulic lime is used instead of quicklime; and for all purposes wherein the mass is subjected to frequent changes of temperature and the constant action of water the use of hydraulic lime or cement is considered preferable to quicklime.

To imitate all the different varieties of marble, the patentee proposes to employ as a colouring substance ground iron ore and the oxide of iron, heated in a close retort and then mixed with the granulated marble.

To give extra hardness to the moulded block, it is saturated for a few hours in soluble glass (silicate of potash), and heated to a temperature of 300° Fahrenheit. This makes it very hard, and renders it capable of receiving a high polish. For all ordinary building purposes this saturating process will be unnecessary, as the lime, sand, and marble will carbonize with time, and so form a block capable of lasting for ages.

Claim.—The moulding of blocks and other articles in artificial stone with a surface of marble, in the manner described.

BEDDING AND RENDERING BRICKS IN FURNACES.

W. Jacobs, *Patentee*, Mile End, November 21, 1856.

This invention consists in the use of an improved composition, consisting of the following materials for bedding and rendering bricks in furnaces. One yard of loam, of the description found in Kent, and known as black foot loam; three yards of pulverized chalk flints, or for this description of sand other sharp sand, such as river or road sand, may be substituted; and one yard of hydraulic or stone lime which has been previously slacked by exposure in the air.

These materials produce an excellent composition for bedding and rendering bricks in furnaces, but the patentee sometimes adds to them the following substances: one half yard of ground malm bricks, and one third of a yard of breeze or fire ashes.

In place of the lime mentioned as forming part of the composition, an equal quantity of Portland cement is sometimes substituted, or a part only of the lime may be replaced by cement.

The materials are mixed with water to the consistency of mortar, and in the composition so prepared the bricks are to be bedded in the ordinary manner, and they may afterwards be rendered with the same composition.

This composition will adhere to the bricks of the furnace with much greater tenacity than fire clay when exposed to a high heat, and it will not, as the fire clay does, scale off and fall out of the joints.

DEODORISING SEWAGE WATERS.

G. J. Vertue, Southampton, *Patentee*, December, 1, 1856.

Lime is the principal agent used, and it is essential that a kiln should be erected at a spot contiguous to the sewer pumping station, drain, or wells through which the sewage matter passes; the lime to be used hot from the kiln, and placed in a tank or vessel in which works an agitator driven by steam power or otherwise. A stream of hot or cold water is led into the tank in sufficient quantities as to bring the lime into a perfectly liquid form; the lime solution is then led through pipes (regulated by cocks or valves) into the sewers, and thus, mixing by its own gravitation with the sewage matter, purifies it and renders it quite inoffensive and non-injurious to the neighbourhood of the outfall or outlet of the sewers.

At a short distance from the mouth of the sewer, a circular vessel of wood or other material is erected, and in the centre of this vessel is placed an upright shaft, having on it stirring arms, which, when the shaft revolves, sweep the whole surface of the vessel at a short distance from its bottom. To the vessel thus arranged a pipe leads in a continuous stream of water, and there is another pipe which leads the water after it is mixed with the lime into the sewer through which the sewage is passing. By the side of the mixing vessel there are lime kilns, in which the lime required for the process is burnt, and from one of these kilns a workman continually takes quantities of the lime while it is still hot from the burning, and throws it into the mixing vessel, where it becomes mixed with the water also introduced into the mixing vessel. Or, if sea water can be obtained, it is advantageous to use it in place of fresh water for mixing with the lime.

The quantity of lime necessary to deodorise a measure of sewage will vary; but it is generally advisable to employ the lime in the proportion of twenty-six tons of lime per annum for every one thousand persons of the population of the locality drained by the sewer.

Claim.—Mixing the lime while it is still hot from the burning with water, and then adding the mixture to the sewage to be deodorised.

FIRE BRICKS, TILES, AND CRUCIBLES.

G. Sherwin, Burslem, *Patentee*, December 12, 1856.

This invention has for its object improvements in the manufacture of fire bricks, tiles, crucibles, and other articles when fire-clay is used. For these purposes, in place of employing the fire-clay and siliceous matters in the ordinary condition, they are first "slipped" separately, and then combined together, and with burned clay and siliceous matters. The fire-clay or marl is prepared by grinding in the ordinary manner, and then "slipped," all particles of iron ore, stones, and other substances (not clay) being removed or separated. The crude or calcined flint, sand, quartz, or siliceous matters are also ground and "slipped." These matters are combined with suitable quantities of similarly prepared clay which has been burned and crushed, and the combined plastic compound is made into bricks, tiles, and other articles in the ordinary manner.

The fire-clay or marl is first prepared by grinding in the ordinary way, and is then mixed with water to make a slip, such a proportion of water being used that one pint of the mixture or slip should weigh 2 lb.; the slip is then passed through a wire sieve, of which the wires are placed at a distance of about the sixteenth of an inch the one from the other. Another slip is also prepared by taking flint, sand, quartz, or other siliceous matter, either in a crude or calcined state, and grinding it when mixed with water; or it may be ground in a dry state and afterwards mixed with water if preferred; in either case the slip prepared should be of the same density as that prepared from the fire-clay. The two slips are now intimately mixed together by agitation, in the proportion of three or four measures of clay slip to one measure of siliceous slip, and with the combined slips an additional quantity of fire-clay is mixed; and the fire-clay for this purpose is prepared by grinding and slipping, as already described, and by burning it in a kiln; when thus prepared it is crushed to a coarse powder, and is mixed with the slips in the proportion of one part of the coarse powder to three parts of dry clay and silica contained in the mixed slips. This mixture having been completely made, it is introduced into a slip kiln, similar to that used by enthenware manufacturers, and the water is there evaporated until the mixture attains a sufficient consistency to be moulded into bricks, tiles, crucibles, or other articles.

The same mixture is also used for bedding and rendering fire-bricks in furnaces, but when used for this purpose, the drying is not carried quite so far as when it is to be moulded into bricks or other articles.

ARCHITECTURAL MUSEUM.

On the 18th ult., the annual conversazione of the Architectural Museum was held in the new building at Brompton. The Right Hon. Earl De Grey, the president, on taking the chair, said he had attended some three or four previous conversazioni, but the present was the first occasion on which he had been able to "see" all who were present. Those who recollected the former place of meeting would remember the extreme pressure that prevailed on these occasions, the difficulty that there was of either seeing or being seen, or in properly exhibiting the examples of architectural taste which it was the object of the Museum to bring before the public eye. The change of situation from the confined position in which they formerly were was undoubtedly a great step in the advances to be made in the future progress and improvement of the Architectural Museum. The first spot that was selected was the best that could be obtained. In the earlier stage of its existence its position was adequate for its purpose, but it was found, long before they actually did remove, that it would be impossible the collection could progress, or that the Institution could confer that reputation on itself, or that amount of profit on the public which it was intended to confer, by remaining in its confined locality. It had been observed, though he thought the observation was without foundation in fact, that, because they had selected a spot more or less connected with government, and the locality of other public institutions, they were therefore likely to be what they might call absorbed by the public institutions around them. He candidly confessed, although the public institutions around them might be large and very powerful, and though they might have a great swallow, he did not think they would swallow the Museum. He thought the Museum would hold its own. The great object of the Museum was not merely to collect together isolated models or casts, but to collect them in the mass. Taken in an isolated way, or individually, they were of little value; but taken collectively, in connection with specimens of the same date, and of the same style of architecture, they became for the purpose of study and comparison invaluable. It then became of value, and available by all connected with the noble profession of architecture. Everything, under these circumstances, that favoured the important object of classification and separation, and avoided that of confused intermixture, by appropriating proper things to proper periods, and placing all in chronological order, in connection with all classes and styles of architecture, must be of immense value. He believed that the Institution only required to be known to be appreciated; that numbers would come to it, and that it would recommend itself to the increased support of the members and the public.

Professor DONALDSON, in moving the adoption of the report, observed, in allusion to the change in the Museum's locality, that they must all admit they had moved from a barn into a palace. While at Westminster they were a solitary Institute, but now they were an associate with other societies of enlarged conception, and for other pursuits and studies. They were not confined to one geographical position as it were, but their conceptions became enlarged, and they regarded architecture in its fullest development.

Mr. SCOTT then moved a vote of thanks to the Department of Science and Fine Art, and to the Committee of Council on Education, for their general co-operation, and also for much personal attention from Mr. Cole, C.B.; Mr. Redgrave, R.A.; Dr. Lyon Playfair, C.B; Captain Fowke, R.E.; and to Mr. Owen. The Architectural Museum was much indebted to all these gentlemen for their co-operation and assistance in a work of great difficulty and disturbance—the removal of the Museum.

Mr. G. GODWIN seconded the motion. He could testify to the truthfulness of the terms in which the motion was couched, and to their general efforts in the promotion of exhibitions calculated to be of so much utility in the cause of art and manufacture in this country. The meeting would well remember most of them in connection with the Great Exhibition of 1851, and would have heard of the services they had performed in connection with the Paris Exhibition. Our architects, our artistic manufacturers, should make it a point of duty not to disregard those who are placed under them, and who, for want of such an institution as the present, have been obliged to be content with what they could pick up in the workshop or the office; but should make a point of sending them to the Museum a certain number of hours on quiet days, when they might draw and study from examples of every period to be found throughout the country, without the trouble of travelling farther than Brompton.

Mr. HENRY COLE returned thanks on behalf of the Department of Science and Art. He might be permitted to express an opinion that the Architectural Museum asserted and showed its value far more in its present location than it did in the old garrets in Canon-row. He thought that it did so on its own merits; but if they looked at it in connection with the architectural collection below, which belonged to the government, he thought they would feel that the two together made a collection much more noble than they did apart. Farther, he would say the effect of bringing together these two architectural collections had already borne very considerable and important fruits. Many of them had heard of Wren's model of St. Paul's, and it was no doubt till now a myth to most; but the effect of the establishment of this joint sort of Architectural Museum had induced the Dean and Chapter to take it from a room where it was rarely seen and to deposit the original monument prepared by Wren in their Museum. Many who had visited Hampton Court had, no doubt found very much out of place, a collection of models of Greek and Roman architecture, and in consequence of this consolidation, the Office of Works have allowed them to be deposited here. This was another proof of the advantages that had arisen out of the union. Then, again, within the last few days, the Dean and Chapter he had almost said, had found out what we had never heard anything about, at least the public knew nothing of them—sixteen models extremely interesting and curious of Inigo Jones' and Sir Christopher Wren's churches in the metropolis, and which had been taken out of a little lumber-room and deposited in the gallery around the model of St. Paul's. The result would no doubt be, that, in a very few years, independent of the accession of students in architecture through the Architectural Museum, and the influence of the Architectural Museum on Government, we should be able to assemble on these, or on much better walls, a collection of architecture which he believed would be unrivalled throughout Europe. In fact, he might say, at the present time, that he knew of no capital in Europe which could display upon its walls such a collection of architectural objects as they had in that museum. It was quite true that in some collections, as in that of the Beaux Arts, in Paris, they might find a few much finer things, but anything like so extensive a collection could only be found here; and he thought he had a right to say, with reference to the collection of architecture at the Crystal Palace, that the two things were quite distinct. In the Crystal Palace it was a collection of architecture reproduced, and more or less a sort of pictorial and popular collection of architecture, which, however valuable to those who know nothing of the art, was, he would venture to say with all respect to what was there, far inferior to the collection of the apparently ramshackling casts that were here, and which was like precious gold to those who knew something of the matter. He did not wish to depreciate the Crystal Palace collection, but they would all feel this, that if they wished to see a genuine cast, of course they would like to see it untampered with altogether. The Crystal Palace, probably from very proper motives, and with which he entirely sympathised, had thought it right to polish up, paint, and decorate, according to their own notions, casts that may or may not be correct; but those who knew most about the matter took leave to question whether this was quite correct. One point of great importance in connection with the Museum was the field of information it offered for study. As regarded the subject of site, he might observe, that whatever any one wanted he thought it pretty well worth his while to go and get. He recollected it was prophesied and almost proved to demonstration, that no one would go to the Crystal Palace in Hyde-park in 1851, and how remarkably the prophecy was fulfilled—nobody did go! So before the Museum was open, there were those who in their dubitancy and dreaming, said, "Oh! you'll have none of the working people here: no one will think it worth his while to come here; you are quite out of the regions of civilisation: there is no place in London that people like to luxuriate and enjoy themselves in so much as Charing-cross." Now he (Mr. Cole) had heard of people going to Hyde-park to enjoy themselves, but he had never heard of their going to Charing-cross to do it. His experience on the matter was, that site had not so much to do with these things as attraction. With respect to the subject of subscriptions, it was not intended to give any aid to the Museum from government: it must rest with the public. He believed the day was past when government thought it should give grants to large and responsible bodies to spend. If they were desirous that the country should possess an architectural museum, it must be wrought out on the voluntary principle, and they must bring in their guineas handsomely; and not only would the guinea so subscribed enable the subscribers to get all the advantages of the institution themselves, but be the means of enabling the people at large to participate in those advantages.

Mr. S. C. HALL, in seconding the motion, congratulated the meeting on the transfer to Brompton. Though they had a large number of friends present as visitors, it was not to be forgotten that the building was for working men, and for the votaries of art generally. While it held out all the advantages that arose from education, it also gave every facility for carrying out that education in every department, and was designed to work out as much real good amongst one class as another, by diffusing a right taste among employers and employed. The conductors of the museum, in view of the public interest and the promotion of art and science, congratulated themselves on the advantages that they had already achieved, and on the prospects that were before them.

The Hon. Mr. COWPER, in moving the thanks of the meeting to the president, said it was gratifying to think that in the appropriation of departments in that building, so large a space had been propriated to the Architectural Museum. It would be an important aid and coadjutor of government in carrying out the design for which the building was erected, namely, the promotion of an institute for the fine arts; and those who paced through these galleries and aisles would learn how to appreciate the productions of past times, and enter into the spirit of those days when mediæval architecture reached a height that left all that preceded it behind, which we might imitate, or rather emulate, but could not excel. Some criticism had been indulged in on the building, and it had been said we had brought together a rather heterogeneous collection; but that, in his opinion, was one of its advantages, for people who came to see one collection were induced to visit the other.

Dr. WHEWELL, Master of Trinity College, Cambridge, in seconding the motion, said he believed that under the auspices of the Architectural Museum, and such munificent and enlightened patrons as their chairman and the gentlemen connected with the Institution, architecture would become one of the most popular subjects that could occupy the mind of the community.

The CHAIRMAN briefly returned thanks, and the assembly separated to view the newly arranged contents of the Museum.

NEW GOVERNMENT OFFICES.

The Report to the First Commissioner of Works of the Judges appointed to consider the designs for the new Government Offices has just been issued. After enumerating the designs to which they recommend the several premiums to be awarded, they say—

"In making these recommendations we desire to observe, in the first place, that we were not in possession of any knowledge as to the sum which her Majesty's government might propose to the House of Commons to expend upon these works. The designs before us were unaccompanied by estimates, and did not admit of any accurate calculation with regard to their probable cost.

"In examining the designs, which are 218 in number, and which embrace nearly 2000 drawings, our first object was to ascertain how far those competitors whom we deemed most worthy of notice, had or had not sufficiently complied with the instructions issued by her Majesty's government.

"In this detailed examination we obtained, through you, the assistance of two gentlemen of great experience and of high professional character, namely, Mr. Angell and Mr. Pownall, and we are anxious to bear our testimony to the valuable services of these gentlemen.

"Of the block plans we desire to remark, that we would not be supposed to approve of all the extensive alterations and demolitions recommended in the selected designs, which we nevertheless believe to contain many valuable suggestions.

"With regard to the designs for the Foreign and War Departments, a difficulty presented itself in consequence of several of the competitors having sent in designs combining in one building, more or less unfitted for subdivision, both the public offices for which distinct prizes have to be awarded, whilst others have either confined their efforts to one of the buildings, or have given separate designs for each.

"It will be evident that these united designs compete under considerable disadvantage with the single designs, and that unless a united design should be superior in both departments to all its single competitors, it could not receive a prize, because one portion of it could hardly be executed without the other.

"We have been obliged to meet this difficulty by treating the lower prizes as marks of distinction for merit rather than as indicating special selection of the design as fitted for separate construction.

"We desire to express our great admiration of the unprecedented collection of designs submitted to us; of the artistic genius, manual skill, and patient labour which have combined to produce it, as well as of the eminent ability which so many of the competitors have displayed in dealing with internal arrangement, and in adapting the required accommodation to a definite area of ground, and to record our opinion that the collection reflects the highest credit upon the architects, Foreign and English, who have so liberally responded to your appeal."

NOTES OF THE MONTH.

The distribution of prizes in the Classes of Architecture and Engineering at University College took place on the 1st of July.

Fine Art.—First year—Prize and 1st certificate, Frederick Judge; 2nd certificate, John S. Babb; 3rd certificate, Walter Smith; 4th certificate, George Molesey.—*Second year*—Prize and 1st certificate, George Mills; 2nd certificate, John Thomas Daintree.

Construction.—First year—Prize and 1st certificate, John S. Babb; 2nd certificate, Walter Smith; 3rd certificate, George Molesey.—*Second year*—Prize and 1st certificate, John T. Daintree; 2nd certificate, George Mills.

Civil Engineering.—First division—Prize, Joseph Fogerty; certificate, John Austie (eq), Laurie Magnus, and Edward Asher.—*Second division*—Prize, Joseph Fogerty; certificate, Leopold Bauer.

Geology—(Prof. Morris).—1st prize, W. H. T. Power; 2nd, J. B. Taunton; certificates, J. E. Minshall, J. F. Payne, and Leopold Bauer.

A society under the title of the Institution of Engineers in Scotland was founded on the 1st of May last, for the encouragement and advancement of engineering science and practice, and to facilitate the exchange of information and ideas amongst its members, and to place on record the results of experience elicited in discussion. The meetings are to take place regularly at least once in every four weeks during each session, commencing in October and continuing until the month of April following. The Society consists of Members, Associates, Graduates, and Honorary Members, the subscription being for Members, first year, three guineas, second year, two guineas; Associates, first year, 2*l.* 12*s.* 6*d.*, second year, 1*l.* 11*s.* 6*d.*; Graduates, one guinea every year. The following gentlemen are the Office-bearers for session 1857-8.—*President*, W. J. Macquorn Rankine; *Vice-Presidents*, James R. Napier, Walter Neilson, Neil Robson; *Councillors*, W. Ramsay, W. Tait, A. M'Onie, W. Johnston, R. B. Bell, B. Connor, A. Allan, J. Downie, D. Mackain, W. Alexander; *Treasurer*, D. More, Montrose Street, Glasgow; *Secretary*, E. Hunt, St. Enoch Square, Glasgow.

Long-projected improvements upon Dunbar harbour are about to be carried into effect. The Treasury are said to be prepared to sanction an outlay of 30,000*l.* towards carrying out the improvements and alterations on the Victoria Harbour, agreeably to plans which the local magistrates have laid before them. The harbour will then be capable of admitting vessels and boats at low water, by which shelter will be obtained by them at all times, instead of running for the Firth of Forth in a storm.

The Military parade-ground, or Brickfield, at Devonport, will probably be converted into a park for the public, at a cost of about 500*l.* The authorities of the War Department are said to have approved of the plan, on condition of having still the use of the ground for parade purposes. New roads are also in contemplation, one 40 or 50 feet wide from the Stoke-road along the boundary-wall of the pleasure-ground in front of St. Michael's-terrace, and parallel with Tamar-terrace, to the proposed railway station at Stoke, which is to be erected on the south side of St. Michael's Church. The railway company will contribute 500*l.* towards its formation, which will nearly cover the cost. It is also proposed to form a direct road from Stonehouse-hill to the head of Fore-street, for the convenience of the military from Plymouth and Stonehouse going on guard at Keyham and Bull Point, and also for a ready means of access to the general military parade-ground—the Brickfield.

The *William Corey*, the pioneer of a fleet of large screw colliers intended to run between Cardiff and London, to supply the London market with Welsh steam coal, was launched last month. It is but a few years since the first steam collier was launched, and the average cargo carried by these vessels does not exceed 600 tons, with engines of about 60-horse power, but the *William Corey* is intended to carry a cargo of 1500 tons, exclusive of 150 tons of fuel, and she has engines of 120-horse power. The iron hull is so constructed that 400 tons of water for ballast can be admitted, a large and efficient steam-pump being also provided to discharge this water within three hours, thus avoiding detention in port. She is of immense strength, and when laden will weigh 3000 tons; it is estimated she will deliver into the port of London during one year 50,000 tons of Welsh coal. Hydraulic machinery has been erected in the Victoria Docks for the entire discharge of her cargo in 16 hours. This vessel is built to maintain the competition with railways in the London market; and if the experiment succeeds, the builders, Messrs. Mitchell and Co., of Low Walker, will have an order for a vessel double the size. The owners anticipate to sail the vessel at 3*s.* 6*d.* per ton, and that a vessel twice her size could be sailed at 2*s.* per ton; of this the owners are perfectly satisfied. She is an exceedingly handsome looking vessel, of greater length than the *Duke of Wellington*, has 23 hands on board, and has been built and finished for sea at a cost of about 23,000*l.*

The news that recurs most frequently in the Russian press is the discovery of extensive fields of coal and strata of iron. The last announcements of this kind are from the Crimea and the land of the Cossacks of the Don. In Kamisch Burun, in the neighbourhood of Kertch, there has been iron ore discovered, which yields 35 per cent. of iron, and is smelted by anthracite coal raised on the banks of the Don. In that district there is said to be an extensive coal-field, of about 2000 square versts, the richest part of which is found in the neighbourhood of Alexandrovska (about 80 versts from Marioupol), where two strata varying from 6 to 7 feet in thickness, are found at a depth of 16 and 20 fathoms from the surface. According to the calculations made on the spot, it is computed that a square verst there will produce 175,000,000 lb. of coals.

The Birmingham Patent Tube Company have introduced an improved description of stove and hot-water apparatus, by which one ordinary fire is made to heat several chambers. The heat is generated in a coil of tubing placed behind the grate; the water in the coil becoming warm, begins to ascend and follow the travel of the piping, transmitting the heat obtained in the coil through to any length of piping. The peculiarity in the grate consists in its having a double back, so that if it be required to increase the heat, the register is shut, and the heated air passes through the coil and up between the backs; while to decrease the heat, it is simply necessary to throw back the register, when the chamber between the backs is closed, and the heat ascends the chimney in the regular way. The improvement in the arrangement of the piping consists in having the ends open, whereby accidents become impossible, and the inconveniences generally attending the use of hot water for heating are removed. The apparatus may be usefully applied.

Connected with the baths near the Stabian Gate at Pompeii, a correspondent of the *Athenæum* announces the discovery of a vaulted chamber, with a species of basin six palms in depth: it is thought probable it was a Fullonica or public washhouse, the ancient Greeks having washed their clothes by treading on them, as is sometimes done in Scotland and elsewhere at the present day. At one side of the entrance to the chamber there are two leaden spouts in the form of the beaks of geese. On one side of the apartment are four very small chambers, each with a small bath. An inscription in another room adjoining records the restoration of the baths by the Ædiles, from money assigned by the law for the public games and for monuments.

OBITUARY.

On the 19th ult., Charles Heard Wild, Civil Engineer. Mr Wild was a pupil of John Brathwaite, and afterwards studied practically in the factory of Messrs. Brathwaite and Co. At a very early age he was entrusted with an important mission in France, to superintend the construction of Ericsson's propeller boats. On his return to England he was placed at the head of Messrs. Fox, Henderson, and Co.'s drawing-office at Birmingham, where the designing of many important works was confided to him; and he here displayed such a remarkable aptitude for engineering science, that he was, on being introduced to Mr. Robert Stephenson, engaged by him as one of his principal assistants on several works of magnitude—among others, the Britannia-bridge, where Mr. Wild largely assisted in devising and carrying out the floating of the tubes. In Mr. Edwin Clark's work on the 'Britannia and Conway Tubular Bridges,' there is a very valuable paper on the "Deflection and relative Strains in single and continuous Beams," from the pen of Mr. Wild, which furnishes a very high idea of his powers. On the recommendation of Mr. Stephenson, Mr. Wild was appointed assistant engineer under Sir William Cubitt, to the building in High Park; and on the formation of the Crystal Palace Company, Mr. Wild was appointed engineer to the building at Sydenham, which was erected under his engineering superintendence. It was at this period that a brain disease, which has just terminated fatally, first declared itself; and he was recommended by his medical adviser to resign his post, and to travel abroad for two years, which he did, with, however, but little benefit. Mr. Wild was the author of several valuable improvements in railways; his railway switch is now universally adopted, and it is considered by engineers that he completely solved the problem of a change of rails. "Warren's girder," which is now so much employed for railway bridges, owes its success to Mr. Wild's assistance, notably at the Newark-bridge and the Crumlin viaduct. His "Hexagon turn-table," and "dock-gates," are also amongst the valuable improvements which Mr. Wild has left behind him, in some way to compensate for a life of such great promise being thus early terminated.

On the 15th ult., at Vichy, in the fiftieth year of his age, Monsieur Lassus, the eminent Gothic architect of France. To the architectural world in England he is familiarly known as the opponent of eclecticism, and as the uncompromising enemy of any but Gothic architecture. His works, which will always secure to his name a distinguished position in the art-records of his country, and are the best known to Englishmen, are the intelligent, honest, and artistic restorations of La Sainte Chapelle, and of the Cathedral of Notre-Dame, in conjunction with Monsieur Violet-le-Duc.

COMPETITIONS.

Plans and estimates are wanted for Day and Sunday Schools, teacher's house, &c. to be erected at Heckmondwike, Yorkshire. Premium 10*l*. Particulars may be obtained of Mr. G. Burnley, Heckmondwike.

Plans are required for laying out about twenty-one acres, in Suburban Villa Sites, at Newcastle-under-Lyme. Particulars may be obtained of Mr. R. Slaney, solicitor, Newcastle, Staffordshire.

Designs are invited for a Monument to be erected at Sheffield, to such natives of the town as perished in the war with Russia. The monument is proposed to be of an architectural character, embodying incidents of the late war, and on which spaces must be arranged so that the name of every man commemorated may be legibly inscribed. The style, size, and material of the monument to be left entirely to the competitors. The cost of the whole complete not to exceed 1200*l*. For the best or selected design a premium of 30 guineas will be accorded, and for the second best 20 guineas. Such designs to become the property of the Committee. The premium for the best design will be given in addition to the usual commission. All designs must be on the scale of one quarter of an inch to a foot, and must consist of plans, elevations, and specifications, and are to be sent in or on before the 15th instant, addressed to the Town Clerk, Sheffield. The designs will be afterwards publicly exhibited.

The Directors and Committee of the Ulster Banking Company are desirous of receiving Designs for the elevations, &c. of a new Bank-house in Belfast. A plan of the block, and other information can be had on application to the secretary. Premium 100*l*. Designs to be sent in by the 17th instant.

Plans, designs, and estimates are invited for erecting an Infirmary at Blackburn, to contain 60 beds; the building to be of brick, with stone facings, and the plans to be prepared with a view to future extensions. Particulars can be obtained of Mr. Thos. Ainsworth, Town Clerk, Blackburn, Lancashire. Plans to be sent in by the 25th instant.

The Cambridge Music Hall and Public Rooms Company is desirous of procuring Designs for the erection of buildings to be used for a music hall, rooms for various public purposes, and public baths and washhouses. Outlay not to exceed 7000*l*. Premium 50*l*., will be given if not employed to carry out the works. A sketch of the site and further particulars may be obtained of Messrs. Reed and Foster, solicitors, Cambridge. Designs to be sent in by the 26th September.

Drawings or models of designs are invited for the erection of a Memorial of the Great Exhibition of 1851. Premium 100 guineas. Designs to be sent in by October 30.

The municipal authorities of Bourdeaux have invited artists of all countries to submit designs for a Fountain of monumental character to be erected in that city. The choice of material is left open, and may be of several kinds; the cost is not to exceed 8000*l*. A premium of 240*l*. will be awarded, if a design of sufficient merit to justify it be presented. In addition, the sum of 160*l*. will be placed at the disposal of the jury, and be appropriated as they may decide. In the event of the execution of the selected design being confided to the author of it, he is to receive, independently of the selected design, an honorarium equal to the twentieth of the whole outlay. The designs are to be sent in by the 20th of November next.

Competitions Awarded.

The Judges appointed to investigate the merits of the Designs for the Government Offices lately exhibited in Westminster Hall, have made the following awards. The names are arranged in the order of merit as decided by the judges, with the motto and amount of premium.

Design No. 1.—Block Plan.

	No., and Motto.	Premium.
1. M. A. Crepinet, Grand rue à Vaugirard, Paris.	12.—A. C.	£500
2. Mr. Hastings, Belfast	189.—Corso.	200
3. Messrs. Morgan and Phipson, 3, Danes-inn, Strand.	128.—Confido.	100

Design No. 2.—Foreign Office.

1. Messrs. Coe and Hofland, 8, Danes-inn, Strand.	94.—Utilitas.	£800
2. Messrs. Banks and Barry, 27, Sackville-street.	58.—Opera 81.	500
3. Mr. George Gilbert Scott, 20, Spring-gardens.	116A.—Nec minimum, &c.	300
4. Messrs. Deane and Woodward, Merrion-street, Dublin.	35.—Thou hast covered my head, &c.	200
5. Mr. T. Bellamy, 8, Charlotte-street, Bedford-square.	17.—B. Z.	100
6. Messrs. Buxton and Habershon, 38, Bloomsbury-square.	54.—Suaviter fortiter.	100
7. Mr. G. E. Street, 33, Montague-place, Bedford-square.	129.—A vaillants cœurs, &c.	100

Design No. 3—War Office.

1. Mr. H. B. Garling, 11, King's-road, Gray's-inn.	77.—Fortiter et fideliter.	£800
2. M. A. d'Haseville, rue du Nord, Paris...	75.—Deus atque jus.	500
3. Mr. J. T. Rochead, Glasgow	61.—Anglo-Saxon.	300
4. Messrs. Prichard and Seddon, Llandaff	140.—Cymru.	200
5. Mr. Cuthbert Brodrick, 17, East-parade, Leeds.	20.—Corona.	100
6. Messrs. W. G. and E. Aberhson, 38, Bloomsbury-square.	54A.—Au bon droit.	100
7. Mr. J. Dwyer, 11, Great Marlborough-street.	126.—Westminster.	100

No. 5, 6, 7, in Designs Nos. 2 and 3, being entitled to premiums of equal value, are placed according to their numbers in the Exhibition, without regard to relative merit.

The committee for the erection of St. Leonard's National School, Bilston, have selected the designs of Messrs. Briggs and Everal, of Birmingham, submitted in competition.

Eight sets of plans were sent in for the Leeds Town-hall Organ, and the sum of 150*l*. awarded to the plans bearing the motto "Semper fideles," to be paid on condition that the committee can succeed in making a contract for the completion of the organ for the stipulated sum of 4000*l*. Messrs. H. Smart, of London, and W. Spark, of Leeds, were the successful competitors.

The committee for erecting the new Church, Ryland-street, Birmingham, have selected the plans of Mr. Bourne, of Dudley, as those from which the intended edifice will be built.

The governors of the Moulton Endowed School have awarded the premium to Messrs. Mitchell and Fawcett, of Sheffield, for the best plans for school-rooms and outbuildings for the Upper School, Moulton.

Twenty-nine designs were sent in for the Minton Testimonial. The decision of the committee was in favour of "To be or not to be," by Messrs. Pugin and Murray, of London and Coventry. The architects guarantee to carry out the design for the sum specified in the advertisement, namely, 2500*l*. The style of the selected design is "Venetian Gothic."

Mr. R Parkinson has been appointed to the office of District Surveyor for the Western Division of the City of London, vacant by the death of Mr. J. H. Stevens.

NEW PATENTS.

PROVISIONAL PROTECTIONS GRANTED UNDER THE PATENT LAWS AMENDMENT ACT.

Dated April 22.

1126. J. Sharples, Crawshaw Booth, near Rawtenstall, Lancashire—Improvements in drying cotton and other fibrous substances or materials

Dated May 6.

1274. J. P. Becker, Paris—Improvements in the mode of silvering animal, vegetable, and mineral objects

Dated May 12.

1330. P. A. le Comte de Fontainemoreau, London—An improved hydraulic motor. (Communication)

Dated May 20.

1418. T. Knight, Upton, Cheshire—Improved cutter and cultivator of land

Dated May 21.

1438. J. W. Hackworth, Darlington — Improvements in machinery or apparatus for forcing, lifting, and exhausting aeriform bodies and liquids, applicable to blast furnaces

Dated May 25.

1462. T. Bullock, Skinner-place, Holloway—The construction of water-closets upon the principle of self-action and self-cleansing, called the self-cleansing water-closet

1464. W. Robertson, Glasgow—Improvements in pistons, and in apparatus connected therewith

1466. W. E. Newton, Chancery-lane—Improved counting apparatus, applicable for counting envelopes, cards, printed papers, or other articles that require to be put up in packets or parcels containing fixed numbers. (Communication)

1467. H. W. Ford, Gloucester—Improvements in apparatus for facilitating the draught and locomotion of carriages

1468. A. Countant, Paris—Improvements in forging and rolling iron wheels for railways

1470. J. Crossley, St. Helen's, Lancashire—Improvements in machinery for grinding and smoothing glass, marble, and other substances

1476. J. Earnshaw, jun., Ossett, near Wakefield—Improvements in the toothed coverings of rag machine cylinders, and in the machinery or apparatus for preparing the same

Dated May 27.

1482. W. Hart, Brigg, Lincolnshire—Improvements in signal lamps

1484. W. S. Clark, High Holborn—Improvements in machines for producing artificial ice from cream and other liquids. (Communication from G. W. Robinson and C. W. Lord, United States)

1486. W. S. Clark, High Holborn—Improvements in copying presses. (Communication from W. Smith and P. Hannay, Washington, United States)

1488. J. Sutcliffe, Manchester—Improvements in water gauges

1490. W. Holland, Birmingham—Improvements in umbrellas and parasols

1492. H. Crompton, Farnworth, Lancashire—Improvements in machinery or apparatus for stretching woven fabrics

1494. J. Savory, Tewkesbury—A machine for separating seeds, whitecoats, and dirt from wheat and seeds, awns and dirt from barley, and for cleaning and polishing wheat, barley, and other grain fit for market

1496. W. Sawney, Beverley, Yorkshire—Improvements in winnowing or corn-dressing machines

1498. V. Bacqueville-Pieters, Paris—Improvements in outside blinds or shades for windows, doors, and other places

1500. R. Cresswell, Conduit-street—Improvements in grease or lubricating boxes for axles and other rotary parts of machinery

1502. R. A. Brooman, Fleet-street—Improvements in distilling and in apparatus employed therein. (Communication)

1504. L. J. A. Danne, Caen—Manufacturing gutta-percha glue, and applying the said glue to various new purposes

1508. E. P. Griffiths, High-street, Camberwell—Improvements in apparatus for beating the whites of eggs and other fluids and matters

1510. W. Hale, Swan-walk, Chelsea—Improvements in rolling iron and steel

1512. A. V. Newton, Chancery-lane—Improved apparatus to be used in the manufacture of iron. (Communication)

Dated May 28.

1514. N. Cox, Liverpool—Improvements in railways. (Communication)

Dated May 29.

1516. W. Wilber, New York, United States—Hot-air apparatus for hulling and extracting oils from oleaginous seeds

1517. T. Willis and G. Chell, Longsight, near Manchester—Improvements in machinery for spinning, doubling, and winding yarn and thread.

1518. C. Fleet, Brighton—Improvements in the manufacture of printing ink. (Communication from G. Matthews, Montreal, Canada)

1520. J. Merrylees, Paisley—Improvements in the manufacture or production of ornamental fabrics

Dated May 30.

1524. W. S. Clark, High Holborn—Improvements in machinery for the manufacture of an instrument for sharpening watch-cleaning sticks used by watchmakers, said instrument being also applicable to the sharpening of small wooden cylinders for other purposes, such as lead pencils, &c. (Communication)

1526. E. Alexandre, Essex-street—Improvements in the manufacture of organs and other similar musical instruments

1528. Dr. H. Bleibtreu, Alum works, near Bonn-on-the-Rhine—A new mode of preparing coke for metallurgical processes

1530. J. James and W. D. Grimshaw, Southampton—Improved screw propellor for propelling ships or other navigable vessels through water

1532. J. Salles, Paris—Improved safety lock

1534. G. W. Pye and T. Oldknow, Nottingham—Improvements in machinery for manufacturing bobbin net or twist lace

1536. T. Sherratt, South-square, Grays-inn—Improvements in time-keepers

Dated June 1.

1540. W. H. Walenn, Chancery-lane—Improvements in the electric deposition of metals and metallic alloys

1544. H. D. Pochin and J. Woolley, Manchester—Improvements in the manufacture of gum from amylaccous substances

1548. R. Wright, Brighton—Improvements in steam boilers

Dated June 2.

1550. C. Shaw, Birmingham—A new or improved manufacture of matts for photographic and other pictures

Dated June 4.

1571. C. Martel, Boulogne—Improvement in fire-arms

Dated June 5.

1586. J. Jordan, Liverpool—Improvements in the construction of iron ships or vessels

1588. J. Morris, Clapham—Improvements in connecting the rails of railways, and in supporting the same

Dated June 6.

1600. H. Clarke, Horncastle, Lincolnshire—Improvements in rotary engines

Dated June 9.

1604. J. Bickford, Crediton, Devon—Improvements in machinery for cutting gutters for irrigating land and for cutting other surface drains or gutters

1606. W. Wright, Forth-street, Newcastle-on-Tyne—Improvements in apparatus for feeding fires and furnaces with fuel

1608. I. Whitesmith and W. Whitesmith, Glasgow—Improvements in weaving

1610. C. A. Kurtz and L. A. Nori—Improvements in extracting the colouring matter from gum lac and other similar substances, and in treating the residues thereof

1614. W. E. Newton, Chancery-lane—Improved arrangement or construction of cut-off gear for steam engines. (Communication)

1616. W. E. Newton, Chancery-lane—Improved construction of faucet or cock. (Communication)

1618. G. Mumby, Cloudesley-square—Improvements in machinery for sewing, embroidering, and other ornamental work

1620. G. Baxter, Northampton-square—Improvements in printing in colours

Dated June 10

1623. J. Brown, Aldgate—Improvement in the manufacture of paper

1624. J. S. Bailey, Keighley, Yorkshire—Improvements in machinery for combing wool and other fibrous materials

1625. G. Jarrett, London—Improvements in apparatus for printing or endorsing in colours on paper or other surfaces, being improvements upon the invention secured to him by Letters Patent dated July 29, 1858

1626. M. Miller, Glasgow—Improvements in cocks, taps, or valves

1627. W. Gorse and S. Pollock, Birmingham—Improved machinery for the manufacture of bricks and other articles of like manufacture

1628. T. H. Roberts, Stonehouse—Improvements in the manufacture of casks

1629. G. Sampson and J. Sampson, Bradford, and E. Ledger, Lofthouse, near Wakefield—Improvements in means or apparatus for effecting the folding or rigging of woven fabrics

1630. A. Dunn, Dalston—Improvement in preparing and packing tooth powder

1631. M. Puddefoot, Queen's-terrace, Woolwich-road, Greenwich—Improvements in mowing machines

1632. E. Lemoine, Paris—Improvements in gas meters

1633. A. V. Newton, Chancery-lane—Improvements in reaping machines. (Communication)

1634. A. V. Newton, Chancery-lane—Improvements in the construction and mode of propelling and steering navigable vessels. (Communication)

1635. W. E. Newton, Chancery-lane—Improvements in printing machinery. (Communication)

Dated June 11.

1636. G. F. Remfry, Riches-court, Lime-street—Improved apparatus for supporting, protecting, and propelling the human body in water

1637. A. Folson, Boston, United States—Improvements in the construction of tunnels or ways under water

1638. D. J. Daly, Tuckey-street, Cork—Improvements in venting casks and in preserving them from bursting by the action of the liquors contained in them

1639. J. Robertson, Glasgow—Improvements in lifting, lowering, transporting, and regulating the motion of heavy bodies

1640. J. Shaw and H. Shaw, Waterhead-mill, Oldham—Improvements in machinery or apparatus for preparing and spinning cotton and other fibrous substances

1641. J. L. Clark, Adelaide-road, Haverstock-hill—Improvements in apparatus for conveying letters or parcels between places by the pressure of air and vacuum

1643. W. Wilkins, Leicester—Improvements in machinery for the manufacture of looped fabrics

Dated June 12.

1644. J. Elce and S. Hartley, Manchester—Improvements in machinery for preparing moulds for casting iron or other metals

1645. J. Whitworth, Manchester—Improvements in ordnance, fire-arms, and projectiles, and in machinery employed in their manufacture

1646. J. Buchanan, Glasgow—Improvements in the manufacture and finishing of heddles or healds for weaving, part of which improvements are applicable to the preparing and weaving of fibrous materials

1647. T. Rutter, Birmingham, and J. Banister, Birmingham — Improvements in umbrellas and parasols

1649. G. Davies, Serle-street, Lincoln's-inn—Improved apparatus for weighing grain and other articles, to be called the electro-magnetic grain scale. (Communication from N. M. Phillips, New York)

1650. B. Noakes and F. Wood, Spa-road, Surrey—A method of and apparatus to be employed in the sealing of the joints in metallic casks and other similar vessels

1651. E. Brasier, Stepney—Improvements in treating flax, hemp, and other vegetable fibres, and in the machinery employed therein

1652. C. d'Ambly, Stuttgart—Improvements in cutting and preparing horn. (Communication)

1653. C. G. Carleman, Jewin-crescent—Improvements in submerged propellers for propelling vessels

1654 M. Macdonald, Glasgow—Improvements in washing, bleaching, cleansing, and preparing textile fabrics and materials

1655. E. Barsanti and F. Matteucci, Florence—Improved apparatus for obtaining motive power from gases

1656. C. Brazil, Chorley, Lancashire—Improvements in looms for weaving

1657. G. Lister, Rivers, near Dursley, Gloucestershire—An improvement in carding engines

Dated June 13.

1660. R. Mushet, Coleford, Gloucestershire—Improvements in the manufacture of cast steel

1661. J. King, Glasgow—Improvements in the manufacture or production of collars, cuffs, and similar articles of ladies' dress

1662. C. March, Alwalton-mills—Improvements in obtaining motive power

1663. E. Cominal, Paris—Improvements in printing shawls and other tissues

1664. T. M. Jones, Cambridge-villas, Fulham—Improvements in apparatus for cutting and gathering fruit and flowers

1665. A. V. Newton, Chancery-lane—Improvement in the manufacture of sulphuric acid. (Communication)

1666. H. Gartner, Mount-gardens, Lambeth—Improved construction of engine for raising and discharging water

Dated June 15.

1667. T. Heaton, Bolton—Improvements in self-acting doors and gateways

1668 C. Vero and J. Everitt, Atherstone, Warwickshire—Improvements in the manufacture of hats and other coverings for the head, and in machinery or apparatus to be employed in the said manufacture

1669. J. H. Johnson, Lincoln's-inn-fields—Improvements in quadrants, sextants, and other similar instruments. (Communication from J. C. Lane, Brooklyn, New York, United States)

1671. W. E. Newton, Chancery-lane—Improvements in puddling iron, and in the furnaces and apparatus employed for the purpose. (Communication)

1672. F. Levick, jun., and J. James, Cwm Celyn and Blaina Ironworks, Monmouth—Improved construction of hot blast stove

1673. A. V. Newton, Chancery-lane—Improved means of registering the performance of railway trains. (Communication)

1674. E. Thompson, Barnard's-terrace, Scawby-with-Sturton, Lincolnshire—Improvements in pianoforte hammers

Dated June 16.

1677. T. W. Lord, Leeds—Improvement in machinery for carding flax, tow, and other fibrous substances
1679. S. Holman, Whitefriars-street—Improvements in force pumps
1680. J. Cocker, Liverpool—Improved construction of gauge for measuring wire and other articles
1681. W. E. Newton, Chancery-lane—Improved mode of and apparatus for feeding in fuel to furnaces and fire-boxes. (Communication)
1683. W. A. Edwards, Denmark-road, Camberwell—Improvements in apparatus for separating iron and other matters from ores and other substances
1684. J. Fowler, jun., Cornhill, R. Burton, Maberley-terrace, Ball's-pond-road, and T. Clarke, St. James's-place, Hackney-road—Improvements in the construction and arrangement of locomotive and other carriages, to facilitate their movement on common roads and other surfaces
1685. G. T. Bousfield, Loughborough-park, Brixton—Improvements in the construction of wheels and axle-boxes. (Communication)
1686. J. Ellis, Brighton—Improvements in apparatus to be used for decanting wine and other liquids, and for drawing corks from bottles
1687. W. B. de Blaquiere, Pall-mall—Improvements in connecting the ends of submarine telegraph cables
1688. R. Goulding, Bonner-road, Victoria Park—Improvements in the extraction of gold and silver and other metals

Dated June 17.

1689. P. Kürten, Cologne—Improved process of manufacturing mottled soap
1690. J. Smith, Oldham, Lancashire—Improvements in the manufacture of woven fabrics
1691. W. Hodgson and H. Hodgson, Bradford, Yorkshire—Improved lubricator or oiler by means of force pumps or valves
1692. S. Sturm, and H. E. Bour, Paris—Improvements in optical lenses, and machines for manufacturing the same
1693. H. Hosch, Old Jewry—Improved shirt-cutting machine
1695. F. Warner, Jewin-crescent—Improvements in supplying water to water-closets and other vessels
1696. G. Marqfoy, Bordeaux—Improvements in actuating railway signals
1697. H. Brinsmead, Fore-street, Ipswich—Improvements in machinery for dressing corn
1698. F. Ransome, Ipswich—Improvements in moulding plastic materials
1699. A. V. Newton, Chancery-lane—Improvements in machinery for forging nails and other articles. (Communication)
1700. H. Hibbert, Salford, and H. Richardson, Manchester—Improvement in finishing or polishing yarns or threads

Dated June 18.

1701. G. P. Clark, Newark, New Jersey, United States—Improved safety valve for steam boilers
1702. T. L. Ralph, and T. L. Ralph, jun., Birmingham—Improvements in the manufacture of metallic tubes
1703. T. Ward, Great Bridge, Staffordshire—Improvements in the manufacture of strip and hoop iron
1704. E. Sykes, and M. W. Crawford, Glossop, Derbyshire—Improvements in the construction and arrangement of the pans or vessels, and the furnaces and flues to be employed for the purposes of soap boiling, tallow melting, bone boiling, dreg boiling, and other similar offensive processes
1705. W. J. Thompson, North Shields—Improvements in machinery for preparing small coal and other matters to be used as fuel. (Communication)
1707. G. W. Charlwood, Tavistock-row, Covent-garden—Improvements in machines for mowing and reaping. (Communication)
1708. H. H. Day, New York, United States—Improvements in preparing and vulcanising india-rubber, gutta-percha, or other analogous gums. (Communication)
1709. H. H. Day, New York, United States—Improvements in the manufacture of elastic fabrics

Dated June 19.

1711. J. Champion, Manchester—Improved arrangements of spindles and flyers, applicable to machinery or apparatus for preparing, spinning, and doubling fibrous materials
1712. S. Pincoffs, Manchester—Improvements in treating madder, munjeet, or any of their preparations
1713. T. Spencer, Southampton-place Euston-square—Improvements in the purification of water, and other fluid and gaseous bodies
1714. J. Hill, Mount Pleasant, near Ferry Hill, Durham—Improvements in the permanent way of railways
1715. J. H. Johnson, Lincoln's-inn-fields—Improvements in pressure gauges. (Communication)
1716. H. Jaegar, Ludgate-hill—Improvements in looms for weaving. (Communication)
1717. H. H. Day, New York, United States—Improved method of treating or purifying gutta percha. (Communication)
1718. J. D. Garrett, Saxmundham, Suffolk—Improved construction of horse-hoe
1719. W. E. Newton, Chancery-lane—Improvements in the construction of railway crossings. (Communication)
1720. R. Rennie, Netherwood, Dumbarton—Improvements in self-acting trap-doors for mines

Dated June 20.

1721. E. Kirk, J. Leadbetter, and C. Wilson, Leeds—Improvements in the manufacture of trunks, boxes, and other similar depositaries
1722. W. Wright, Sheffield—Improvements in flushing apparatus applicable to cisterns and waterclosets
1723. E. V. Gardner, Norfolk-street, Middlesex-hospital—Improvements in the means employed for burning fuel and in the distribution of heat
1724. S. Fox, Deepcar, Sheffield—Improvements in fly presses
1725. T. Grahame, Upper Seymour-street—Improvements in facilitating the passage of carriages on inclines of railways
1726. S. Fox, Deepcar, Sheffield—Improvements in the manufacture of umbrellas and parasols
1727. H. Dunington, Nottingham—Improvement in the manufacture of cotton and silk and other warp pile fabrics
1729. E. Clark, Great George-street, and J. H. Tuck, Pall-mall—Improvements in blocking or supporting ships and other vessels for the purpose of docking them
1730. J. White, Coventry—Improvements in escapements for chronometers and other timekeepers
1731. L. St. L. Bunn, Wallbrook—Improvements in the manufacture of Wellington boots
1732. W. R. Lomax, Albion-road, Hammersmith—Improvements in governors and pressure gauges
1733. T. F. Caldicott, Boston, United States—Improvements in planes. (A communication)
1734. L. Cowell, Adelphi—An improved machine for teaching the art of swimming
1735. W. E. Newton, Chancery-lane—Improvements in looms for circular weaving, partly applicable to other purposes. (Communication)
1736. J. G. Lynde, Great Queen-street, Westminster—Improved means of detecting and preventing the waste of water in cisterns
1737. C. Fletcher, Gloucester—Improvements in machinery for making bricks, tiles, and other articles of clay, or plastic materials
1738. G. W. La Baw, Jersey, Hudson, United States—Operating the sails of vessels from the deck by means of vertical shafts

Dated June 22.

1739. P. A. le Comte de Fontainemoreau, London—Improved propeller. (Communication)
1740. W. E. Newton, Chancery-lane—Improved machinery for cutting files. (Communication)
1741. J. Norris, jun., New York, and G. Worstenholm, St. Louis, Missouri, United States—Improvements in machinery for making nails, bolts, spikes, screws, rivets, and screw blanks
1742. Sir F. C. Knowles, Lovell-hill, Berks—The manufacture of aluminium and of certain re-agents to be used therein
1743. R. Murdoch, Baltimore, Maryland, United States—Improved running gear for vehicles
1745. T. Mackenzie, Rathbone-place, Oxford-street—Improvements in the internal decorations of those parts of buildings to which window draperies are to be affixed, and in the arrangement and construction of the curtain fixtures
1746. W. Knapton, Monk-bar, York—Improved machine for drilling holes in metal and other substances

Dated June 23.

1747. T. C. Bridgman, Bury St. Edmunds—Improvements in the construction of sieves, screens, or riddles
1749. R. Shaw and J. Robinson, Burnley—Improvements in machinery for preparing cotton and other fibrous materials
1750. D. Proudfoot, Glasgow—Improvements in drying and preparing garancine
1751. J. Hinks, Birmingham, and J. S. Nibbs, Handsworth, Staffordshire—Improvements in securing and liberating the corks or stoppers of bottles, and in the construction of the necks of bottles, for facilitating the securing and liberating of corks and stoppers
1752. D. Evans, Railway-terrace, New Town, Stratford—Improvements in locomotive and other furnaces, and in heating water to be supplied to steam boilers
1753. R. A. Brooman, Fleet-street—Improvements in breech-loading fire-arms. (Communication)
1754. J. S. Rousselot, Paris—Improved method of obtaining motive power, and engine for applying the same
1755. R. A. Brooman, Fleet-street—Improved method of engraving and of copying figures, patterns, and other devices. (Communication)
1756. W. E. Newton, Chancery-lane—Improvements in generating or obtaining motive power. (Communication from W. Storm, New York)
1757. E. Woolley, High-street, Marylebone—An indicator for registering the names of persons occupying chambers and other apartments or offices, and for signifying whether such persons are in or out, and at what time they will return

Dated June 24.

1759. R. Morcom, Redruth, Cornwall—Improvements in dressing ores
1760. C. Herault, Paris—Improvements in apparatus for producing aërated waters. (Communication)
1761. R. Mallet, Bridge-street, Westminster—Improvements in tiles and coverings for roofs and other parts of buildings
1762. C. F. Vasserot, Essex-street, Strand—Improvements in the permanent way of railways. (Communication from J. C. Durand, Marseilles)
1763. H. Genhart, Liege, Belgium—Improvements in fire-arms, in rifleing the same, and in projectiles employed therewith
1765. J. Juckes, Dame-street, Islington—Improvements in washing machinery
1766. A. Parkes, Birmingham—Improvements in coating metals with other metals
1767. J. Church, Upper Kennington-lane, Vauxhall—Improvements in the manufacture of artificial fuel
1768. C. Sanderson, Sheffield—Improvements in the manufacture of railway bars, girders, and other articles requiring great strength and stiffness to resist pressure, concussion, or strain
1769. G. H. Muntz, Handsworth, Staffordshire—Improvements in the manufacture of metal tubes, and axles or shafts
1770. J. Exley and J. Ogden, Leeds—Improvements in furnaces or fireplaces for the prevention of smoke
1771. E. A. Bourry, St. Gall, Switzerland—Improvements in apparatus or machinery for working, expressing, and moulding clay and other plastic materials
1772. J. H. Johnson, Lincoln's-inn-field—Improvements in apparatus for testing the strength of materials. (Communication from F. C. Lowthorp, Trenton, New Jersey, United States)
1773. J. H. Johnson, Lincoln's-inn-fields—Improvements in the preparation of surfaces for receiving painted or printed impressions thereon. (Communication from E. Lee, Baltimore, United States)
1774. R. A. Brooman, Fleet-street—Improved composition or polish for maintaining the brilliancy of varnished or patent leather. (Communication from Dollier brothers, Paris)
1775. E. B. de la Pontonerie, Paris—Improvements in apparatus for consuming smoke

Dated June 25.

1776. C. G. Page, Washington city, United States—Improvements in cylindrical door bolts
1777. J. T. Pitman, Gracechurch-street—Improvements in machinery for making wood screws. (Communication)
1778. E. A. Bourry, Saint Gall, Switzerland—Improvements in kilns or ovens for burning or baking bricks, tiles, and other earthen or ceramic matters
1780. J. Loach, Birmingham—A metallic air-tight coffin
1781. J. Wright, Ernest-street, A. Wright, Bayham-place, and F. Roberts, Bayham-street, St. Pancras—Treating the rhubarb plant, to render its fibres applicable to the manufacture of paper, and the juice thereof to the manufacture of wines and spirits
1782. E. J. Crocker, Liverpool—Improvements in the rigging of ships and other vessels. (Communication)
1783. J. Ingham and E. Ingham, Bradford, and B. Ingham, Halifax—Improvements in preparing worsted yarns for dyeing
1785. A. Pelez, Southampton-buildings—A new composition for the manufacture of imitative stones. (Communication)
1786. J. Green, Onehouse, Stowmarket, Suffolk—Improvements applicable to bedsteads and other articles of furniture, for the purpose of excluding therefrom bugs or other similar insects
1787. W. Palmer, Western-road, Brighton—Improvements in watering-pots, garden-engines, and other apparatus for watering surfaces
1788. J. L. Hancock, Pentonville—Improvements in means or apparatus for washing or cleansing
1789. W. P. Struvé, Swansea—Improvements in miners' safety-lamps
1790. W. Bough, Bunhill-row—Improvements in lamps for burning resin and other oils and fluids, also an improvement in Argand gas burners
1791. S. Bourne, 4, Leonards-square, Kentish-town—Improvement in the manufacture of felted fabrics

Dated June 26.

1793. J. Lloyd, Anglesea—Improvements in utilising and deodorising sewage matters of dwelling-houses and other places, and in apparatus to be used in connection with the same
1794. R. Hattersley, Ardw.. near Manchester—Improvements in machinery for distributing and setting up or c...sing type

1796. W. Parsons, Brighton—Improvements in fittings to door handles and spindles
1797. B. Nicholls and S. Ledward, Manchester—Improvements in mules for spinning
1798. W. Crook, G. Rushton, and J. Crowther, Blackburn, Lancashire—Improvements in looms
1799. F. Watkins, Victoria Works, Smethwick, near Birmingham—Improvements in the manufacture of screw-nuts. (Communication)
1800. M. Michaelis and J. Clemson, Manchester—Improvements in the production of ornamental textile fabrics by printing
1801. B. J. Heywood, Leicester-square—Improvements in the manufacture of india-rubber goods
1802. S. Gaudrion, Chancery-lane—Improvement in screw propellors. (Communication)

Dated June 27.

1803. J. Preston, Pendleton, Lancashire—Improvements in apparatus for regulating the pressure of steam and other fluids
1804. J. Pollard, Highdown, near Hitchin, Hertfordshire—Improvements in machinery or apparatus for distributing manure
1805. C. Thurber, Worcester, Massachusetts, United States—Improved caligraph or writing machine, for writing and similar purposes
1806. J. Green, Newcastle-upon-Tyne, and W. Coppin, jun., Blyth, Northumberland—The preservation of timber
1807. R. Howland, London—Improvements in the construction of mangles
1808. P. E. Liger, Rouen, department of Sarthe, France—Improvements in grinding-mills
1809. A. A. Olivier, Paris—Improvements in treating or preparing and winding silk from the cocoon, and in apparatus for the same
1810. G. Swindells, and J. Arnold, Bollington, near Macclesfield—Improvements in spinning and doubling yarns, and in machinery or apparatus of the kind commonly known as mules and twining jennies
1811. J. Carter and B. Hodgson, Halifax—Improvement in weaving carpets and other fabrics
1812. W. E. Newton, Chancery-lane—Improved machinery for grinding the teeth of card cylinders. (Communication)
1813. J. Biggs, New Oxford-street—A portable folding perambulator, which is so constructed as to occupy less space than any that has hitherto been invented

Dated June 29.

1814. N. Laurent, Paris—Improvements in the process of dressing and manufacturing shammy leather
1815. S. Nye, Wardour-street—Improvements in mills for grinding coffee, pepper, spices, and other substances
1817. J. Pattison, Moorgate-street—Improved rotary pump
1818. J. Lawrence, Colnbrook, Middlesex—Improvements in apparatus for brewing
1819. J. F. Meakin, Baker-street, Portman-square—Improvements in carriages for children, commonly called perambulators, and applicable to carriages for invalids
1820. H. Gilbee, South-street, Finsbury—Improvements in machinery for moulding vermicelli and other paste. (Communication)
1821. J. L. Field, Lambeth, and C. Humfrey, jun., Camberwell—Improvements in the manufacture of candles
1822. G. A. Buchholz, Strasburg, France—Improved machinery for hulling and cleaning rice, wheat, and other grain.
1823. W. Maltby, Grove-hill, Camberwell—Improvements in the mode of extracting ammonia and other compounds from gas, gas liquor, sewerage, and other substances

Dated June 30.

1825. T. Hardcastle, Bradshaw, near Bolton-le-Moors, Lancashire—Machine for doubling, winding, plaiting, and measuring cotton and other fabrics
1826. I. C. Cl0et, Chancery-lane—An improved rice and barley mill
1827. W. Parsons, Clifton-street, Brighton—Improvements in fastenings for windows and casements, and for other similar purposes
1829. A. Spottiswoode, James-street, Buckingham-gate—Improvements in machinery for compressing artificial fuel and other substances
1830. W. Pole, Birdcage-walk—Improved means of supporting telegraph wires. (Communication from C. C. Adley, Serampore, East India)

Dated July 1.

1831. J. Nickless, Coalbrookdale, Salop—New or improved railway chair
1833. T. Brewer, Neithrop Banbury, Oxfordshire—Improvements in machines for cutting and reducing turnips and other vegetable substances
1833. A. Prince, Trafalgar-square—Improvements in the construction of irons used by tailors and others for pressing cloth and other materials. (Communication from Schaffer and Walcker, Berlin, and J. Herschmann, Prague)
1834. C. J. L. Leffler, Westbourne-terrace—Improved machinery for cutting corks, bungs, and other similar articles. (Communication)
1835. W. E. Newton, Chancery-lane—Improved processes for ornamenting metallic surfaces, and for producing surfaces in intaglio or in relief for printing purposes. (Communication from C. Nègre, Paris)

Dated July 2.

1837. F. L. H. Danchell, New Oxford-street, and H. Kimber, Grove-terrace, Clapham—Improvements in the manufacture of fire and waterproof bricks, plates, crucibles, and other vessels, forms for castings, and similar articles. (Communication from C. Buring, Rostock, Mecklenburg)
1838. A. Smith, Princes-steet—Improvements in the construction of life boats and other boats or vessels
1839. E. B. Olofson, Cologne, Prussia—Improvements in the manufacture of pigments or colours for preserving iron
1840. A. P. Malard, South-street, Finsbury—Improvements in filtering water and other liquids
1841. M. A. Laurent, South-street, Finsbury—A new antiseptic composition
1842. T. Moy, Clifford's-inn—Improvements in the mode of working steam engines
1843. W. M'Craw, Edinburgh—Improvements in the production of photographic pictures
1844. E. T. Bellhouse and W. J. Dorning, Manchester—Improvements in steam boilers
1845. C. Orphin, and E. Lyons, Birmingham—Improvements in table and other lamps
1846. G. Davies, Serle-street, Lincoln's-inn—Improved marine steam-engine governor. (Communication from W. H. Elliot, Plattsburg, New York, United States)
1847. G. Cutler, Manchester—Improvements in mangles
1848. T. Brown, Liverpool—An instrument for ascertaining the true or actual acclivity or declivity of bodies
1849. W. Rowan, Belfast—Improvements in scutching and heckling flax and other similar vegetable fibres, and in machinery employed therein
1850. W. Rowan, Belfast—Improvements in steam boilers and furnace flues
1851. C. W. Woodworth, Liverpool—Improvements applicable to capstans and other like purchases. (Communication)

Dated July 3.

1853. J. Lockett, Strangeways, Manchester, and W. Watson, Alexandria, Dumbarton,—Improvements in machinery for engraving or tracing designs on cylindrical or other surfaces for printing calico and other materials
1855. A. A. Croll, Harold's Wood Lodge, near Romford—Improvements in the treatment of liquors containing combinations of sulphur with ammonia
1857. E. Ruegg, South-street, Finsbury—Improved calendar inkstand
1859. H. D. Mears and W. Houlton, jun., Baltimore, United States—Improved seal for railway luggage vans and for other purposes
1861. W. T. Hendry, Upper Thames-street, and R. H. Hancock, Great Percy-street, Pentonville—Improvements in the manufacture of flexible tubes or hose pipes
1863. T. Royds, T. Roscow, and J. Lord, Rochdale—Improvements in lifting heavy bodies under certain circumstances, such as minerals or other substances from mines to the surface of the earth, or from one story of an edifice to another, and in machinery or apparatus to be used for such purposes

Dated July 4.

1865. M. Henry, Fleet-street—Improvements in machinery or apparatus for cutting vegetable substances. (Communication from Messrs. Ouin and Dugué)
1867. G. Cooper, Stanley-street, Sheffield—Improvements in safety lamps
1869. J. Mills, Leicester—Improved method of covering ricks, booths, tents, and such like places

Dated July 6.

1871. T. Bowden, Pendleton, Lancashire—Improvements in apparatus for discharging the water resulting from the condensing of steam used in apparatus heated by steam
1873. F. C. Hills, Deptford, Kent—Improvements in the manufacture of sulphuric acid

Dated July 7.

1875. J. Alison, Hainault Forest, Essex—Improvements in preparing vegetable substances for feeding animals, and in apparatus for that purpose
1877. W. A. von Canig, Birmingham—A new or improved compound or composition to be used as a substitute for gum, paste, and other adhesive materials, and for finishing, sizing, or stiffening fabrics and other articles to which the same is or may be applicable
1879. J. Platt, Audlem, Cheshire—Improvements in gun locks
1881. J. Speight, Bradford—Improvements in wool combing and in machines known as "Collier's combing machines"
1883. P. H. G. Bérard, Paris—Improvements in manufacturing azotic cotton or pyroxile for photographic and other purposes
1885. J. L. Jullion, Foot's Cray, Kent—The mechanical and chemical separation of solids from fluids
1887. R. A. Brooman, Fleet-street—The manufacture upon circular frames of a fabric suitable for petticoats and other garments, curtains, and other articles of furniture. (Communication from M. Lucevilliard)
1889. W. Burgess, Newgate-street—Improvements in reaping and mowing machines
1891. M. Henry, Fleet-street—Improvements in railways and wagons used therewith in loading and discharging coals, stones, ballast, earth, and other materials. (Communication from B. A. Soullié and G. Vigneau)

Dated July 8.

1893. J. T. Pitman, Gracechurch-street—A conical tent. (Communication)
1895. T. F. Henley, Bromley, Middlesex—Improvements in the preparation or manufacture of certain beverages or liquors of the nature and character of home-made wines, and in the means of obtaining the same
1897. J. Gibbs, Abingdon-street—Improvements in extracting gold and silver from their matrices, and from other substances and materials with which they are combined, mixed, or associated
1899. E. T. Bellhouse and W. J. Dorning, Manchester—Improvements in hydraulic presses
1901. L. A. Bahn, Greek-street, Soho—Improvements in galvanizing metals, and in the apparatus employed therein
1903. E. Moore, Isleworth, Middlesex—Improvements applicable to navigable vessels and the propelling thereof

Dated July 9.

1905. C. P. Stewart and D. Graham, Manchester—Improvements in the valve gear of locomotive and other engines
1907. J. D. MacNicol, Manchester—Improvements in machinery or apparatus for cylinder printing
1909. J. S. Russell, Millwall—Improvements in apparatus and slips for moving ships and vessels out of, and into, the water
1911. C. Logie, Royal Horse Guards—Improvement in or addition to fire-arms
1913. F. Delmas, Paris—Improvements in ventilating ships, mines, and other places
1915. W. Johnson, Lincoln's-inn-fields—Improvements in capstans. (Communication from — Muirhead, Halifax, Nova Scotia)

Dated July 10.

1917. C. de Bergue, Dowgate-hill—Improvements in the manufacture of apparatus for condensing and cooling purposes
1919. I. L. Pulvermacher, Paris—Improvements in pipes and tubes for smoking
1921. Sir F. C. Knowles, Lovell Hill, Berks—Improvements in the manufacture of iron
1923. J. Gill, Newtyle, Forfarshire—Improvements in reaping machines
1925. J. Moon, Malton, and R. Belt and G. Ewbank, Lutton, Yorkshire—Improved agricultural implement
1927. W. Woodman, Paris—Improvements in railroad wheels. (Communication from J. W. Aldin, New York)
1929. R. Hornsby, jun., Spittlegate, near Grantham, Lincolnshire—Improvements in apparatus for hummelling, removing the husk from, and cleansing grain

Dated July 11.

1931. E. Primard, Paris—Improvements in treating auriferous, argentiferous, or other metallic ores
1933. D. E. Rugg, New York, United States—Improvement in water-gauges for steam boilers
1935. F. Burot, Paris—A new process for gilding and plating over silk, cotton, wool, and all other textile and fibrous matters
1939. A. A. N. Dépinhay-Pre-Hamon, Paris—Improvements in windmills

Dated July 13.

1941. H. Starr, Liverpool—Improvements in hinges. (Communication)
1943. N. Williams and T. Williams, Helston, Cornwall—Improvements in the form and arrangement of the driving gear of thrashing machines, and in the form and mode of applying the straw shakers to such said machines
1945. J. H. Whitehead, Royal George Mills, Saddleworth, Yorkshire—Improvements in milling endless cloths
1947. W. E. Newton, Chancery-lane—Improvements in the manufacture or reduction of platinum. (Communication from J. H. Debray, Paris)
1949. W. E. Newton, Chancery-lane—An improved mode of preventing incrustations in steam boilers. (Communication)

Dated July 14.

1951. B. Urry, Vectis Works, Newport, Isle of Wight—Improvements in seed drills
1953. F. C. Calvert, Manchester, and C. Lowe, Halifax—Improvements in the manufacture of size

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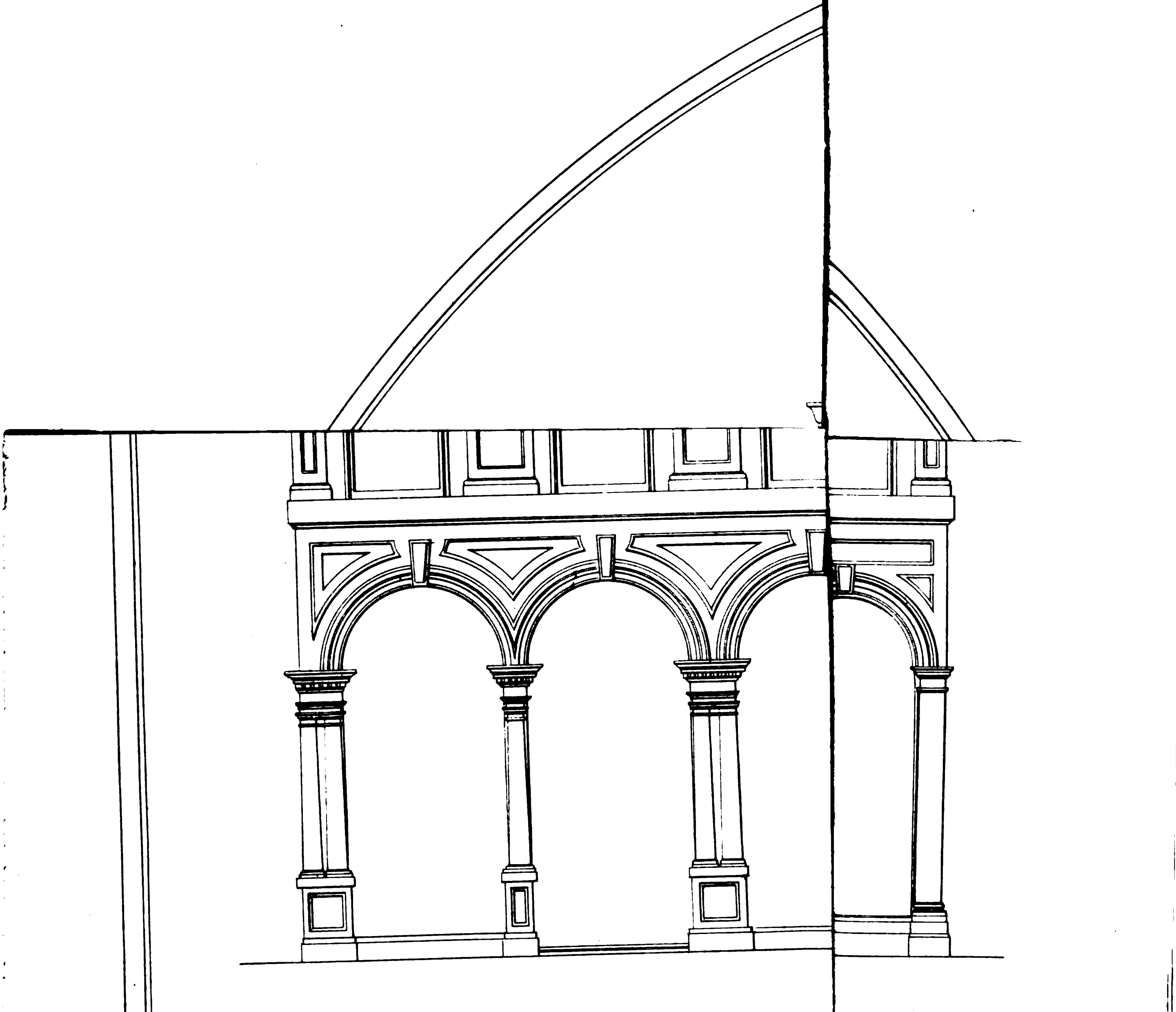
PATENT APPLIED FOR WITH COMPLETE SPECIFICATION.

1795. J. Bourne, Billiter-street—Improved steam train for navigating shallow rivers.—June 26



J. R. Jobbins

MESSRS. SARL AND SONS' PREMISES, CORNHILL.

(With an Engraving, Plate XXIV.)

These new buildings, of Venetian character, overlook the Royal Exchange, and form a conspicuous feature in the view from the Bank of England. The main front, 40 feet in width, rises 96 feet from the pavement. Pope's-head-alley, 7 feet 6 inches wide, and 15 feet high, has been restored, and provides an arcade to the buildings on each side. The ground story, 25 feet from the floor line of shop, has Ionic pilasters of polished red granite, Portland stone caps, and grey granite bases, with bronze sashes, the spandril over being formed of white marble, richly carved. The entrance lobby, recessed 6 feet, with an ornamental clock over the doors, is paved with inlaid marble. The whole of the front above the shop level is carried on a wrought-iron tubular girder (as described in the *Journal, ante* p. 206), the frieze of the entablature over the shop being supported by a wrought-iron apron-piece, inside of which revolving shutters are fixed. The upper stories are built of Bath stone, polished red granite columns supporting the entablatures of the first and second story; polished granite being also introduced in the panels of pedestals to principal pilasters. The spandrils of the windows of the second story are filled in with emblematic figures of Poetry, Music, Painting, Sculpture, Architecture, and Genius; a frieze of masks and foliage, terminated at each end by massive festoons, balconies with carved trusses, and niches, enrich the upper stories, the whole being surmounted by a massive console cornice 8 feet high.

A slight description of the interior of this building may not be uninteresting to our readers. The plan is a rectangle, 36 feet in front and 28 feet deep. The shop floor, 25 feet high, with gallery on three sides, has a double order (Doric and Composite) of columns and pilasters, with arched recesses for plate glass and ebony cabinets. The ceiling of the shop is deeply coffered and enriched with coupled figures. The handsomely decorated staircase, in a recess at the back of the shop, leads to the gallery and show-rooms, &c., with an office attached. The show-room is decorated in the Elizabethan style, with ebony cabinets, &c. The staircase continues to the show-room and office on the second floor. The remaining portion of the building, consisting of a dining-room, partners'-room, various offices, kitchen, and dormitories, communicating by a separate fireproof staircase with the private entrance in Pope's-head-alley.

THE WELLINGTON MONUMENT.

The following is the report of the judges appointed to examine the models submitted in competition for a monument to the late Duke of Wellington :—

"We have thus endeavoured to adjudge the prizes we have been instructed to distribute (in the scale of which we have not thought ourselves at liberty to make any change), in the order which appeared to us to be that of the relative degree of merit in the models, such models falling within the prescribed conditions as to the space to be occupied, and the cost to be incurred.

"In so doing we have not considered ourselves bound to take into exclusive consideration the peculiar fitness and adaptation to that spot in St. Paul's Cathedral which appears to be in contemplation for the erection of the proposed monument, which consideration might possibly have led to some difference in the selection.

"We cannot, at the same time, forbear suggesting that, before any design is finally adopted by the Government, it would be desirable, considering the peculiarity of the situation contemplated, and that it essentially differs from that of all the other monuments now existing in the Cathedral, the opinion of some experienced artists should be called for, who would be better judges of the local effect than we consider ourselves to be; more especially as Mr. Cockerell, the only one of the appointed judges professionally connected with the arts, though we have derived from him valuable assistance and information in the progress of the examination, has declined on that account taking a part in the ultimate decision.

"We may be permitted to add that it is with much regret that we have found ourselves precluded from admitting into the competition some of the models, from the circumstance of their having exceeded the limits as to space, distinctly laid down in the prescribed conditions."

THE SUBMERGENCE OF THE ATLANTIC TELEGRAPH CABLE.

By Homersham Cox, M.A., Barrister-at-Law.

The recent accident to the Atlantic telegraph cable, by which it was broken in the course of its descent, has been attributed by some persons to the thinness, and consequent weakness, of the cable. It is partly the object of this paper to show from mechanical considerations that this opinion is incorrect, if the cause of the accident were that which it is generally understood to have been. The wire in the course of its descent is stated to have acquired a velocity which alarmed the person superintending the process of paying it out; and he, by checking the apparatus unduly, retarded the descent, thereby inducing in the cable a strain which its strength was unable to bear.

It is not however correct to assume that had the cable been thicker it would have been better able to bear the strain just mentioned; for though the tensile strength of the cable would increase, all things else being similar, proportionally to its sectional area, the mass and weight of a given length of it would increase in the like proportion. The strain of retardation so depends on these quantities, that no gain of tensile strength would arise from such an increase of the thickness of the cable.

Previously to the investigation of the strain due to a given retardation of the descending wire, it will be instructive and interesting to consider the nature of the descent of the wire if *not* retarded. With a little care the problem may be solved with scarcely any aid of mathematical symbols; and it is certainly a problem of remarkable interest, not only on account of its practical application to so grand an enterprise as the Atlantic telegraph, but also considered merely as an abstract mechanical investigation. Some of the results of the investigation are, as will be seen, very curious.

The problem which in the *first* place will be here discussed is this—To determine the greatest velocity acquired by a uniform perfectly flexible and smooth chain, of which by far the greater part rests on a horizontal plane, and a small part descends *in vacuo*, under the action of gravity, vertically from a point in that horizontal plane, and is deposited on another horizontal plane. Of course in the problem thus stated several suppositions occur which will have to be corrected in applying its results practically.

The part of the cable which is not descending will have some motion; the coils nearest the descending part being successively uncoiled and approaching the point at which descent commences. But it is obvious that only a small part of the coiled chain will be thus affected. When the chain first begins to run out, before any part of it reaches the bottom plane, the motion of descent will be a continually accelerated one; but after the chain has begun to be deposited, there will arrive a time when the motion becomes *steady*, that is, when the chain will have acquired a *terminal uniform velocity* of descent.

The cause of this terminal velocity may be explained as follows. Consider first the simpler case in which the descending portion of the chain, instead of being connected with a much larger portion *coiled* on the upper plane, is connected with a portion not thus comparatively large laid *straight* on the upper plane. The moving chain then consists of two parts at right angles to each other, and having at every point the same velocity. Call the tension at any point in the descending mass, t. Now so long as the chain is descending with accelerated motion, t must be less than the weight of chain below the point where t acts; for it is the difference between this weight acting downwards and t acting upwards which produces the acceleration; the force at the lowest point of the descending mass being nothing. But on the other hand, the tension t can never exceed (though it may equal) the weight below it, as may be seen as follows. If it did, the upward force would predominate, and produce *retardation* of the mass below t. On the other hand, the moving mass above t would be *accelerated* by t acting downwards, and by the weight of part of it; the straight part on the upper horizontal plane moving without resistance. Consequently there would be acceleration in the part of the chain below t, and retardation in the rest; which could not happen if the chain were inextensible. Consequently t can never exceed the weight below it.

The same conclusion applies where a large mass of chain is coiled on the upper plane; for as we said, but a very small part of this has any motion, and therefore any tension. Where the tension thus ceases, the chain for the purpose of our argument might be considered to be severed. Then, as in the preceding case, all the moving mass above t is accelerated by t acting downwards, and by the action of gravity on part of it, and is acted on by no retarding force. Consequently, as before, there would be retardation in one part of the chain and acceleration in another, if t exceeded the weight below it,—an impossible result if the chain be inextensible.

We arrive then at the conclusion, that the tension at any point of the descending chain becomes after a time equal to the weight below that point; and after that time the motion is uniform, because each part of the chain is acted on by two equal and opposite forces—its gravity and tension.

The terminal uniform velocity in question may now be determined. The principle of Conservation of Vis Viva as applied to the present case shows that the total *vis viva* gained by the moving mass in any time is equal to twice the *work done* by gravity in the same time. Now consider the motion of all the mass moving at any time, except a small portion (say 1 foot) at the lower end of the moving chain. The effect of this 1 foot may be neglected as inconsiderable. When all the mass in question has descended 1 foot, it is clear that the "work done" is equal to the weight of the descending chain multiplied by 1 foot; or if g be the force of gravity, mg the weight of 1 foot of chain, and h the length of the vertical chain in feet, mgh is the weight in question, and mgh is also the work done, the descent being through 1 foot. If we suppose the coiled chain absolutely at rest, the effect of this work has been to give 1 foot at the top (which was before at rest) the same velocity as the rest of the chain. Call that velocity v. Then by the principle of the Conservation of Vis Viva, equating the *vis viva* gained to twice the work done,

$$mv^2 = 2mgh \quad \dots \quad \dots \quad \dots (1)$$

or

$$v^2 = 2gh \quad \dots \quad \dots \quad \dots (2)$$

That is, *the terminal velocity is equal to that of a body descending freely to the same depth as the chain descends.*

This result is somewhat analogous to Torricelli's celebrated law of efflux of fluids through small orifices, the quantity of issuing fluid being supposed small compared with that in the reservoir. The formula obtained is the same, and a very similar process is applicable for obtaining it, as may be seen by referring to the number of this *Journal* for December 1856, p. 398.

A correction of the preceding result must be made on account of the buoyancy of the fluid in which the cable descends, and also for the friction of the fluid with the surface of the cable; the latter is probably small as compared with the weight of the cable. The effect of the buoyancy is, by the well-known hydrostatic law, to diminish the weight of the cable by a quantity equal to the weight of fluid displaced. Hence, if $m'g$ be the weight of a column of fluid displaced by a foot of the chain (*i.e.* if the relative specific gravities be as $m' : m$), the buoyancy of a length of chain h will be $m'gh$, and for the equation marked (1) must be substituted

$$mv^2 = 2(m - m')gh; \quad \text{or, } v^2 = 2\frac{m - m'}{m}gh \dots\dots (3)$$

By the formula (2), taking $g = 32$, $v = 8\sqrt{h}$, or the velocities per second corresponding to various distances of descent, are as follows:—

Depth in Feet.	Velocity in feet per second.
400	160
900	240
1,600	320
2,500	400
3,600	480
4,900	560
6,400	640
8,100	720
10,000	800
12,100	880

To allow, however, for the effects of buoyancy, we must reduce these velocities according to formula (3), by multiplying by the fraction on the second side of that equation. The specific gravity of the whole cable does not appear to have been published. It consisted of an inner "core" of copper wire surrounded by gutta-percha and tarred hemp, and this again by spiral strands of iron wire. Even if we suppose the gutta-percha and hemp no heavier than water, the specific gravity of the whole cable is at least as great as that of the wire, or about eight times that of water. From this it would result, that the velocities in the above table ought to be reduced by not so much as 10 per cent.

The above investigation of the tension of the cable remains true, whether the cable descend at its terminal or any less velocity, provided that the velocity be uniform. The tension is then the same as if the cable were suspended at rest.

If the cable descend from a ship which is moving, the descending part will move through the water, and, owing to its resistance, will not descend vertically. The deflection of the cable from the vertical may be caused also by currents of the water itself. The deflecting forces due to the relative motion of the cable and water will act horizontally. If every part of the cable were to move uniformly in both the horizontal and vertical directions, the tension would be the same as it would be if the cable were at rest. Therefore, by statical principles, equating the vertical forces acting on the descending cable, the vertical component of the tension at its summit is equal to its total weight. The amount of that weight cannot be ascertained exactly, as we cannot ascertain the form of the catenary which it assumes. But whatever the form be, if the chain move unformly, its tension may be estimated in the way just mentioned; so that if ϕ be the angle at which the chain is inclined to the water at its horizontal surface, and t the total tension there, $t \sin\phi$ is the horizontal component which is equal to the weight of the descending chain; also mgh is less than that weight as the the chain is not vertical. We have therefore t greater than $mgh \div \sin\phi$.

We may now consider the tension induced by retarding the motion of the chain when it is moving uniformly and vertically, with any velocity v. Suppose this retardation to be uniform, and the tension while it takes place to be a constant T, near the top of the descending chain. Then the total force acting on the chain is $T - \frac{m - m'}{m}gh$, and if this act for t seconds it will produce a retardation

$$\left(T - \frac{m - m'}{m}gh\right)t;$$

or if V be the velocity at the end of t seconds,

$$mh(V - v) = \left(T - \frac{m - m'}{m}gh\right)t.$$

Therefore, $$T = \frac{m - m'}{m}gh + mh\frac{V - v}{t}.$$

In this formula the quantity $mh\frac{V - v}{t} = mgh\frac{V - v}{gt}$ represents the *extra* strain due to a given retardation. We may compute from this formula the extra strain which the chain will be subject to in order to reduce its velocity any number of feet per second, $V - v$ being the amount of that reduction. Supposing it, for instance, to be 32 feet per second; then the extra strain which the chain will have to bear will be mgh, which is the weight of the chain itself. So again, to reduce the velocity by 16 feet per second, the extra strain will be ½ the weight of the chain, and similarly for any other fraction or any multiple of 32.

It follows, *that if the chain be moving with uniform velocity, the tension is the weight of the suspended chain in water, and that if by retarding the apparatus the velocity be reduced by any multiple or fraction of* 32 *feet per second, the strain will be increased by the like multiple or fraction of the suspended weight.*

It is important to notice the application of the foregoing conclusions with respect to an apparatus called the "Indicator," which is said to have been constructed to indicate the strain sustained by the cable at any time in its descent. In the account of the Atlantic Telegraph in the *Times*, dated Valentia, August 8, it is stated that—

"The cable passes round a series of sheaves grooved to receive and embrace nearly half its circumference. The pressure is thus thoroughly distributed and the circular form is preserved. Moreover, the sheaves being fitted on their axles outside the bearings, the cable can be released from the paying-out machinery at once when required, and the indicating apparatus which forms a portion of the appliances used for the Atlantic telegraph effects the great improvement of enabling the engineer to ascertain at any moment, with accuracy, the strain which the cable is enduring."

In the engineer's report to the Directors upon the accident, after stating how the velocity of the cable increased in deep water, he says:—

"The retarding force was therefore increased at 2 o'clock to an amount equivalent to 30 cwt., and then again, in consequence of the speed continuing to be more than it would have been prudent to permit, to 35 cwt."

Is it to be inferred from these and similar statements that the engineer assumed that, because a retarding force of given amount was applied to the cable, that was the *total amount* of its tension? If so, a serious mistake was committed, and one probably quite sufficient, if acted on, to account for the rupture of the cable. It is not here asserted that the error was committed, for there does not appear to be any distinct account of the subject; but certainly the matter is deserving of careful inquiry.

The tension of the chain must (with the approximations indicated) follow the laws established in the above investigations, whether a retarding force be applied or not. If the velocity be not uniform, the tension depends (as has been shown) on the diminution of velocity in a given time. If the velocity be uniform, the tension must be equal to the weight suspended,—for the simple reason already given, that if a body move uniformly in any direction, the forces resolved in that direction must be equal and opposite.

To measure the tensions or other internal forces of a system in motion by means of *fixed* indicators would be utterly fallacious. Where two parts of the same system move uniformly together, an indicator might be used between them to show their mutual pressure or tension. Thus a dynamometer placed between the tender and first carriage of a railway train *moving uniformly* will show the total resistance to which the carriages are subject. Again, the tension of a rope towing a barge might be shown by a spring interposed between the rope and the barge, because the whole system moves together uniformly. But if the indicator be attached at points which approach or recede from each other, it cannot show the amount of strain to which they are subject. It seems therefore inconceivable how, in the case of the Atlantic cable, an indicator attached to the ship, and also to apparatus moving relatively to it, could of itself show the strain of the cable.

A very simple case may be taken to show the error of such a mode of measuring tensions. Suppose a heavy rope, one part of which is many times greater than the other, to pass over a fixed axle which is so rough that the one part descends and the other ascends uniformly vertically. Can it be supposed that the friction of the axle indicates the tension of the rope? It is quite clear that there is no more reason why the friction should indicate the tension of the ascending rather than that of the descending part of the rope. But it is also quite clear that the friction cannot indicate both tensions, for on account of the great disparity of the weights they are manifestly unequal. In the case just supposed, the tension of each part of the rope is equal to the weight suspended by it, and an elementary dynamical investigation would show that the friction depends on the velocity. In the same way, the friction acting on the Atlantic cable in motion was not equal to the tension, but depended on the velocity.

The extreme depth to which copper wire of any uniform thickness can be payed out without breaking may be seen as follows: It appears from Moseley's 'Engineering,' Table iv., that the specific gravity of copper wire is about 8·8 that of water, and the weight of a cubic foot of copper wire is 560 lbs. Consequently, a cubic foot would lose about 63 lbs. in water, and its weight in water may be taken in round numbers at 500 lbs. Therefore a wire a square inch in sectional area will weigh in water 3·47 lbs. per foot of length. Now the tenacity of copper wire is 61,288 lbs. per square inch; and as 17,644 feet of wire of that sectional area would weigh that number of pounds, it follows that a uniform vertical copper wire at rest or in uniform motion cannot be suspended to a greater depth in water than about *three miles and one-eighth.* Taking the tenacity of iron wire at 40 tons per square inch, and reckoning for its less specific gravity, it appears that iron wire cannot be similarly supended to a greater depth than *four miles and a half.* The gutta-percha and hempen twist cannot be supposed to have added to the strength of the cable relatively to its weight. The cable was lost in a depth of 2¼ miles; that is, half the depth to which iron wire could be suspended, and about three-fourths the depth to which copper wire could be suspended. Considering the effects of deflection and currents in the water, and the strains due to occasional retardation of the descent of the cable, this seems scarcely a sufficient excess of strength. The only ways to increase the strength appear to be, by connecting the cable with buoyant materials of less specific gravity than water, or by forming it partly of materials which have greater tenacity than copper or iron relatively to their specific gravities.

These remarks have been written in no spirit of hostile criticism of the conduct of the great enterprise of laying down the Atlantic Telegraph. On the contrary, it is conceded that great ingenuity and scientific knowledge have been exhibited by those to whom the undertaking has been entrusted. But it seemed important to show the effects of retardation of the descending cable, and to establish a formula from which the tension to which it is likely to be subjected may be at least approximately determined.

Experiments.—During the progress of the *Agamemnon*, the vessel carrying the cable, to the Downs, the mechanical appliances for regulating the delivery of the cable into the sea were kept continually in motion by the small engine on board which was connected with them; the sheaves and gearing worked with great facility and precision, and so quietly that at a short distance from them their motion could scarcely be heard.

The strength of the girders which carried the bearing of the entire apparatus, and which to the eye of a person unskilled in the practical working of this description of machinery might seem at first to be unduly ponderous, was found to contribute greatly to the easy motion and satisfactory steadiness of this most important agent in the success of the undertaking.

So soon as the *Agamemnon* had passed the track of the Submarine Company's cable between Dover and Calais, in order to avoid the possibility of its being injured by the laying or hauling up of another line at right angles to it, the experiments commenced. A 13-inch shell was attached to the end of a spare coil of the Atlantic cable, for the purpose of sinking it rapidly with a strain upon it to the bottom, and was then cast into the sea, drawing after it a sufficient quantity of slack to enable it to take hold of the ground and so set the machinery in motion. The paying out then commenced at the rate of two, three, and four knots an hour respectively. The ship was then stopped, and the cable was hauled up from the bottom of the sea with great facility, by connecting the small engine to the driving pinion geared to the sheaves. When the end was brought up to the surface it was found that the shell had broken away from the loop, by which it had been fastened for the purpose of lowering it. The cable, when recovered, was found to have been cleaned as bright as the specimens which have been so freely distributed among the friends of the enterprise, and which are so generally known. The exterior coating of tar had been completely rubbed off by being drawn through the sandy bottom of the sea, and attached to the iron coating of the cable were some weeds and several small crabs which came up with it to the surface.

On the following day a length of cable was run out and hauled in with perfect success, opposite the Isle of Wight, attached to an anchor. The speed was increased in this case to five knots. During the afternoon of the same day a length was run out having fastened to the end of it a log of timber, and after having been towed with a mile and a-half of cable was coiled in again with success.

About half-way between the Land's End and the coast of Ireland, another length was run out at the rate of six and a-half knots per hour, and subsequently hauled in. The *Agamemnon* then steered for and reached Queenstown Harbour.

Some highly successful experiments were also at the same time performed with an electrical log invented by Mr. Charles Bright for the purpose of continuously ascertaining with accuracy the rate at which the ships are sailing, and thereby of enabling him to give corresponding directions as to the rate of paying the cable so as to prevent the possibility of any unnecessary strain being put upon it. The log is suspended in the sea from the ship's quarter by a line, carrying within it a wire insulated by gutta-percha, which is in connection with a battery and electro magnet contained within an indicating instrument on deck. This is so arranged that at each revolution of the wheel below an electric current is broken, and by the deflection of a magnet which forms part of the circuit a step by step movement is communicated to a register which indicates the distance run and the rate made by the vessel.

On August 1, the electrical experiments through the Atlantic cable were completed. The signals passed through the 2500 miles in the most satisfactory manner.

When the *Agamemnon* came to moorings in Queenstown Harbour, at about a third of a mile from the *Niagara*, before noon one end of each cable was carried to the opposite ship, and so joined up as to form a continuous length of 2500 miles, both ends of which were on board the *Agamemnon*. One end was then connected with the apparatus for transmitting the electric current, and on a sensitive galvanometer being attached to the other end, the whole cable was tested from end to end, and found to be perfect.

The arrangements for attaching the recording instruments to indicate signals were left to be completed afterwards. The amount of electric power developed at the further end, and exhibited by Mr. Whitehouse's magneto-electrometer, amounted to an attractive force of 25 grains. As 3 grains are sufficient to record intelligible signals upon the receiving apparatus, it will be perceived that a considerable surplus of electric power remains, a convincing proof of the perfect integrity of the cable, and no less of the careful adaptation of scientific means to the desired object.

On resuming operations, it was found that all communication was cut off; and after underrunning the portions of cable laid out between the two ships, it was ascertained that one had been completely severed by entanglement with the mooring chains during the time the *Agamemnon* was swinging with the tide, and that the other portion was so injured from the same cause as to be unfit for use.

On re-establishing the communication between ship and ship, the transmission of electric telegraph messages through the entire length of 2500 miles was immediately commenced, and proceeded satisfactorily.

In carrying this out, each terminal station or end of the cable was separately connected with the earth, as is usual in lines laid out in actual length, and the electrician noted that a considerable interval of time elapsed during the passage of the current, the amount of retardation being equal to nearly a second and three-quarters upon each electric wave or signal. Yet notwithstanding this, it was found that three signals could be practically and intelligibly transmitted in two seconds. This confirms the accuracy of the previous experiments made upon shorter circuits of wire, by which it had been demonstrated that several waves of electric force can co-exist in a long unbroken length of completely insulated conducting wire, and yet reach their destination with sufficient intervals between them to record intelligibly the indications they are intended to convey.

The battery employed by Mr. Whitehouse consisted of a voltaic series of 40 cells, the plates of which were formed alternately of zinc and platinised silver, each about nine inches square. The exciting fluid or medium is simply diluted sulphuric acid, the troughs containing which are swung upon a gimballed frame, to prevent the fluid from being washed over the connections between cell and cell by the motion of the ship.

The force developed by this battery in its direct action was so great that a piece of iron three inches long and three-eighths of an inch in diameter, can be entirely consumed in a few minutes by the heat developed on retaining the two poles of the battery simultaneously in contact with it.

The battery current thus generated is, however, only the primary agent in the act of telegraphing through the cable, and is solely used as a means of inducing, through the aid of electro-magnetic electricity, a current of a suitable character, for being transmitted through such long distances. The electro-magnetic electricity actually employed is obtained from large induction coils.

Provision having been made in this manner for the through transmission of the electric current, the adaptation of an instrument suitable to the indication or recording of signals is simply a matter of mechanical ingenuity, and any of the sensitive indicating or recording instruments now in use may be employed for the purpose.

The form of instrument at present used for developing signals by the Atlantic Telegraph Company is a modification of the well known marking instrument invented by Professor Morse.

The vessels containing the submarine cable left Queenstown Harbour *en route* for Valentia Bay. During their stay at that anchorage the two cables were connected, and the time occupied in traversing the 2600 miles was ascertained to be one second and a quarter. From experiments instituted whilst the two coils were in connection, the maximum obtained was an average of seven words per minute, five being the minimum. Opinions were, however, entertained by some that, when submerged, and the wave of electricity not compelled to take such a series of circles, a higher rate would be obtained. Some difficulty was experienced in coiling the inshore portion of the cable on board the *Niagara*, which caused a slight delay, it being of much greater strength, and far more difficult to manage than the smaller.

The end of the cable having been laid about three miles from Cahirciveen, on the shore of Valentia Bay, the vessel proceeded on its route.

Report of Mr. Charles Bright, Engineer.

After leaving Valentia on the evening of the 7th inst., the paying out of the cable from the *Niagara* progressed most satisfactorily until immediately before the mishap.

At the junction between the shore and the smaller cable, about eight miles from the starting point, it was necessary to stop to renew the splice; this was successfully effected, and the end of the heavier cable lowered by a hawser until it reached the bottom, buoys being attached at a short distance apart to mark the place of union.

By noon of the 8th we had paid out forty miles of cable, including the heavy shore end, our exact position at that time being in lat. 51° 59′ 36″ N., long. 11° 19′ 15″ W., and the depth of water, according to the soundings taken by the *Cyclops*, whose course we nearly followed, ninety fathoms.

Up to 4 p.m. on that day the egress of the cable had been sufficiently retarded by the power necessary to keep the machinery in motion at a rate a little faster than the speed of the ship; but as the water deepened it was necessary to place some further restraint upon it by applying pressure to the friction drums in connection with the paying-out sheaves, and this was gradually and cautiously increased from time to time, as the speed of the cable compared with that of the vessel, and the depth of the soundings, showed to be requisite.

By midnight, 80 miles had been safely laid; the depth of water being then a little more than 200 fathoms.

At 9 in the morning of the 9th we had finished the deck coil in the after part of the ship, having paid out 120 miles. The change to the coil between decks forward was safely made.

By noon we had laid 136 miles of cable, the *Niagara* having reached lat. 52° 11′ 40″ N., long. 13° 10′ 20″ W., and the depth of water having increased to 410 fathoms.

In the evening the speed of the vessel was raised to five knots per hour. I had previously kept down the rate at from three to four knots for the small cable, and two for the heavy end next the shore, wishing to get the men and machinery well at work prior to attaining the speed which I had anticipated making.

By midnight 189 miles had been laid.

At 4 o'clock on the morning of the 10th the depth of water began to increase rapidly from 550 fathoms to 1750 in a distance of eight miles. Up to this time, 7 cwt. strain sufficed to keep the rate of the cable near enough to that of the ship; but as the water deepened the proportionate speed of the cable advanced, and it was necessary to augment the pressure by degrees until in the depth of 1700 fathoms the indicator showed a strain of 15 cwt., while the cable and ship were running 5¼ and 5 knots respectively.

At noon on the 10th we had paid out 255 miles of cable, the vessel having made 214 miles from shore, being then in lat. 52° 27′ 50″ N., long. 16° 00′ 15″ W. At this time we experienced an increasing swell, followed later in the day by a strong breeze.

From this period, having reached 2000 fathoms water, it was necessary to increase the strain to a ton, by which the rate of the cable was maintained in due proportion to that of the ship.

At 6 in the evening some difficulty arose through the cable getting out of the sheaves of the paying-out machines, owing to the tar and pitch hardening in the grooves, and a splice of large dimensions passing over them. This was rectified by fixing additional guards and softening the tar with oil.

It was necessary to bring up the ship, holding the cable by stoppers until it was again properly disposed round the pulleys. Some importance is due to this event as showing that it is possible to lie to in deep water without continuing to pay out the cable—a point upon which doubts have been frequently expressed.

Shortly after this the speed of the cable gained considerably upon that of the ship, and up to 9 o'clock, while the rate of the latter was about 3 knots by the log, the cable was running out from 5¼ to 5¾ knots per hour. The strain was then raised to 25 cwt.; but, the wind and sea increasing, and a current at the same time carrying the cable at an angle from the direct line of the ship's course, it was not found sufficient to check the cable, which was at midnight making 2¼ knots above the speed of the ship, and sometimes imperilling the safe uncoiling in the hold. The retarding force was therefore increased at 2 o'clock to an amount equivalent to 30 cwt., and then again, in consequence of the speed continuing to be more than it would have been prudent to permit, to 35 cwt. By this the rate of the cable was brought to a little short of 5 knots, at which it continued steadily until 3·45, when it parted, the length paid out at that time being 335 miles.

I had up to this time attended personally to the regulation of the breaks, but, finding that all was going on well, and that it being necessary that I should be temporarily away from the machine, to ascertain the rate of the ship, and to see how the cable was coming out of the hold, and also to visit the electrician, the machine was for a moment left in charge of a mechanic who had been engaged from the first in its construction and fitting, and was acquainted with its operation.

I was proceeding to the fore part of the ship when I heard the machine stop; I immediately called out to ease the break and reverse the engine of the ship, but when I reached the spot the cable was broken.

On examining the machine, which was otherwise in perfect order, I found that the breaks had not been released, and to this, or to the hand-wheel of the break being turned the wrong way, may be attributed the stoppage, and the consequent fracture of the cable. When the rate of the wheels grew slower as the ship dropped her stern in the swell, the break should have been eased; this had been done regularly before whenever an unusually sudden descent of the ship temporarily withdrew the pressure from the cable in the sea; but, owing to our entering the deep water the previous morning, and having all hands ready for any emergency that might occur there, the chief part of my staff had been compelled to give in at night through sheer exhaustion, and hence, being shorthanded, I was obliged for the time to leave the machine without, as it proves, sufficient intelligence to control it.

I perceive that on the next occasion it will be needful, from the wearing and anxious nature of the work, to have three separate relays of staff, and to employ, for attention to the breaks, a higher degree of mechanical skill.

The origin of the accident was no doubt the amount of retarding strain put upon the cable, but had the machine been properly manipulated at the time it could not possibly have taken place.

It has been suggested as a cause of the failure that the machinery is too massive and ponderous. My experience of its action teaches otherwise; for three days in shallow and deep water, as well as in rapid transition from one to the other, nothing could be more perfect than its working, and since it performed its duty so smoothly and efficiently in the smaller depths, where the weight of the cable had less ability to overcome its friction and resistance, it can scarcely be said to be too heavy for deep water, where it was necessary for the increased weight of cable to restrain its rapid motion, by applying to it a considerable degree of additional friction. Its action was most complete, and all parts worked well together. I see how it can be improved by a modification in the form of sheave, by an addition to the arrangement for adjusting the breaks, and some other slight alterations; but, with proper management, without any change whatever, I am confident that the whole length of cable might have been safely laid by it, and it must be remembered, as a test of the work which it has done, that, unfortunate as this termination to the expedition is, the largest length of cable ever laid has been paid out by it, and that in the deepest water yet passed over.

After the accident had occurred, soundings were taken by Lieutenant Dayman, and the depth found to be 2000 fathoms.

It will be remembered that some importance was attached to the cables in the *Niagara* and *Agamemnon* being manufactured in opposite lays. I thought this a favourable opportunity to show that practically the difference was not of consequence in effecting the junction in mid-ocean. We therefore made a splice between the two vessels, and several miles were then paid out without difficulty.

I requested the commanders of the vessels to proceed to Plymouth, as the docks there afford better facilities than any other port for landing the cable, should it be necessary to do so.

The whole of the cable on board has been carefully tested and inspected, and found to be in as perfect condition as when it left the works at Greenwich and Birkenhead.

One important point presses for consideration at an early period; a large portion of the cable already laid may be recovered at a comparatively small expense. I append an estimate of the cost.

I do not perceive in our present position any reason for discouragement, but I have, on the contrary, a greater confidence than ever in the undertaking. It has been proved beyond a doubt that no obstacle exists to prevent our ultimate success; and I see clearly how every difficulty which has presented itself in this voyage can be effectually dealt with in the next.

The cable has been laid at the expected rate in the great depths; its electrical working through the entire length has been most satisfactorily accomplished, while the portion laid actually improved in efficiency by being submerged, from the low temperature of the water, and the close compression of the texture of the gutta-percha.

The structure of the cable had answered every expectation that I had formed of it, and if it were now necessary to construct another line I should not recommend any alteration from the present cable, which in its working has confirmed my belief that it is expressly adapted to our requirements. Its weight in the water is so adjusted to the depth that the strain is within a manageable scope, while the effects of undercurrents upon its surface proves how dangerous it would be to attempt to lay a much lighter rope, which would, by the greater time occupied in sinking, expose an increased surface to their power.

The commanding officers of the several ships composing the Atlantic Telegraph Squadron have expressed their opinions with reference to the Atlantic telegraph. They are of opinion, drawn from their several observations and experience, that no obstacles of a nautical or physical character exist in the way of the enterprise, and that the efficiency of the form of cable adopted by the company is in every way adapted to its mission. With regard to the machinery they are of opinion that the form of controlling power adopted, and the mode of lubricating and adjusting the breaks admit of very great improvement. They are thoroughly convinced from the soundings made by Lieutenant Berryman, United States' navy, on the plateau between Newfoundland and Ireland, subsequently confirmed by Lieutenant Dayman, Royal Navy, and the investigations of Lieutenant Maury, United States' Observatory, and from their own nautical experience, that no under or surface current exists between these points to interfere with the successful laying of the cable. They all agree in thinking that no form of submarine telegraph cable could be devised more suitable in every respect to the object intended to be accomplished; that its lightness, toughness, and flexibility adapt it in every way for the purpose of being laid between Newfoundland and Ireland, and are unwilling to recommend its modification or alteration in any way. They are also of opinion that no natural obstacles exist to prevent its being successfully laid between those points, and their views as to the future prospects of the enterprise are sanguine.

Messrs. Bright, Canning, Webb, and Woodhouse, who have been engaged as engineers during the construction, shipment, and submersion of the cable, consider it to be so eminently suited for laying in deep water that they cannot suggest any improvement in its form and construction, and recommend that no change whatever should be made in the manufacture of any future cable for crossing the Atlantic. The outer covering being composed of strands of iron wire, instead of single wires, as in former cables, gives such flexibility to the rope as almost to prevent the possibility of kinks occurring in the paying out if the cable is properly coiled, while the strength with an equal weight of metal is also increased. In case of a broken wire passing into the paying out machine no damage is done, while with the solid wire it sometimes unravels, and occasions serious inconvenience. The conducting wire beiug also formed of a strand of seven copper wires, the chance of continuity being lost in the circuit is reduced to a minimum from the improbability of any flaw or weakness occurring in more than one of the seven wires at the same place.

Messrs. Whitehouse, Morse, and Thomson have reported that every experiment which they have made upon the cable, every test to which they have subjected it, both for its insulating and conducting power, has uniformly resulted in demonstrating the perfect fitness of the cable for its office. The treble covering of gutta-percha so entirely provides for the remote possibility of accidental flaw occurring in either of the first or second coat, that all risk of defective insulation is thus avoided. Experiments made with a short length had previously proved that an hydraulic pressure of five tons to the square inch in no way injured the insulation, and in the highest degree confirmatory of this is the result of the trial recently made in the great ocean depths. The actual pressure which a depth of water exceeding two miles had exerted upon its structure produced not the slightest injury to the insulation of the submerged portion of the cable; while the low temperature by which it was then surrounded produced, as had been anticipated, a distinctly beneficial effect on the electrical condition of the gutta-percha. For a cable of great length, necessarily limited to a single conductor, they cannot suggest, on electrical or other grounds, any improvement upon the form adopted by the company.

THE *Bombay Times* has a notice of the railway tunnels and other works in the process of construction at the Bhore Ghaut, where the line ascends to the great central Indian plateau towards Poona. The total ascent of 1000 feet is to be achieved in a distance of fifteen miles, the mildest gradient being one foot in 75, and the severest one in 37. In this ascent there are 12 tunnels, measuring in all 2300 yards, or about a mile and a half. The longest, nearly a quarter of a mile in length, runs through a mass of "porphyritic clinkstone," absolutely harder than flint, and into which as many workmen as can stand together can only penetrate a foot a day. There are also several viaducts of great length, and one of them 150 feet in height.

REVIEWS.

Abridgments of the Specifications relating to Marine Propulsion. Part I. London: Great Seal Patent Office. 1857. pp. 112.

This Abridgment is printed by order of the Commissioners of Patents. It is carefully prepared and forms a very interesting and valuable record of the inventions relating to marine propulsion. An index of names of the patentees commences the work, foreigners' names being printed in italics. A history of propulsion from the earliest periods is given, from which it appears that on the Nile and the Euphrates and in the West Indies the natives still use bundles of reeds or inflated skins, on which they float, propelling themselves by their legs moving in the water; these being the methods adopted by the ancient people of Assyria, Egypt, Babylonia, and China. It is, however, with the modern system of marine propulsion that we are concerned, the progress of which, from its first crude development, may be traced in the following brief outlines, gleaned from the work before us.

In the year 1543, Blasco de Garay, a Spaniard, is said to have propelled the vessel "Trinadad" at Barcelona, by an engine which consisted of a large cauldron or vessel of boiling water and a moveable wheel attached to each side of the ship.

1682. A horse "tow-vessel" was used at Chatham, moved by paddles on an axle turned by horses.

1693. Du Quet tried a propeller "in which four oars set in an arbor are made to revolve like a paddle-wheel, and the emerging float is feathered by being turned edgeways to the water in its ascent."

1707. Papin used Savery's engine to propel a steamboat on the Fulda.

1732. Count de Saxe presented an account to the Academy of Sciences of a barge moved by paddle-wheels turned by horses; also of a barge moved by horses upon it winding up a rope.

1770. James Watt mentions a screw propeller turned by a steam-engine.

1774. Comte d'Auxiron tried experiments on the Seine, which were followed up by Perrier, who used a steam-engine (of about 1-horse power) to move two wheels, one on each side of a vessel.

1776. The Marquis de Jouffroy used a steamboat on the Doubs, with propellers which opened and closed like louvre boards.

1780. Jouffroy used as an engine for his boat with the duck-foot propeller, two cylinders, inclined at an angle, and turned by a barrel with a chain.

1781. Jouffroy used a steamboat at Lyons, with paddle-wheels on a shaft turned by chains fixed to pistons in two cylinders inclined in opposite directions at an angle of 30° to the horizon.

1783. J. Fitch moved a boat "by paddles," worked by a steam engine on the Delaware river.

1788. Patrick Miller's "double pleasure-boat" was propelled by a steam-engine turning two paddle-wheels, one before the other, in the space between the hulls. The steam-engine of this boat used by Miller, Taylor, and Symington, will be found in Mr. Woodcroft's collection of Curiosities at the Great Seal Patent Office. It is of about 1-horse power, with two upright cylinders working the shaft by chains. The following notice is given of it in the descriptive catalogue of the Museum of Patented Inventions at South Kensington, where the engine was exhibited last June:—"This little machine has the following claims to be considered the parent engine of steam navigation. Prior to the year 1788, when it was applied to propel a boat, numerous projects had been proposed, and a few abortive attempts had been made, to propel vessels by steam power, commencing with an experiment in 1543, but the whole of the projects and experiments made previous to the application of this engine proved valueless for any practical use. The results of the experiments with this, and with a larger one subsequently made on the same plan, demonstrated to Symington that a more simple arrangment of the parts forming a steam-engine was required before steam power could be applied practically to navigation. In 1801 Symington was employed by Lord Dundas to construct a steamboat, and having by his former failures learned what was required, he availed himself of the great improvements recently made in the steam-engine by Watt and others, and constructed an improved engine in combination with a boat and paddle-wheel, on the plan which is now generally adopted. This boat, called 'Charlotte Dundas,' was the first practical steamboat; and for the novel combination of all the parts Symington obtained letters patent on the 14th October 1801."

1789. A second steamboat was used on the Forth and Clyde canal, of 12-horse power, and similar in construction to that already made by the same three persons, Miller, Taylor, and Symington.

1793. John Smith used a steamboat with paddle-wheels on the Duke of Bridgewater's canal from Runcorn to Manchester. It had an engine on the old atmospheric principle, was worked with a beam, connecting-rod, double crank, in a horizontal line, and with seven paddles on each side, which propelled her after the rate of two miles an hour.

1796. A Dutchman used horses and ponies to propel a boat on the Ohio by paddle-wheels.

1798. Fulton tried successfully to propel a boat with a four-bladed screw propeller.

1802. Symington used on the Forth and Clyde canal a steam-boat (the "Charlotte Dundas") with one paddle-wheel at the stern.

1803. Fulton described some experiments with paddle-wheels, from which he was convinced that their use would be more advantageous than that of the "chapelet," or endless band of floats. He also proposed so to form the bows and sterns of boats to be towed in line that, being convex and concave, they would fit into each other, and form a line of boats with almost continuous sides, and free to bend at the points where the ends of the boats touched each other.

1803. Fulton and Livingstone launched a small steamboat with paddle-wheels, on the Seine.

1804. Stevens, in America, tried a steamboat propelled by a screw propeller turned first by a rotatory engine, and then by Watts' reciprocating engine.

1804. Boaz tried a screw propeller.

1807. Fulton launched a steamboat on the East river, America. This vessel (the "Clermont") was propelled by engines made by Boulton and Watt, in England.

1809. The "Fulton the First," a steam-frigate, was launched at New York.

1811. The "Comet" was built by Bell at Glasgow.

1812. Bell used the "Comet" between Glasgow and Helensburgh.

1813. The "Elizabeth" steamboat plied on the Clyde.

1815. Dr. Dodd went from Glasgow to London in the steam-vessel "Thames" (built on the Clyde). She is represented as a steamboat with one mast, and sails on the funnel used as another mast. This vessel was originally called the "Argyle." She was of 70 tons register, 79 feet long, and 16 feet beam, with engines of 14-horse power, consuming a ton of coals for every 100 miles, and carried 15 tons of coals. The paddle-wheels were 9 feet in diameter. She steamed 758 nautical miles in 121½ hours.

1815. Steam navigation was introduced into France.

1818. D. Napier established regular steam packets between Greenock and Belfast.

1818. Colonel Beaufoy described a "spiral oar," or screw propeller, with two spiral rims fixed on arms which he had seen used thirty or forty years before in a model made in China.

1819. The "Savannah" steamboat first crossed the Atlantic from New York to Liverpool.

1822. The first steam-vessel that carried the Admiralty pennant, the "Comet," was built at Deptford by Mr. Lang. The first that carried guns was the "Salamander," built ten years afterwards.

1823. An account was published of a double boat at Nyphenburg, moved by hinged propellers on levers worked by a man's feet.

1824. A revolving paddle scull or screw propeller was used by Waddell.

1824. Swan tried double-bladed screws immersed at the sides of a vessel to propel her.

1825. The "Enterprise" started from London, reaching Calcutta in 113 days.

1825. A boat with a screw propeller in the bow was used on the Thames by S. Brown.

The various inventions that have been patented are given in chronological order, with the date, number, name of patentee, and a short abstract of the specification; with notes on the same, and references to the works in which the patent or an account of the invention is to be found; and an index of the subject matter is given at the end of the Part.

THE MEDIÆVAL SOCIETY.

A Society bearing the above name has been formed, the object being the collection of copies of works of art of all kinds executed during the middle ages, but especially of those executed before the end of the thirteenth century; and this not as counteracting the independent influence of our own time upon its own art, but with the view of promoting the study of the mediæval period as the highest and purest of former times.

The subscription for ordinary members is one guinea per annum; and the meetings for discussion and reading of papers are to be held at such times as the committee may appoint, but not to be less than six in number during the year. The following gentlemen have been elected on the committee and as officers:—G. F. Bodley, F. Madox Brown, W. Burges, J. R. Clayton, W. Holman Hunt, W. Morris, Coventry K. Patmore, R. Poplewell Pullan, D. G. Rossetti, W. M. Rossetti, John Ruskin, Rev. J. Fuller Russell, W. B. Scott, J. P. Seddon, G. E. Street, Tom Taylor, W. White, B. Woodward. Honorary Secretary, Frederic Warren, 2, Duke-street, Adelphi, W.C.; Treasurer, George Edmund Street, 33, Montagu-place, Bedford-square, W.C.

The committee have power to protest, in the name of the Society, against any attempt to destroy old works of art, either wantonly, or under pretence of restoration; and to forward such protests to the proper quarters, or publish them when it may seem to them to be desirable to do so. They have also power to lend the drawings, casts, &c., belonging to the Society to the members for one month.

The Society are to cultivate, as far as possible, friendly relations with architects, sculptors, painters, and others, who are pursuing on the continent the same objects as the Society, and to have power to elect them honorary members.

ARCHITECTURAL UNION COMPANY (Limited).

A meeting was held on the 4th ult., at the Royal Institute of British Architects, to consider the best mode of purchasing certain premises, No. 9, Conduit-street, the residence of the Earl of Macclesfield (which are held on lease from the city of London, at a low ground rent, and which is perpetually renewable at a small fixed fine), for the purpose of providing the different societies connected with the art of architecture, with a building suitable for them, and an exhibition gallery.

Mr. Ashpitel, F.S.A. (the chairman), briefly stated the object of the meeting, and Mr. James Edmeston, jun., reported on the steps taken. In the course of his remarks he mentioned that the premises in question had been first brought under notice by Mr. Charles Gray. The matter had then been carried forward by Messrs. Ashpitel, Wyatt, Papworth, Gray, Hesketh, and Wylson, as a sub-committee appointed by the committee of the Architectural Exhibition, who had been most cordially received by the premises committee of the Royal Institute of British Architects, and no one had bestowed more personal pains and trouble, and assisted in a more practical manner in the latter stages than Mr. Digby Wyatt, the honorary secretary of the Institute.

It was unanimously determined that a Company under the above name should be at once formed. This has been done, and a prospectus issued. The Earl de Grey has expressed the warmest sympathy with the undertaking, and his intention, in the event of the measure proposed being carried out, of purchasing 25 shares in the contemplated Company, 20 of which he would present gratuitously to the Institute, and 5 to the Architectural Exhibition. The capital is 15,000*l.*, in 1500 shares of 10*l.* each.

The following gentlemen have been elected *Honorary Directors:*—Chairman, Sir Charles Barry, R.A., F.R.S., &c.; Deputy Chairman, William Tite, F.R.S., M.P., &c.; Messrs. Ashpitel, R. W. Billings, I. K. Brunel, D. Brandon, H. B. Garling, C. Gray, P. Hardwick, P. C. Hardwick, W. G. Habershon, R. Hesketh, E. I'Anson, J. James, J. Jennings, O. Jones, J. T. Knowles, E. B. Lamb, J. M. Lockyer, C. Mayhew, G. Morgan, C. C. Nelson, J. Pennethorne, J. L. Seckham, S. Smirke, J. Whichcord, S. Wood, M. D. Wyatt, J. Wylson. *Honorary Secretary:* James Edmeston, jun. (Hon. Sec. Architectural Exhibition).

Arrangements are already made with the Royal Institute of British Architects, and with the committee of the Architectural Exhibition, by which a rental of 450*l.*, and a premium of 500*l.*, is at once secured for portions of the premises, upon the understanding that certain alterations are made in the house, and that the galleries are erected. The rents estimated as obtainable for the ground and second and third floors, and the galleries, when not occupied by the Exhibition, are calculated at a further sum of 550*l.*, making a total rental of 1000*l.* per annum.

The main object of the Company will be to devote the whole of the premises to art or scientific societies of a kindred character. The cost of conducting the business of so small an undertaking will be but little, and the expense of a secretary will be shared with other societies who may be tenants in the building, and the whole outgoings for taxes, ground rent, &c., are estimated at about 300*l.* per annum. A net rent of 700*l.* per annum will thus be obtained, which will return an interest of say 6 per cent. upon the capital invested.

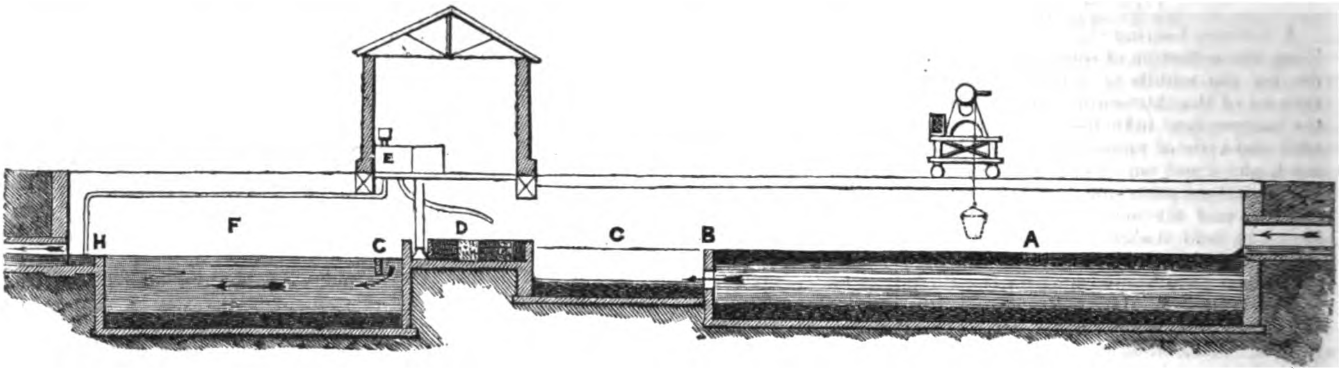
The Auxiliary Donation Fund, so nobly commenced by Earl de Grey, with his donation of 250*l.*, to be invested in shares in this company, has since been further subscribed to by A. J. B. Beresford Hope, Esq., M.P., and other gentlemen, and it is intended to keep the list open, that those who prefer this mode of affording assistance may have the opportunity. The interest payable on the shares may be devoted, in some way or other, to the encouragement of the art.

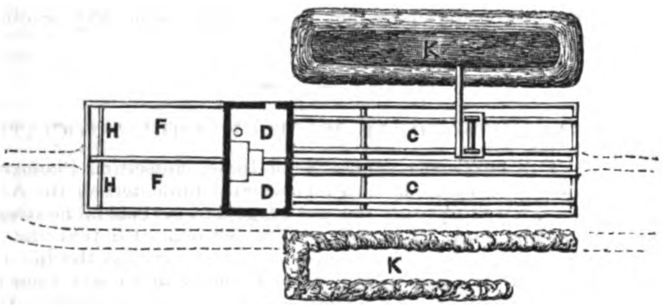
ARCHITECTURAL PHOTOGRAPHIC ASSOCIATION.

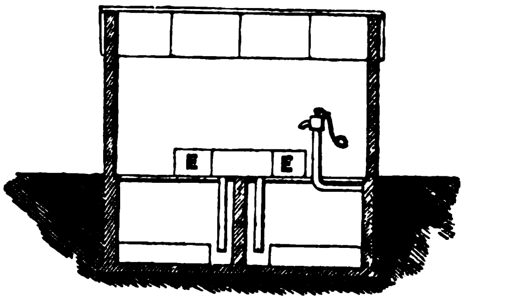
The provisional committee of the Architectural Photographic Association have made a report to the promoters of the Association, which was received and adopted at the general meeting held on Thursday, May 14th. They recommended that the Association be forthwith established. The Council of the Institute of British Architects have allowed the further use of their rooms for the meetings of the Association during the ensuing twelvemonth. After deliberating upon the various methods which have been already suggested by which the objects of the Association may be effectively promoted, and others which have since occurred or have been suggested to them, the committee express their conviction, that not only may the Association obtain their photographs in such manner as will prove most serviceable to them, but also at a greatly reduced cost. They consider that at least three copies of the largest ordinary size—viz., 21 inches by 17—might be issued for a guinea, whereas one of them is now ordinarily sold for about 25*s.* Smaller sizes might be issued in considerably increased numbers, and they intimate that probably from 30 to 40 stereoscopic views might be given for a similar subscription. But it is obvious that an Association, having a large and definite number of copies to provide, almost all of which will be issued; having no vendor's profits to pay; and possessing many other advantages not accessible to individuals, may greatly enlarge the issue beyond the number which estimates upon present data would afford. An additional object to architects may probably be attained by enabling them to ascertain, not only the relative proportions, but also the actual sizes of buildings and their details, as would be effected by simply measuring and noting the distance from the station of the instrument to a fixed point on the object. This would even render it practicable to lay down, on geometrical drawing, every line or point seen on the picture. If the distance should be noted in the measures of other countries, this advantage would be equally extended to them. After the main object of the Association shall have been provided for by the distribution of photographs amongst members, to such extent as the funds shall admit of, the formation of a collection of photographs will obviously form a feature in the scheme, and perhaps their exhibition from time to time may be made to further the interests and the objects of the Association.

The following gentlemen have been elected officers for 1857:—*President:* C. R. Cockerell, R.A. *Trustees:* P. Hardwick, R.A., S. Smirke, A.R.A., and W. Tite, M.P. *Treasurer:* T. H. Wyatt. *Ordinary Members:* A. Ashpitel, the Rev. C. Boutell, M.A., E. Christian, C. H. Clarke, E. N. Clifton, J. Edmeston, jun., — Ferrey, H. B. Garling, P. C. Hardwick, R. Hesketh, G. Mair, C. C. Nelson, Sir W. C. Newton, R.A., J. W. Papworth, Capt. Ross, R.E., G. G. Scott, A.R.A., Capt. Scott, R.E., S. Smirke, A.R.A., S. Wood, T. H. Wyatt, and M. D. Wyatt. *Auditors:* G. Aitchison, jun., and B. Thurston. *Honorary Secretary:* R. Hesketh, 95, Wimpole-street.

DEODORISING AND UTILISING THE SEWAGE OF TOWNS. By Henry Austin, C.E.







It will be evident that the best means of deodorising and dealing with the sewage of towns demands much further investigation than has yet been made of the subject; but it will probably at the same time be gathered from the experience so far obtained, that by certain processes and admixtures the main object of this inquiry may be in great part at once secured; that is to say, that much of the offensiveness of the sewage of towns may be removed, and therefore much pollution of the rivers and streams of the country avoided; that a solid manure of a certain low value may be obtained by these processes, which under certain conditions will probably pay for the outlay; and that on sanitary grounds, therefore, the adoption of some such process by local boards, wherever the Public Health Act is applied, or by the local authorities of the towns where it is not, ought to be insisted upon, wherever an offensive outfall exists, whether arising from new works of drainage or from old.

It would appear that various patent processes are adequate to this partial dealing with the subject; but while the arrangements or materials adopted in those which have been brought into practical operation are for the most part expensive, there is no evidence of their having realised any better results than have been obtained by a simple and economical method adopted with the same object in the town of Cheltenham. Such methods, unfettered by patents or other difficulties, appear to come strictly within the duty of the local body charged with the disposal of the refuse of a town, being, in fact, little more than a transference to the outfall, of duties which they are already bound to perform, namely, the removal from the separate houses of the contents of the midden or cesspool and dustbin.

In proposing, however, for general adoption, some such arrangement for separating the solid portion of sewage from the water in which it is conveyed,—as the first step towards the removal of that pressing evil, the poisoning of rivers and streams throughout the country,—I desire to submit for consideration certain modifications in the plan, with a view to the more efficient and economical working of the process. These may perhaps be of service for the guidance of local bodies, more especially in towns of the smaller class.

The great bulk of the solid matter, when the sewage comes to comparative rest in the reservoir, divides itself into two bodies; the heavier particles at once deposit themselves at the bottom, and the lighter portions collect, in a solid floating mass, on the surface. It appears to me that the chief proportion of these matters may be intercepted in the first tank A, both above and below, without a filter, by a simple division, B, with basket work and perforated boards in the middle, allowing the water to pass through only at a certain depth beneath the surface.

The second tank or reservoir, C, need not then be so deep or so large as the first. At the end of it, filtering materials of different kinds should be arranged, through which the sewage would pass laterally; 1st, coarse screened gravel, beach, or broken stones; 2nd, gravel of medium coarseness; and, 3rd, some finer material. And there would be much advantage in having this filter, D, shallow and broad, rather than deep and narrow; the surface water only would pass away, and thus allow of further deposit from the main body before filtration; it would be subject to greater friction and disengagement of the solid matter and foul gases; and the filtering medium itself would be less readily clogged, and would be more accessible for cleansing without removal, as it could be turned over in its place and subjected to complete washing, from a water tank, E, above, as often as desired. A very small area of filter so placed would be found sufficient for all practical purposes.

By proper arrangement, the work may be brought more compactly together, and the scavengers' carts may deposit the ashes, K, on the spot where they are wanted, and where they may be at once formed into continuous banks for the reception of the sewage deposit, which would be hoisted in the buckets and discharged by a shoot into the midst. Much labour in filling, wheeling, and mixing would be thus saved, and much exposure also of the sewage, which at certain times must be as offensive to the smell as it will always be to the sight, where such an operation is openly conducted.

The same necessity for a covering shed over the filters will then no longer exist, and it may safely be dispensed with, provided that the premises are enclosed with a boundary fence, or wall. A small shed only will be required for the liming process, and for housing apparatus and tools.

The reservoir for deposition, F, after the addition of the lime, should be considerably larger than that at Cheltenham. There is not time, in that case, for the precipitation to take place. The lime and remaining sewage flow off in suspension to the stream, and have an unsightly effect, if no other inconvenience.

It is stated as one of the results of the Manchester experiments, that the lime falls at the rate of an inch and a half per minute. The admixture being made as the sewage flows into the reservoir at each side, I propose that it should be intercepted by a fender, G, that it may not disturb the main body of water, and that the discharge to the outfall should take place over a weir, H, allowing only a surface film of the water, from which the lime has descended, to pass over.

The depth of this surface water passing over, and the length of the reservoir, must be of course determined by the quantit which has to be discharged.

THE MONSOONS OF THE INDIAN OCEAN.

By Thomas Hopkins, M.B.M.S.

The south-west or summer monsoon of Hindostan presents to view an extraordinary display of meteorological phenomena, which have long excited the curiosity of inquirers into the various changes that take place in our atmosphere. This wind is found south of the equator, in the latitude of 15°, near to Madagascar, and it sweeps over the Indian ocean to Hindostan. For the quantity of rain that it conveys to some of the places of its termination, it is probably unequalled on the surface of the globe, and it has meteorological peculiarities which make it a subject worthy of inquiry and study. India is one of those places that are referred to by writers who advocate a particular theory of wind, as proving the influence of sun-heated surfaces of land on movements of the atmosphere, and therefore while it justifies a separate examination, challenges close investigation.

The blowing of the summer monsoon commences in the southern hemisphere, and terminates in the northern, extending in some parts beyond 30° of north latitude, and passing over 45° in the two hemispheres. It alternates with another wind, less formidable in its character, called the north-west monsoon, which does not go far to the south of the equator, although it appears to come overland from a great distance in the north during our winter, generally terminating in Hindostan about the month of March. With intervening periods between the changes, these two winds blow during the year over a very extensive area.

Milner, in the 'Gallery of Nature,' says: "It is an extraordinary fact that, in India, as soon as one monsoon ceases, though a month may elapse before the succeeding one appears, the clouds take the direction of the coming monsoon." This movement of the clouds indicates that the particular causes of the monsoons come into action first in the higher parts of the atmosphere; and in the south-west monsoon these parts must be near the lofty range of the Himalayah mountains, as towards them the south-west monsoon blows.

All accounts represent that this wind begins to blow, in the lower regions of the atmosphere, about the month of April, which is shortly after the sun has entered the northern hemisphere. The surface of the southern tropical Indian ocean has then been much heated by vertical solar rays, and evaporation of water from that surface must have sent a large amount of vapour into the air, which, ascending within it, makes it misty, and probably by condensations into clouds and re-evaporations of those clouds, as is common in the tropical regions, the vapour is taken to great elevations in the atmosphere. Now some of this vapour, when expanding northward, on reaching and ascending the Himalayah mountains, would probably be condensed, and cause an influx of air, in which clouds might be borne in the higher regions towards the mountains, as described by Milner.

It appears from Forbes' account of Ceylon, the most southern part of India, that the rains from the south-west begin there in April, and it is known that in the following month they successively reach various parts on the western coast, extending to Bombay and Surat. Mrs. Postans informs us that the south-west monsoon may generally be expected to set in in Cutch at the end of June or beginning of July. Burnes says, when ascending the river Indus, "We passed Zeia on the 9th of June, and Guring on the 11th, and moored off Dera Ismael Khan on the 16th, thus performing a voyage of about 200 miles in eleven days, the wind being fair all the way, although the weather was squally with rain, thunder, and lightning. The prevailing winds of the Indus conform to the direction of the river, blowing for 6 months up the river, and as many down. From April to September the breeze is southerly, and during the other months of the year it comes from the north." (p. 89.)

On the eastern side of the Bay of Bengal, in Arracan, the periodical rains, according to Crawford in his account of Birmah, are extremely heavy, and continue from April to November. At Martaban, in 16° 20′ of latitude and 97° 25′ of longitude, "the south-west monsoon and the rains set in together about the beginning of May, when they are comparatively mild. They are severest in the months of June, July, and August." At Chierra Poonjee, among the hills, more than 4000 feet high, in 25° of latitude and 91° of longitude, the south-west wind sets in steadily in April, and continues during the months of May, June, July, and August. Thus we see that this wind from the south-west, coming from the wide expanse of the Indian ocean, blows from Birmah in the east to the mouth of the Indus in the west, a breadth of say 30° of longitude, and throughout the whole extent its direction is towards the Himalayah mountains, where at that time heavy rains are falling.

It is not easy to obtain information respecting either the winds or the amount of rain in the higher parts of the Himalayan range, but all accounts represent the mountains to be covered with dense clouds, which pour down enormous quantities of rain. The brothers Gerard, who penetrated far into them, state, under date of 17th April, that "from Buddea they crossed the Sursa, where it rained almost the whole way, and completely drenched the party." And these rains become more continuous as the summer advances. The increase of water in the rivers in the same season, sufficiently proves, in addition to the melting of snow, the great and continuous falls of rain among the mountains. The greatest falls with which we are acquainted are those at Mahabaleshwar near Bombay, and at Chierra Poonjee in Arracan, the former being 302 inches in the year, and the latter the enormous amount of 600 inches; and these falls take place principally at the time when the south-west monsoon rages in its greatest strength. During this period, also, the large rivers fill. By the end of June the Ganges rises 15 feet, and at the end of July all the low adjoining land is flooded. It may be said, in general terms, warranted by innumerable accounts, that in the months of June, July, and August, nearly the whole of India is deluged with rain. These facts, taken together, show that the vapour which produces the rain is brought by the south-west wind, and that that vapour is condensed among the mountains. But then comes the inquiry,—What causes the winds to blow from the Indian ocean to these mountains? This is the interesting point for the meteorological investigator, that is not satisfactorily treated in books written professedly on the subject.

The general statement in meteorological works is, that the sun heats the surface of the continent of Asia in the summer, sufficiently to warm the lower air that rests upon it, and to make it ascend; when cooler air is said to come from the Indian ocean to supply the place of that which ascends. Malte Brun, who may be considered to express the general opinion on the subject, says: "The south-west monsoon blows over Ceylon while the sun is north of the line, the temperature of the continent being then higher than that of the ocean; this continues from the end of April to the beginning of November." The Rev. T. Milner, while admitting that we have a scanty measure of information on the subject, observes, "that the south-west monsoon which prevails to the north of the equator, is coincident with the sun being vertical to that region, when Hindostan, Siam, and the adjacent countries, receive their maximum of heat. Consequently, the incumbent air, being rarefied, ascends, and a rush of colder air to supply its place is produced from the southward." He afterwards says, that "these are explanations commonly given, though they do not account for the whole of the phenomena."

But where does the heating of the land surface take place? Is it over the low plains of Hindostan? The affirmative of this is not plainly asserted, as it is known that those plains are well screened in the summer by a thick canopy of clouds, through which the solar rays do not readily penetrate. On this subject, Dr. Buist, at the meeting of the British Association of 1851, informed us that, "on the setting in of the south-west monsoon, with its deluges of rain, we have the light of a cloudy English day instead of intolerable glare, and *a fall* of 10° or 12° of temperature." This account is in harmony with others that are given respecting the state of India during the summer monsoon. These represent that on the setting in of the rainy season, clouds so far protect the surface of the ground from the direct action of the sun's rays, as to cause the temperature of that surface to fall greatly below what it had been previously during the cloudless period. And during the whole of the wet season the temperature of the surface is comparatively low. So that the assertion, that the land in Hindostan is greatly heated by the direct action of the sun in the summer, when the monsoon blows the strongest, is manifestly incorrect. Yet the assertion is generally made in so loose a way, with reference to the continent of Asia, as to render a glance at the parts beyond India necessary, in order to see whether it is their heated surfaces that cause the cooler air to flow towards them from the Indian ocean in the south.

As the wind, of which we are speaking, comes from the south-west, if it were produced by heated surfaces beyond India, those surfaces ought to be in a north-eastern direction. But a barrier of lofty mountains extending from Arracan to Cabul, as already described, lies in this quarter, which mountains are in great part covered with snow in the summer, whilst beyond them is the elevated desert of Cobi, distinguished for the coldness of its climate; the heated land sought for cannot, therefore, be found in this direction. The only part left that can be thought to countenance the statements that are here combated is the low desert of Bokhara, and parts adjacent extending towards the Caspian sea. It is to be observed, however, that this country is to the west of India, and therefore a south-west wind in India cannot be said to blow towards the desert of Bokhara. The passes from Cabul to this desert, to a certain extent, admit air sometimes to make its way through them; in passing from India, however, this wind would be an east and not a west wind, such as blows over India: but in fact no palpable wind blows through the passes from the south,—there is therefore no foundation for the assertion that the sun heats the parts beyond India, so as to permit air from the Indian ocean to flow thither from the south-west.

But when the low desert of Bokhara, lying to the north-west of India, as it does, is visited by travellers, in what state do they find it, and, particularly, what winds prevail in it? Do the winds which bring so much rain from the Indian ocean, in some way pass over Cabul and through the passes of its lofty mountains, to the desert of Bokhara, taking with them their vapour? It may with confidence be said that they do not. In the part of the desert nearest to the Affghan mountains no south wind is found, and it never rains there in the summer, when at that period India is deluged.

Burnes, who traversed the dry desert from the Cabul passes, had his attention strongly directed to the weather that he encountered, and these are samples of the way in which he speaks of it:—"In Cabul, during May, the thermometer stood at 64° in the hottest time of the days, and there was generally a wind *from the north* cooled by the snow that covers the mountains. It must usually blow from that quarter, since all the trees of Cabul bend to the south." In advancing from the Hindoo Koosh mountains, after passing the Oxus, going towards Bokhara, he says: "The climate was dry and variable, and the thermometer, which stood at 103° in the day, fell to 60° at night, which was cool and delightful. In this country a steady wind generally blows *from the north*." (p. 218.) This was about the 16th June.—"On the 23rd, after having passed the Oxus, the desert was overgrown with brushwood, but the tract was entirely destitute of water. The heat of the sand rose to 150°, and that of the atmosphere exceeded 100°, but the wind blew steadily, nor do I believe that it would be possible to traverse this tract in summer if it ceased to blow. The steady manner in which it comes from one direction is remarkable in this inland country." These extracts are quite sufficient to show that there is no foundation for the assumption, so generally made by compilers of books, that the air from the Indian ocean rushes as a wind to the sun-heated surface of the continent of Asia, to be by that surface heated, raised, and sent into the higher regions of the atmosphere.

Some of the north winds that blow in the desert of Bokhara in the summer make their way southward, not only to the rainy mountains of Affghanistan, but over parts lying farther west, including Persia and Beloochistan, rendering those rather elevated countries dry. The winds then pass forward over the Arabian sea, and ascend the valley of the Indus, up which, according to Burnes, wind blows during the six summer months, when heavy rains are falling near its sources; and the winds to a considerable extent retain the dry character of the countries over which they have recently passed. But in going from Persia to the Arabian sea, the wind passes from sun-heated land to the comparatively cool Arabian sea, which, in this instance, is the reverse of the process so generally, but loosely, alleged to take place, of blowing from the cool sea to the land; showing that the allegation is not only without foundation, but directly opposed to the facts of the case.

We have now arrived at the point where it becomes necessary to make inquiry as to the real cause of the south-west wind blowing with such great strength, as it does in the summer in this part of the world. And there is no reason to doubt that it is the same as that which produces all the great winds in other parts.* When the sun passes from the southern into the northern hemisphere, his rays act with increased effect on the surface of the Indian ocean within the northern tropic, vapourising more water and sending the vapour into the atmosphere. This vapour rises in the atmospheric space, and expands in all directions; and some of it may, even at an early period—as seems to be indicated by the passage of clouds at great heights towards the mountains—reach the more elevated parts of the Himalayah range. It is, indeed, probable that some condensation of vapour is taking place among the higher parts of the mountains during the whole winter, as snow is falling there frequently. But on the nearer approach of the sun with a larger supply of vapour, more vapour is condensed, when comparative vacua are created at such elevations as determine air to flow towards the locality of condensation in the higher regions, taking clouds with it as already described. This will account for the south-west wind showing itself sooner in the upper than in the lower regions of the atmosphere, which would not occur if surface-heated land was the moving power, as then the first flow of air from the sea to the land would be in the lower regions.

As the sun advances northward, and additional condensation of vapour takes place in lower parts, atmospheric vacua are made in lower strata, and air passes from the ocean to the land at less heights; and when the northern tropic is reached by the sun, much water is vapourised, the air made very humid, and a large amount of vapour is condensed. Within, but near to, the tropic the sun remains for a certain time, having first to advance northward, and then to return; during this time therefore the greatest power of the sun is exerted on the surface of the ocean, evaporation is the most energetic, and shortly afterwards the greatest condensation of vapour takes place over contiguous elevated lands. This occurs principally against the sides of the ghâts and the more southern portion of the Himalayah mountains, where condensation of vapour creates comparative vacua in the atmosphere, which allow air to rush from the Indian ocean with the force and constancy that is experienced in the south-west monsoon. Here, then, is to be found the source of the wind. It is the heat, which being set free from its chemical union with water, attaches itself to the atmospheric gases that are in the locality where the condensation takes place, expands them and makes them lighter; when the heavier air from the Indian ocean rushes into the vacuum, and being itself well charged with vapour, has that vapour condensed as the air ascends, producing the drenching and continued rains that distinguish this part of the world.

It is then towards these heated areas—these comparative atmospheric vacua near the mountains, and not to sun-heated land, that the south-west winds of the Indian ocean blow. They come more from the south when passing over Arracan, from the south-west over the ghâts, and to the middle of the Himalayahs, and become nearly west when passing from the Arabian Sea; but they all blow to the same ranges of mountains, and with strength proportioned to the rain-falls in the different parts of those mountains. Air also passes towards the vacua that have been thus created, from the north over Persia and Beloochistan, as well as towards the mountains of Affghanistan, being supplied by the constant wind that blows over the desert of Bokhara. From the north-east no palpable wind comes to India, on account of the elevated land that intervenes, and any air that comes from the farther east is partly arrested by the lofty mountains of China. Thus all the facts harmonise with the hypothesis that attributes the summer winds in this part of the world to the heat derived from condensing vapour; whilst they are irreconcilable with that which points at sun-heated land as the prime mover;—leaving us at liberty to conclude that the latter hypothesis is fallacious, and that the former may be true.

In the *Philosophical Magazine* for October 1854, M. Dove, of Berlin, is represented as having stated that "a greatly diminished atmospheric pressure taking place in summer over the whole continent of Asia must produce an influx from all surrounding parts; and thus we have west winds in Europe, north winds in the Icy sea, east winds on the east coast of Asia, and south winds in India." No doubt such facts as those named by Dove exist, but there is a want of precision and of completeness in his language, arising apparently from an endeavour to make the facts harmonise with his own views, which are Hadleian. He says that north winds in the summer blow in the Icy sea, which is true; but they blow as north winds much farther than he describes, as they extend over the low surface of Northern and Central Asia to the feet of the Himalayan mountains: this is stated by Burnes and other travellers, and is shown by the climate. And when M. Dove says that east winds blow on the eastern coast of Asia, and west winds in Europe, he also asserts

* See "On the Atmospheric Changes that produce Rain and Wind." London: Weale, Holborn. p. 289.

what is in accordance with facts. But these winds do not merely proceed to a dry, sun-heated surface of land, to be, as insinuated, there raised; on the contrary, those which reach Central Asia go to the lofty mountains in the south where heavy rains are falling. The diminished atmospheric pressure must be, as Dove presumes, at the part in the atmosphere towards which all the winds tend; but this part cannot be the sun-heated surface of the land of Asia, seeing that where the winds really terminate there is no such surface. But there is a very large amount of vapour condensed in that part, and to the condensation of that vapour the vacuum that causes all these winds must be attributed.

The south-west, however, is not the only wind of the Indian ocean that is called a monsoon. There are two others, namely, the north-west already alluded to, and the petty monsoon. The former of these is a winter wind of the northern hemisphere, and it blows over Persia, Mesopotamia, and Arabia, to the Indian ocean, as a very dry north wind. Colonel Messora Bey, of Bagdad, in an interview with the Commercial Association of Manchester, asserted "that it never rained at Bagdad." (*Manchester Guardian*, Dec. 12, 1856.) The wind passes as a dry one along the western side of India, and crosses the great ocean to the East Indian Archipelago. In its passage, however, in due time it loses its dryness by taking up moisture from the ocean; and at last reaches its place of termination as a moist wind. Malte Brun says, "In Sumatra the north-west or rainy monsoon begins in December and ends in March." (p. 428.) "In Timor the hot and dry season, which reigns from May to November, is succeeded by torrents of rain, accompanied by a violent north-west wind, lasting from November to March." (p. 522.) And Davidson, in his 'Trade and Travels in the Far East,' states that "at Batavia the breaking up of the monsoon takes place in April and October. In November and December the north-west monsoon brings on the rains, which certainly then come down in torrents." In Brooke's account of Borneo we are told that "the *Royalist* (ship) will probably reach Singapore in the month of March, at the latter end of the north-west or rainy monsoon." (Appendix, p. vi.) And that "the wet season commences from September and ends in April, when heavy rains, hard squalls, and much thunder are experienced. To the southward, about Benjarmasing, the monsoons are the same as in the Java seas, *i.e.*, westerly from October to April, and easterly the rest of the year." (Hunt's 'Sketch.') Earl, in his account of tropical Australia, informs us that in the Coburg peninsula, in, say 12° of south latitude, "the westerly monsoon seldom sets in decidedly till December, it then blows with considerable strength, and continues without intermission for days together, bringing dense clouds surcharged with moisture from the Indian ocean. This is the commencement of the rainy season. During intervals of fine weather the south-east trade wind often resumes its course for a day or two, but it is comparatively faint and interrupted." When at Port Essington, in latitude 12° south, he says, on January 1st, "The wind was now usually from the western quarter, and occasionally blew rather fresh, in squalls. The passage to the westward through Torres straits is supposed to be closed by the westerly monsoon during October and five following months." (p. 54 and 61.)

These facts taken together show that the north wind from the continent of Asia blows over the Arabian sea, turning towards the east, and then passes over the Indian ocean as a north-westerly wind, until the lofty islands of the East Indian Archipelago are reached. Now these islands are not at this time strongly heated by direct solar rays; on the contrary, they are generally covered with dense clouds, which shower down heavy rain, and the mountains of these islands extend along a broken chain from Sumatra on the west to Timor on the east;—but it is sufficiently apparent that among these mountains the same operations are going on in the winter of the northern hemisphere that are found in the Himalayahs in the summer. And to the condensation of vapour among the islands, and the vacua that are produced over them, we may attribute that influx of air from the Northern Indian ocean which is known by the name of the north-west monsoon.

It has been said that the eastward flow of air across the Indian ocean is caused by the sun heating Northern Australia. But if this were true the wind would become stronger as it approached that part, and the part itself would be drenched with rain, like Sumatra and Java; whereas the wind becomes feeble as it approaches Australia, and the country is dry. Our information respecting this portion of that country is imperfect, but such as we have points at an arid district, rather than one towards which air was drawn from an extensive ocean. Earl says, "In the Coburg peninsula, at the commencement of the rainy season in December, squall after squall passes along with heavy showers, often for several hours together, when the bright sun appears, to be again obscured by other showers. The westerly monsoon blows almost a gale, but the south-east trade not so strong." This account does not lead us to infer that the heated surface of northern Australia produces a vacuum in the atmosphere, into which air rushes from the wide expanse of the Indian ocean, but it accords with the hypothesis that condensation of vapour over the lofty islands creates such a vacuum, which draws air towards them, and that a part of the Australian coast receives some of the vapour thus brought.

The south-east trade wind just named is that which, between the latitudes of, say 15° and 35° south, extends westward from near Australia to Africa as a constant wind; and it is only in the winter of the northern hemisphere that the north-west monsoon partially breaks in upon it about Australia. Earl says, "at the commencement of April the south-east trade blows steadily with considerable strength and occasional showers, until May, when rain ceases. From this time till October the weather is fine." This wind therefore blows from Australia generally as a dry one, and as such it is known until it approaches the Mauritius and Madagascar, by which time it has acquired moisture, and furnishes rain to these islands.

But there is another wind, known to navigators by the name of the petty monsoon, which has not been noticed by meteorologists, that blows almost parallel with the perennial south-east trade of this ocean, but nearly in an opposite direction. It is found at some distance from Madagascar blowing towards Java, at the time that that island is drenched with rain; and it may be presumed to be produced by the rains of the Archipelago. This seems to be another instance of what occurs in the Atlantic and Pacific oceans, where elevated lands on opposite sides of wide oceans draw air over these oceans in contrary directions, through the comparative vacua that have been created on both sides of the oceans.

It may, however, possibly be still imagined by theorists, that the south-east wind of the Indian ocean is produced by the cause recognised in the Hadleian theory, notwithstanding that it is at such a distance from the equator. But on that theory how can the petty monsoon be accounted for? This wind not only blows in an opposite direction to the south-eastern trade of the part, but in defiance of the theory travels close to the equator from west to east; and of course, in the rotatory motion of the earth, moves faster than the part of the globe over which it is passing. Navigators frequently speak of this wind, but it will be sufficient to give the following extract from the travels of the Rev. H. Malcolm. He says, "The petty monsoon is a remarkable intrusion on the south-east trade wind. It exists six months in the year, from November to May, between latitudes 2° and 10° south, and extending from Madagascar to Java: it is sometimes broader. After leaving Java Head, in 6° south, on Dec. 7, we had it as far as 16°. It generally blows fresh, and often in squalls. In 16° south we reached the regular south-east trade wind, and rolled before it more than 4000 miles in a month." (vol. ii. p. 197.)

We thus find that in the Indian ocean three currents of air flow from the west towards the east, and of course they must move faster than the surface of the globe over which they pass. The south-*west* monsoon blows in the summer from Africa, over the whole ocean towards the Himalayah mountains. In the winter the north-*west* monsoon blows from the Arabian sea, across the northern Indian ocean to the great area of condensation of vapour in the Archipelago. And during the same season the petty monsoon blows from a little south of west to the same area. Nothing, therefore, in the Indian ocean indicates the existence of Hadleian south-east or north-east winds blowing to the equator to ascend there; but all the winds blow towards localities where abundant rains are falling.

It seems strange that in the face of such evidence as this the Hadleian theory of winds could have been adopted. In order to sustain it, however, it was necessary to assume that sun-heated land existed in Asia, where the lofty Himalayah mountains rear their snow-covered heads; and that winds blow from the north-west to the dry plains of north-western Australia. The latter assumption is however as unfounded as the former, seeing that an eastern wind blows from that part of Australia during the whole year; whilst western winds blow to the Indian islands and through Torres straits one-half the year, only just reaching Australia, though they probably pass on to some of the lofty islands beyond those straits. All other meteorological facts in this part of the world furnish evidence, though not equally striking, of the fallacious nature of the Hadleian theory of winds, and of the substantial truth of that which attributes strong winds to condensation of atmospheric vapour.

THE HINDOSTAN AND THIBET ROAD.

Report on the Operations from 1850 *to* 1855.

By Lieut. David Briggs, Superintendent, Hill Roads.

1. In the spring of 1850, a variety of circumstances combined to attract the attention of the Marquis of Dalhousie, governor-general of India, to the most oppressive practice of "begar," or forced labour, prevalent in the protected Hill States, which occupy that portion of the Himalayahs situated between the rivers Sutlej and Jumna. This species of serfdom had been general throughout these principalities from time immemorial, and was doubtlessly introduced, not only as a substitute for revenue in the absence of other means of taxation, but because the exigencies of the chiefs required the entire disposal of the time and labour of their subjects in peace, as well as in war. As long as the chiefs were solely dependent upon their subjects for support, and were only preserved by their help from the encroachments of their warlike neighbours, the union between them was such as to ensure the subject a certain amount of consideration from his chief; else would the subject transfer his allegiance to another and more politic master. Since, however, the British government extended its protection to these states in 1815, these relations have changed; and the serf being no longer necessary to the safety and support of the chief (these being sufficiently guaranteed by the paramount power of the British government), has lost the balance of power he formerly possessed. Without dread of interference (which the nature of our political relations precludes), the chief may now at his pleasure increase his demands upon the time and property of his subjects. True it is, the latter may appeal against his oppression to the Superintendent of Hill States, but from the nature of existing treaties, that officer has in general no course to pursue but to refer the case back to the chief against whom the complaint lies; with what hope of obtaining justice for the oppressed, I need not say. Thus "begar," or unremunerated forced labour, as the term implies, is a system of the internal government of the Hill States.

2. In 1815, Sir D. Ochterlony, finding the Hill States impoverished to an immense extent by the protracted invasion of the Goorkahs, thought it sufficient to impose upon the chiefs whose countries he restored, a recognition of our paramount authority in the shape of a trifling annual tribute, and the duty of providing begar, whenever the exigencies of the state required it.

And foreseeing with his wonted sagacity, the only means by which the condition of the inhabitants of the fertile valleys embosomed within the Himalayahs could be ameliorated, he added to the engagements of each chief the obligation of constructing roads, 10 feet wide, in whatever direction the British government should desire them, within their own chiefships. For thirty-five years, or up to 1850, this last condition had remained a dead letter. With the exception of slight improvements made in the different hill paths, communicating with the residences of the several chiefs and Simlah, these improvements, except in a few instances, effected no change in the mode of carriage throughout the hills; as they were confined to the widening of old pathways, adopted before the employment of beasts of burthen had been thought of by the hill-men, and were consequently of a gradient impracticable to all but themselves.

The second condition had therefore of necessity been more generally exacted, as the exigencies of the British government within these states became yearly greater. When the sanitaria of Simlah, Subathoo, Kussowlie, and Dugshai (which have proved of such inestimable benefit to thousands of Europeans), were established, great and continuous was the demand for labour in all shapes. In the absence of other carriage, thousands of porters were yearly required for the conveyance of government establishments, invalids, and their numerous servants; troops and camp followers; supplies and merchandise, from the plains to the sanitaria; and thousands were again required a few months afterwards to convey the same down again. Barracks were required for the troops, hospitals for the invalids; and materials for their construction had to be brought, by the unassisted efforts of men, from glens and mountains ten miles in the interior. To assist in these laborious tasks, the people of the plains were found to be perfectly unfit. The long rugged ascents, and narrow tortuous footpaths of the hill-men, were scarcely practicable to them under any circumstances, wholly impossible when laden. Thus the whole duty fell upon the scanty population of the Hill States, and heavy and grievous was the burthen. Begar was claimed by their own chiefs; begar was an obligation owed us by their treaties of 1815; and although, to the credit of our government be it spoken, they never were called upon to work without receiving remuneration, yet what amount of wage could remunerate a man for being dragged against his will from his home and family, without warning, without consideration (for what government native official has consideration when armed with his master's warrant), to a distance of many days' journey; there to wait weary days, without shelter, without his usual food, until his services were required. Then to be laden as a beast of burthen, to be insulted, to be buffetted by the low dependents of an European master, until the time of his slavery was accomplished; when he was suffered to depart, with feelings mortified and wounded, to his distant valley. There perhaps to find, that seed-time or harvest had passed during his absence, and no provision been made for his unhappy family.

It might be supposed that the influx of large sums of money, within a limited period, must have tended to enrich the population, and so reconciled them to the evils of begar. But, as previously shown, the system of our political relations with the chiefs allows of an *imperium in imperio*, and thus deprives the subject of any protection against the tyranny and malpractices of the native authorities of the states to which he belongs. The consequence is, that no amount of care on the part of the disbursing officer insures to the "begar" the permanent possession of the wages paid to him. I have been assured by the late Superintendent of Hill States, Mr. William Edwards, that having on one occasion a large sum to disburse to subjects of the Hindoor States, he attended in person and saw the money put into each man's hand; notwithstanding which, he afterwards discovered that the hardars of that state took from the unfortunate men all that he had been so careful that they should receive.

3. Besides the cruelty of the system, it was to our government a most expensive one. I have learned from the Superintendent of Hill States, that the sums disbursed on account of the carriage of the government establishments from 1820 to 1852, to and from Simlah, amounted to seven lacs of rupees. The cost of the barracks and other buildings for one regiment at the Dugshai sanitarium, has amounted, I understand, to six lacs of rupees. Taking the same sum as the cost of each of the other sanitaria of Kussowlie and Subathoo, and one lac of rupees for the other buildings, the expenditure on public works within the Hill States has probably not been less than nineteen lacs of rupees.

From personal experience I will venture to state, that the chief items of expense in these works was carriage of materials; and yet there is no country in the world where building materials are more abundant; stone, lime, and wood exist in profusion within a circuit of ten miles, and all that was wanted was the means of carrying it.

To the officers and servants of the government, who annually visit Simlah and the neighbouring sanitaria for the recovery of their health, or on duty, and average about 500 persons, the cost of the journey, and the high price of supplies, becomes to many a most serious consideration. The cost of the transport of stores and supplies from the plains to Simlah, a distance of 42 miles, averages about 3 rupees per cwt., a sum which ought to suffice for the carriage of the same weight for a distance of 1000 miles.

Had carriage-roads been at once constructed, government would have saved 50 per cent. upon the past outlay, which, as will be shown hereafter, would have sufficed for the construction of 500 miles of carriage-road; and the servants of government, with their families, who have visited the hills, might have returned to their duties with renovated health, purchased at a less ruinous cost.

4. It remained for the Marquis of Dalhousie to initiate ar-

rangements having for their object the construction of roads that would admit of the transport of baggage on four-footed animals or carts, and thus render the agency of human beings in employments so degrading, unnecessary. With this view, his lordship, in the spring of 1850, sanctioned the commencement of a road, which leaving the plains in the neighbourhood of Kalka, 36 miles from Umballah, should ascend to Simlah, having branch lines to the stations of Dugshai, Kussowlie, and Subathoo. Further, as a part of the same project, his lordship directed the continuation of the line beyond Simlah towards Thibet, through the temperate valley of the Sutlej; with the twofold object of affording an easy entrance into the justly celebrated salubrious valley of Konawur, and of opening a direct commercial intercourse with central Asia and Western China, and thereby directing into our own provinces the trade at present monopolised by Russia. As it was expected by the terms of the treaties of 1815 that these works, so humane and important in their object, would be effected by the hill chiefs, the continuation of the line beyond Simlah was a measure of good policy, as it would have been objectionable to have called upon a few and not upon all the chiefs for assistance; and it would have been but a continuation of the worst feature of the begar system, to have demanded the attendance of the subjects of northern chiefships to the south of Simla, so many miles distant from their own districts.

5. The distance by this new road from the plains to Simlah is 56 miles, which upon the opening of the tunnel, and the completion of other improvements, will be reduced to 50 miles. The distance by the old road (which is practicable only for porters and light-laden beasts of burden) is 42 miles. The present ascertained traffic is above 8000 tons per annum, without calculating the occasional increase consequent on the presence of the head-quarters of the government at Simlah.

It has been stated by some, that the annual repairs of this road will be enormous. This opinion is proved to be erroneous by the fact, that the roads hitherto constructed are at this present moment in as good condition as they ever were, and the total amount expended in three years on the repairs of 78 miles has been Rs. 8312 : 15 : 5, or Rs. 35 : 8 : 5 per mile per annum. As traffic increases, it will probably be necessary to metal certain portions of the line, but it is to be supposed that the increased traffic will afford increased income.

But far above and beyond these considerations, is the opening out of the fertile valleys of these mountains to future European colonists. Blessed with a climate not surpassed in Europe, possessed of a soil which requires but the labour of man to produce anything; pregnant with minerals of unknown value and extent, abounding in virgin forests, the depths of which have not yet heard the sound of the woodman's axe. All, and far more than the early colonists of America ever promised themselves, is to be found here; where under the blessings of a mild and paterna government, the colonist might increase his store, as fully assured of safety to life and property, as if the scene were in the heart of Great Britain, instead of under the shadows of the mighty Himalayahs. Instead of permitting the old worn-out European pensioner to idle away all that is left him of life under the scorching sun of Chunar, it might be worthy the attention of government to give him a cottage and a spot that he might call his own within some of these elevated valleys; where, with something to occupy his time, he might, under proper superintendence, lay the foundation of an European colony; the youth of which, educated to a military life in the neighbouring Lawrence Asylum, and Roorkee College, might furnish our Indian army with recruits as strong, and better educated and acclimated than the mother country does produce.

6. It is here necessary to show that this was the best line that could have been selected between Central Asia and Hindostan, whether considered mathematically, commercially, or politically; the more so as it is one that has not been hitherto so generally adopted by merchants as other routes. Viewing Lé on the Indus as the entrepôt between central Asia and Hindostan, we find five different routes from it to the plains, viz., two to the south-west through Kashmir, one to the south through the East India Company's territories of Sahul and Mundee, and two easterly branches of this last through Spiti and Bussahir.

The first two roads are, according to Cunningham, 350 miles in length. The most westerly crosses the passes of Namyika, Photo-la, Pir Panjal, and Ratanpir, varying from 12,000 to 13,300 feet in height. The other is still more difficult, and crosses five passes, respectively 16,952, 16,495, 18,125, 14,794, and 10,165 feet in height. The southern road is 370 miles in length, and crosses the passes of Sung Sung (17,500 feet), Lunga Lacha (17,000 feet), Bara Lacha (16,500 feet), and Rotang (13,000 feet). The two more easterly branches are respectively 434 miles and 479 miles in length, the first of which crosses five passes varying from 15,282 to 18,502 feet in height, and the second encounters the same number of obstacles varying from 14,821 to 17,500 feet. The great elevation of these passes necessarily renders the several lines I have named impracticable during many months of the year.

They also, with their corresponding depressions, render even an approximately true mathematical line impossible, and two of them, from lying within a foreign state, are politically objectionable, even had they possessed other superior advantages.

7. But Lé is not the most conveniently situated spot for a commercial entrepôt between central Asia and Hindostan. It has certainly long enjoyed this distinction, but rather on account of the despotic influence of its rulers and the jealous care with which they have directed the trade of Central Asia towards their own territories, than for any advantage the place itself possesses. A glance at the map will show how circuitous is the route to Hindostan *vià* Lé from the Thibetan provinces of Chang Tang and Rudok, and from the productive districts of Western China. It will also show that from the rich mineral and silk-producing provinces of Khoten and Akson, a suppositious line may be drawn through Rudok and Chang Tang to the plains of India considerably shorter than if drawn through Lé, or through any other given point.

The British protected Hill States lie comparatively contiguous to Chang Tang and Rudok, and are bisected by such a line.

There is another line from Thibet to Hindostan used by merchants from the eastwards, that *vià* the Niti Pass, through the Almorah district. It does not afford so direct a communication with Thibet as the one we have adopted, but it is more convenient with reference to L'hassa and Western China. The Niti Pass, however (nearly 17,000 feet high) will ever prove an insuperable obstacle to regular and active trade. It therefore appears beyond a doubt that the best line between Thibet and Hindostan is one from the uplands of Chang Tang through Bussahir and Simlah to the plains near Kalka. Here, and here only, has the awful barrier of the Himalayahs been pierced and its ramifications threaded by the waters of the Sutlej, so that passes of great elevation do not present themselves, and the mathematical correctness of the line is not impaired. This is the line that has been adopted for the Hindostan and Thibet road, and I believe that the most sceptical will now allow it is the best that could have been selected, and the best calculated to improve the commercial relations of the two countries.

8. The project of uniting Hindostan with Central Asia by a great commercial line having been determined on, but before operations had been commenced, Major (now Lieut.-colonel) J. P. Kennedy, military secretary to Sir Charles Napier, (then commander-in-chief in India), an officer of great talent and European reputation as an engineer, proffered his services as temporary superintendent of the new road. The principles upon which he determined to conduct the duties of superintendence had for their especial object, first, the best mathematical line of road, with especial reference to levels; secondly, the construction of the same at the smallest possible cost.

His first care was to obtain accurate information regarding the country through which the proposed road was to run. Reserving to himself the examination of the country to a distance of 40 miles on either side of Simlah, he deputed me to examine the country towards Thibet. The result of our examination was, that no condition of the first principle need be vitiated, but that from the difficult nature of the ground, the second principle would be considerably affected by the scrupulous observance of the first. Major Kennedy considered the importance of the first principle of too much consequence to admit of modification; but I feel confident that greater experience of the astounding obstacles presented to a level road by the Himalayahs, and the number and depth of the inflections, which add so much to its length, would have induced him to admit as a condition of the best mathematical line, economy in distance. At any rate, I have found it necessary in practice to admit of such considerations, but at the same time have been careful that they should not be allowed to affect the general correctness of the line.

9. To those who have examined the Himalayahs it will be known that they conform to a system of river basins and dividing ridges, generally extending at right angles to the main chain. These ridges, from their numerous subordinate ramifications (each pair of which form their own tributary basin), present to the uninitiated eye a confused mass without system or arrangement. Yet, between each principal artery exists a connected chain of mountains from the snowy range to the plains of Hindostan. Between the Sutlej and Ganges there are four such connected ridges, forming the water-shed lines between the four great rivers, the Sutlej, the Touse, the Jumna, and the Ganges. It requires no demonstrative proof to show that these ridges afford the best mathematical lines for a road, as they present unbroken bases, intersected by no water-courses. If the elevation of these ridges was gradual in its increase, as they approached the main chain, or snowy range, there would be little difficulty in constructing a roadway along their water-shed lines: but the incline is by no means regular; on the contrary, the outline of each ridge consists of a series of rising peaks and corresponding depressions; and it is a singular fact that, in many instances, the ridges are capped, near to where they subside into the plains, by peaks of greater altitude than the generality of those rising from parts of the range nearer the snows. In like manner, the depressions or passes on the ridges are irregular in their elevation, and those nearest to the snows are frequently of less altitude than others on the same range nearer to the plains. It is therefore apparent, that if a road was constructed so as to follow the crest of the ridge, it must conform to these rises and falls, and consequently would not be mathematically correct; as the first condition of such a line is, that it shall not rise or fall unnecessarily. A perfect hill road must therefore be laid out with reference to these lowest or "obligatory" points, and instead of mounting over the intervening peaks, must pass round, or cut through them. Two objections may be raised to the practical application of the above principles. First, the increased length and tortuous course which is given to the road by passing round, instead of over, such impediments. Second, the necessary destruction of a portion of the hill to afford the roadway, which thereby deprives a part of the hill side of its natural base, and renders the bank above the road liable to slip, and fill up the roadway. Both objections are good, but the first is capable of considerable modification by the judicious construction of the road; and the second continues to exist only until the bank resumes a slope which will admit of the earth remaining at rest.

10. Applying the above principles to our investigations, we selected a line the maximum gradient of which is 1 foot in 33⅓, or 3 feet in 100. In but a very few places have I thought it necessary permanently to increase this gradient, and then only to effect a great saving in distance. No permanent sacrifice of principle was admitted to avoid natural difficulties, such as precipices, deep ravines, &c.; but in future operations within the Himalayah, I would recommend that this point should receive due attention, as not unfrequently a scarcely appreciable deviation from the true gradient will enable the engineer to escape difficult ground, and to effect a reduction of expenditure.

11. The new line leaves the plains in the neighbourhood of Kalka, and gradually ascends, for 14 miles, to a gorge in the extensive range of hills which border the plains, and extend from the Sutlej to the Jumna. On the left lies Kussowlie, six miles distant; nearer, and overlooking the gorge, stands the Lawrence Asylum. To the right is Dugshai, close under which the road winds to the low neck of land which connects the long outer range above mentioned with the main body of the Himalayahs. Here an abrupt spur thrown off to the eastward, at right angles to the desired direction, renders a tunnel of 1900 ft. necessary. From this the line runs to the next obligatory point near the rich valley of Solon, which it enters at a spot eminently calculated for a large European settlement. It then skirts the southern flank of the Krole mountain, and running through the next obligatory point at Kundah, commences an ascent of 5 miles to Kearee Ghât, passing above the valley of Bhagurree. From this it runs nearly level, through the volcanic cliffs of Tara Devi, to an obligatory point within 4 miles of Simlah, to which it ascends at a gradient of 1 in 25, steeper than any on the whole line, but rendered necessary by the elevated position of the sanitarium. Two and a-half miles beyond Simlah, after emerging from the fifth obligatory neck, another rugged spur, running to the south-east, renders a tunnel of 550 feet necessary; from which the line runs at an imperceptible gradient, for 40 miles, to the Nagkundah Pass, 9300 feet above the level of the sea. From this, skirting the northern face of the massive Huttoo mountain, it holds a level course to the obligatory point under Bagee; from which an easy ascent brings it to the highest point on the line at Kundrelah, which has an elevation of 9660 feet. Descending to the obligatory Soongree Pass, it turns northward to avoid the snow limit of the Himalayahs, and seeks the valley of the Sutlej. Skirting this at a general elevation of 6000 feet (temporarily vitiated by the tremendous cliffs bordering the Nogurree torrent), it crosses the Sutlej river above the old bridge of Wangtoo; from which it ascends to the village of Chini, unrivalled for the beauty of its scenery and the salubrity of its climate. Gently descending in order to avoid the deep inflections of the snow bed tributaries of the Sutlej, it runs through the rich vineyards of Rarung and Akpah, until it again meets the Sutlej under the town of Soongum and Kanum, renowned no less in the ecclesiastical history than in the commercial estimation of Thibet and Western China. Under Sapooree the line again crosses to the left bank of the Sutlej, now flowing at an elevation of 8300 feet, and taking advantage of an old bed of that most turbulent stream, 100 feet above its present level, it emerges on the high lands of Thibet, near the Chinese village Shipke; from which, roads as old as the people themselves, run east, west, and north, traversed by baggage cattle of all descriptions. But it must not be supposed that the ease with which I have sketched the direction of the line affords any adequate notion of the extent or nature of the obstacles which oppose the construction of a road. In presenting a summary view of these, I cannot do better than accompany it with such remarks on the geological formation of the country as my limited knowledge of the science will permit; for there can be no surer criterion of the natural obstacles which oppose the road engineer's progress.

12. On leaving the elevated plain (composed of loose conglomerate and alluvium formed from the detritus of rocks) lying between the Sewalik range and the outer spurs of the Himalayahs, the line enters a series of indurated sandstone piled in confused masses. The angle formed by the mountain side varies from 30° to 35°. This continues for about 5 miles from Kalka, when the line enters the basin of the Kossilah and its tributaries, when the slope of the hill becomes less abrupt, so that all the minor spurs have been reduced to terraces for the purposes of cultivation. Higher up, the spurs are capped by masses of granite and other inferior rocks, forming hard and difficult walls through which to excavate a road. As the line approaches the summit of the extensive ridge between Dugshai and Kussowlie, the slope of the hills assumes an angle of 40°; and their composition is generally of broken and detached masses of granite, imbedded in stiff ferruginous clay, frequently intersected with walls of gneiss and overlying beds of indurated sandstone, forming obstacles of considerable magnitude from their excessive hardness and frequent recurrence. Perched above the gorge at Dhurmpoor, at an elevation of 4900 feet, is an extensive mound of half-baked stratified rock, abounding in fossiliferous remains, especially shells of the *Spirifer Walcotii*, *Gryphæa obliquata*, *G. vergula*, *G. dilatata*, *Podopsis trunculata*, *Turrilitis tuberculatus*, and others which I have been unable to identify. The formation of the Dugshai hill, and that through which the long tunnel is necessary, appear outwardly to be of granite masses and gneiss walls; but our excavators have exposed thick beds of graphite and marl, which, from their want of consistency and the quantity of water they contain, have considerably retarded the progress of the miners, and rendered a partial lining of the tunnel necessary. On the spur to the north of this tunnel the line runs through masses of yellow sand, argillaceous limestone, and other deposits of the oolitic system. The argillaceous limestone is so regularly stratified as to form perfect rectangular blocks, valuable for building. A white efflorescence (probably muriate of soda) occurs in the graphite under the limestone. Above this are immense masses of coralline magnesian limestone, of fantastic shape, in places overhanging the road. The Krole mountain is almost entirely composed of this mountain limestone, full of fissures and caverns. From its toughness and

numerous cavities, it is very difficult of reduction, and consequently offers great resistance to the excavators.

Between the Krole and Tara Devi mountains the formation is of clay slate, finely laminated, but much broken. The slope of the hill side is generally about 40°, which renders the cuttings for a roadway heavy. On this, from its southern exposure, no tree vegetation appears to thrive; but the hill side annually produces a valuable crop of natural grass, and further down in the valley, where the detritus has accumulated, much fine cultivation has ensued.

The Tara Devi mountain is of volcanic origin, composed of several of the primary rocks fused into a conglomerate mass. It appears either to have cooled irregularly, or, after cooling, to have been the scene of fresh volcanic agency, as mass is detached from mass by extensive fissures, the edges of which are not of a sharp or broken appearance, as if caused by fracture from convulsions subsequent to their formation, but rounded as if the masses had been rubbed against each other. The composition of one such contiguous mass frequently differed from the composition of another, and the fissures are in many places lined with crystals of sulphur, iron, and other minerals. Mounds of black scoriæ are here, as also on the Krole, of frequent occurrence. Here also is found a bright vermilion powder, of considerable demand amongst the natives; and at another place, quartz veins impregnated with iron pyrites of a bright golden hue, gave hopes to many of the discovery of a new gold-field. Along the whole extent of the Tari Devi mountain and its neighbourhood, the cliffs are lofty and very precipitous, presenting obstacles of great magnitude to a road.

Of the formation of the ranges between Simlah and the uplands of Thibet I need say little, as they are all of the mica slate and gneiss series, crossed but seldom with any other element interesting to the geologist. This formation is however pregnant with difficulties to the engineer. The mica slate is piled up into precipices of many hundred feet, and the gneiss is exposed in not less precipitous masses of thousands of feet in extent. Neither, from being stratified, are favourable to blasting operations, and both have been already too severely tried to yield to fire and water. Veins of quartz, piercing every description of rock, form a network throughout the whole of this formation. Near Mahasoo, at an elevation of 7000 feet, an extensive bed of lime rock lies above the slate. At Kundrellah the mica slate is strongly impregnated with iron ore, but this will be described hereafter, when treating of the iron mines opened out by the road.

Throughout the gneiss and mica slate series the hills are most rugged and abrupt, breaking into extensive cliffs, and intersected with narrow and precipitous glens. The action of the weather on their rugged outlines causes constant demolition, and the consequence is that rocky avalanches of enormous size not unfrequently descend with crushing force, carrying ruin and devastation in their impetuous course. The thin superstratum of soil lying on the sharp incline of the slate hills, in severe seasons, becomes saturated with moisture, and loses its adherence to the slate stratum underneath. It then frequently slides upon its base, and deposits its load of forest trees and surface rock into the glen below, leaving a shelving precipice of bare rock where formerly existed a rich forest.

All these serve to increase the difficulties attending the construction of a mountain road, where the principles of gradients are strictly observed.

13. The preliminaries having been arranged, operations were commenced on the Hindostan and Thibet Road in July 1850, by the formation of a 5 feet mule-track at several points on the line. It has been frequently remarked, that it would have been a wiser plan to have finished one portion of the road and opened it to the public, instead of commencing on a number of unconnected portions, unavailable for traffic. The reason is to be found in the nature of the labour employed. Each state furnished its quota of labourers, and as it would have been an unmitigated hardship to have demanded their services at a great distance from the boundaries of their states, they were employed at that point of the line which lay nearest to their homes. Hence the commencement of work on a number of detached portions.

14. Major Kennedy, in his letter to government dated the 17th September, 1850, fully details the means he took to obtain the efficient performance of his duties from every individual employed on the road. That he was eminently successful admits not of a doubt; but that the sanguine expectations entertained in that letter should be realised, was simply impossible. He then stated that there was little doubt but that the whole line from Kalka to Chini, in the valley of Konawur, might be made passable for loaded animals by November 1850. That is, that a nearly level road, 5 feet wide and 200 miles in length, might be constructed through the most precipitous chain of mountains in the world, within a period of four months. Major Kennedy had only inspected the lower hills: he had not examined the two miles of sheer precipice at Mutteeanah; the walls of perpendicular rock lining the Nogurree and Munglad; the Rogee abyss; or indeed any portion of the line in the rock valleys of Bussahir and Konawur. The work actually constructed within these four months was the opening of 50 miles of an irregular path, just passable for horsemen, between Simlah and Dugshai. Where cliffs occurred they were avoided by temporary ramps, made either over or under them. Twenty-five miles of similar pathway were constructed between Simlah and Chini; but as intervening cliffs were not reduced, no portion of it was available for traffic.

15. I must here observe, that I have learned from experience how erroneous is the system of opening out a hill road to a less width than what is eventually contemplated. I do not mean that no lock-spit should be made, for without it the road would not be kept level; but I object to opening the road first to 5 feet, then afterwards to 12 feet, then perhaps to a greater width. In opening a road to a width of 5 feet, the excavators with great labour blast and chip off just enough to afford the pathway required, and the debris falls down and fills up the re-entering angles. When it is required to increase the width, the labourers have to recommence to excavate the bank above the former cutting, and to perform the same operation as was required for the 5-feet road, only that the labour is increased in ratio to the increased dimensions of the section. From the accumulation of the debris of the first cutting the natural bank below the road is hidden, and much labour is expended in removing the rubbish to commence the excavations for the foundations to the revetment walls. It is my opinion, that after the cutting of the lock-spit, the intended width of the roadway should be finally determined, and the foundations of the retaining walls laid out and excavated at once. The cutting into the hill side may then be commenced, the fragments of rocks being used for the walls as they are dug out. By this means all unnecessary labour will be avoided, the sharp angular turns in the road will be reduced to a minimum, and the foundations of the walls, from being cut out of the unbroken hill side, will be stable.

16. The number of labourers employed in the construction of 46 miles of Major Kennedy's pathway was 80,966, or an average of 1730 labourers per mile. The cost, at the market rate of 2 annas per man, would have been 216 rupees per mile. The actual cost to government, in consequence of the amount of tribute labour at that time supplied, was only 147 rupees per mile.

17. In December 1850, after Major Kennedy's return to England, I commenced the widening of the Simlah and Dugshai track to 12 feet; correcting all irregularities of gradient which had previously been allowed in order to avoid difficult ground; throwing bridges over the principal torrents, and erecting staging bungalows. It was now found that the labour provided by the hill states, in terms of their treaties, was such as to render it impossible for the British Government long to avail themselves of it.

Sir D. Ochterlony's treaties were looked upon as a dead letter by another generation than that which had benefitted by his mild rule; and the chiefs obeyed with evident reluctance the orders of the political agent for the assemblage of the working parties.

That officer (Mr. W. Edwards, of the Bengal Civil Service) had been highly instrumental in bringing to the notice of the governor-general the evils of the begar system; and insisted on the construction of roads as the only means of reforming it. The assessment of the quotas of labourers exigible from each state for the construction of the road was entrusted to his care; and he was careful to make it with reference to the size and population of the states, so as in no instance to exceed 1 per cent., and in a few instances ½ per cent. of the population. But all his efforts failed to enlist the good-will of the chiefs towards the work; and although from dread of the consequences of disobedience they furnished a considerable body of labourers, they adopted no means for their support, and did their utmost to make the work unpopular with their subjects.

18. It would be tedious to describe each of the many works which were necessary in order to form a nearly level roadway of 12 feet in width, through the difficult country before described. I will merely mention a few of the works of the greatest magnitude, plans of which accompanied my report of the 1st October, 1852. The most expensive undertaking was the reduction of the extensive range of cliffs which line the western flank of the sacred Tara Devi mountain. These extended for a distance of nearly two miles, varying from 50 to 200 feet in height. One portion of 400 feet in length was cut down to a depth of 150 feet, in order to obtain a sufficient breadth of roadway; another portion, 300 feet in length, was of such a height, and so sheer, that in order to obtain a roadway, the reduction of the cliffs must have commenced 300 feet above the line of road; to this I preferred erecting a viaduct of 260 feet across the precipice. Under Prospect Point, near Simlah, a series of cliffs, 500 feet in length and averaging 60 feet in height, were reduced by blasting, and a cutting of 100 feet in length and 50 in depth was made through a sharp projecting spur. Revetment walls varying from 10 to 50 feet in height were built in many places: these were constructed of hammer-dressed stones, laid without mortar, having a general batter of one-fourth of their height.

I cannot give a better idea of the amount of work performed in opening the 40 miles of road between Simlah and Dugshai to a breadth of 12 feet, than by stating the cubic measurement of each description of work.

	Cubic feet.
1. Of hard rock, reducible only by blasting	5,734,663
2. Of slate, shingle, stones, and earth ...	14,170,417
3. Of revetment walls	823,893
Total cubic feet of work ...	20,728,973

The average expenditure per mile was as follows:—

	Rupees.
On labour	776
On artificers	44
On superintendence and accounts	320
On contingencies	97
Total expenditure per mile	1237

Besides the large viaduct mentioned above, eight wooden bridges varying in span from 30 to 90 feet, of the "American lattice" description, were constructed. They were only furnished with single trusses, in the manner of cattle bridges, as greater strength was not considered necessary. Heavy 24-pounder guns with carriages were taken over them with safety. These bridges, spanning a length of 662 feet, have cost 9000 rupees. That is, their cost per lineal foot has averaged Rs. 13 : 8. They were constructed solely of deodar, with oaken trenails. I do not, however, now think that they are well suited for the hills; as deodar is not of a nature to withstand the great transverse strain the component parts of the lattice bridges are subject to; and the tremendous gusts of wind which sweep down the ravines of the Himalayahs cause much undue lateral pressure upon the trusses. The largest bridge was thus blown down in 1853, but has been replaced, without much additional expense, by another of simpler description.

19. These several works, commenced in December 1850, were completed in September 1851, between which periods there were only 248 working days, in consequence of the severity of the winter and the long continuance of the rainy season.

20. The works since completed to the south of Simlah upon the principles of those just described, are roads 12 feet wide, connecting the military stations of Dugshai and Kussowlie, and Dugshai and Subathoo, and the extension of the Hindostan and Thibet road to the plains; the whole amounting to 78 miles of 12-feet road, constructed upon true scientific principles, through a country unrivalled in natural difficulties. The number of labourers employed has been 626,228; and the total cost on account of labour to government, Rs. 73,971 : 9 : 6, or Rs. 922 : 11 : 5 per mile. The widening of a part of this between Simlah and the plains to 16 feet is now progressing; and ere six months elapse I have a right to expect that there will be no more difficulty in conveying goods upon waggons from the plains to Simlah, than there is in conveying them from Allahabad to Cawnpore. Only at one place will the draught be severely felt, and that will exist until the tunnel through the Chewar range of hills is completed. This tunnel, 1990 feet in length, was commenced in January last, and notwithstanding the unfavourable nature of the hills, which deterred our progress until both entrances were arched with masonry, the gallery is now advanced 400 feet into the interior. The expenditure on labour up to the present time has been 3000 rupees.

The other heavy works which have been lately constructed, or are now in progress of construction, are a viaduct of 420 feet in length, to correct an irregularity of gradient which had formerly been permitted near Tank Cliffs; another of 100 feet at Kundah Ghât; and a queen post bridge of 45 feet span, near Kearee. Besides the widening of the road to a minimum breadth of 16 feet, a parapet of rubble masonry coped with turf is being constructed, wherever revetment walls or precipices exist throughout the whole length of the line. Where the bank is sloping, oaken posts 6 inches thick are set at every 10 feet. I intended to connect them with a rail, but the pilfering propensities of the natives have interfered with this.

A dâk bungalow of the largest size is being completed at Dhurmpore, where the roads to Kalka, Kussowlie, Dugshai, and Subathoo diverge.

21. I will now proceed to show what progress has been made in the works to the north of Simlah, on the line towards Thibet, and should objection be taken to it, I beg that it will be borne in mind that in the Himalayan working year there are not above 190 days.

From the end of November to the end of March it would be fatal to the labourers to be encamped at elevations above 6000 feet; and again, during the wet season there are many days when work must be deferred;—add to this the great natural difficulties to be encountered; the limited amount of labourers that are procurable from the northern states; the fact that these are changed every fifteen days, thereby entailing on the road overseers a continual and most harassing amount of training, the benefits of which they are never destined to reap; and the frequent desertions of entire working parties at perhaps most critical times;—and the wonder will not be, how little has been accomplished, but rather that anything has been effected at all. With the exception of two breaks of 2 and 3 miles respectively, 115 miles of 6-feet road are completed.

In this there is one abnormal portion temporarily admitted, in order to avoid the tremendous cliffs which line the Nogurree torrent. A few general improvements are required, but the whole is practicable for laden mules and horsemen. At present the working parties are pushed forward to Wangtoo, on the Sutlej, where I hope they will be able to continue at work during the winter; and by next spring I expect that but 35 miles will remain of unfinished work between Simlah and Chini, and 60 between Simlah and the frontiers of China.

22. Where all is so difficult it appears scarcely neces[illegible] to particularise special works. There are a few, however, [illegible] I will briefly notice. A tunnel 560 feet in length has been [illegible] through a hill 2½ miles north of Simlah, and not th[illegible] remarkable circumstance connected with this work is that [illegible] constructed almost entirely by convict labour. The night[illegible] were alone composed of free labourers, and a few of th[illegible] class assisted during the day in wheeling barrows, and i[illegible] works as the convicts' chains rendered irksome. In the [illegible] tion of this work 10,000 convicts and 8450 free labourer[illegible] employed. At the market rate of labour it would ha[illegible] 1057 rupees, but as a certain amount was furnished as "tr[illegible] it only cost 391 rupees. A further sum of 220 rupe[illegible] expended on artificers, so that the total cost of the tun[illegible] government was 611 rupees. The period occupied in it[illegible] struction was twelve months. Considering the valuabl[illegible] thus obtained from convict labour, I cannot refrain from e[illegible] ing my disappointment, that since the completion of this [illegible] I have been wholly deprived of the services of the few pr[illegible] that were employed on it.

The next heavy works are the cliffs under Phagoo [illegible] have been cut down to a depth of 120 feet.

Between Theog and Mutteeanah three strong and h[illegible] viaducts have been erected; one of these is 212 feet in length. Beyond Mutteeanah, the tremendous range of cliffs which extend at intervals over a mile and a half have been cut down to a depth of 130 feet, so that a 10-feet road now runs through this range of precipices where formerly a goat could not have found standing room. From Bowlee to Thedah the road is carried for 5 miles through one continuous range of cliffs. Before reaching Serahun it passes through the fearful precipices that overhang the Munglad, and beyond Serahun it is cut for half a mile through a sheer mass of rock.

23. A few remarks upon the material used in the construction of the road works, and found in the neighbourhood of the line, do not appear to be irrelevant to the subject of this report; and, first, with reference to building timber.

It appears to be a normal condition of the Himalayan forests that they shall have a northern aspect, the flanks of the mountains facing that quarter being alone covered with tree vegetation. So much is this the case, that a traveller from the southward is at first impressed with the barren appearance of the mountains, and the utter absence of forest scenery. When, however, he has penetrated further into the interior, and turns his face southwards, he is made aware of the erroneousness of his first impressions, by the extensive breadths of dark pine forests he has passed. To account for this singular fact several reasons may be adduced, although none appear wholly satisfactory. It may be from the accumulation of snow on the northern flanks during the winter, which protects the young plants from the severe frosts, and affords an inexhaustible supply of moisture during the summer; or perhaps from the general dip of the strata being towards the south, from which those slopes have an even and regular declination, but retain no depth of soil, from the facility with which it is washed off; whereas, from the disintegration of the northern exposed edges, deep deposits accumulate, receiving yearly increase in depth and richness from the debris of decayed vegetation. So rich does this soil become, that at elevations between 8,000 and 12,000 feet, some of the most delicate of European vegetables and flowers are naturally produced. Asparagus, celery, rhubarb, strawberries, gooseberries, raspberries, scented violets, primroses, potentillas, anemones, cowslips, are all numerous.

From the Hindostan and Thibet road, following the left or south bank of the Sutlej, it necessarily passes through several extensive forests, but the majority of the trees furnish timber of little value except as fuel. The immense forest extending from the Shallee Peak in the Bujjie State, to Turandah in Konawur (a distance of at least 100 miles), does not contain one tree in a thousand capable of yielding good durable timber. Within this distance there are a few patches of *pinus deodar*, than which there can be no finer timber, and at a lower elevation many strips of *pinus longifolia* fit for deal boards and battens; but the mass of the forest is of *pinus excelsa* and *abies Smythiana*, the timber of which much resembles that of the spruce fir of Europe, and is of little use except for fuel. From Turandah upwards the *pinus deodar* becomes more abundant, and when approaching the arid uplands of Thibet, it with the *pinus Gerrardiana* (the neoza, or edible pine) forms the general tree vegetation.

Without stopping to notice the deodar forests of the Putteealah, Keunthal, and Kotee chiefs, within ten miles of Simlah—out of which have been built the sanitaria of Dugshai, Kussowlie, Subathoo, and Simlah, and which, from the short-sighted rapacity and negligence of the chiefs, have been ruthlessly destroyed and not replanted,—I shall briefly mention the position and extent of the other patches of deodar, which I before stated occur occasionally on the left bank of the Sutlej, before reaching the comparatively high point of Turandah, on that river.

Near the summit of the Shallee Peak there are some 800 trees of large dimensions growing at a general elevation of 5000 feet above the Sutlej, and separated from it by 5 miles of rough descent.

At Kotegurh there is a young healthy strip of forest, which, however, is not likely to prove more than sufficient for the local demand.

In several of the deep valleys between Kotegurh and the neighbourhood of the Soongree Pass, at Bowlee, and at Dharun, all stages on the Hindostan and Thibet road, there are several groves of deodar, but all of limited extent, and held sacred by the villagers as their household gods. These all exist at very long distances from the Sutlej.

Besides these patches there are of course many individual trees of deodar amongst the dense mass of inferior pines; but they are in no place sufficiently numerous to deserve special notice, and can only be discovered after considerable search. The same forests also produce walnut, maple, horse chestnut, hazel, several cedars, and two oaks (*quercus incana* and *quercus semicaspifolia*), the timber of which is tough and durable. It is little used by the hill-men on account of the difficulty of working it, and the crooked nature of the tree rendering it not easily adaptable for building purposes. I consider this timber as peculiarly well adapted for railway sleepers, and carriage and waggon trucks.

It is not until reaching Turandah that the deodar becomes sufficiently abundant within a moderate distance of the river to suggest the possibility of floating the timber down to the plains. The rocky nature of the bed of the Sutlej within the hills, and the rapidity of its fall, has until lately been held to render improbable the success of any attempt to float timber from a high elevation. But an experiment commenced by Mr. Edwards, and carried out by Lord William Hay, has proved the possibility of doing so; and although the result of the experiment was not satisfactory in a financial point of view, this was attributable to causes which I believe to be remediable.

The great fact of the possibility of floating timber of almost any dimensions, from a high elevation on the Sutlej to a point where rafts may be constructed, was proved. The following were the causes of the want of success in a pecuniary point of view.

First. The difficulty of transporting the timber from the place where it was felled to the river, in consequence of the precipitous nature of the country.

Second. The perishable nature of the timber floated down, four-fifths of it being *P. longifolia*.

Third. The unnecessary delay of two years in forwarding it to Ferozepore, arising from the timber having been cut down too late to take advantage of the floods in the Sutlej, without which there was not sufficient water to float them down; and,

Fourth. The want of a proper establishment at Belaspore, where the current becomes sufficiently easy to allow of rafts being formed.

The first of these difficulties, and the only one I consider necessary to notice, I would remove by the erection of a slide between the forest and the river. Turandah itself is not suitable for such an arrangement, as the forest is not sufficiently extensive, and the ground between it and the river is too precipitous. The capabilities of Nachar, the next stage, are far greater. There are two forests in that neighbourhood; one to the south-east, consisting of 900 splendid trees, averaging in girth 9½ feet and in height 115 feet. The maximum girth measured was 24 feet, the minimum 4 feet: trees of greater dimensions exist, and even reach the enormous girth of 37 feet. The other forest is immediately above the village of Nachar, and contains 20,000 sound trees, averaging in girth 8 feet, and in height 110. The direct distance of these forests from the river is 2100 yards, the first 800 yards of which is at an average slope of 20°, the next 500 yards are at 22°, and the last 800 (down to the river's edge) vary from 35° to 40°. I was apprehensive that these last gradients would prove too steep for the efficient working of a slide, but I have since constructed an experimental slide at an angle of 40°, and found it to answer every requirement. The frequency and depth of the inflections render a diagonal line along the hill side impossible. I now feel perfectly confident of the success of this scheme, which I recommended to government in 1852. The probable cost of the erection of the slide would be 10,500 rupees, and the Ferozepore value of the timber which might be daily sent down by it from May to September (whilst the river is flooded) 3000 rupees.

Three lacs' worth of the finest timber, of a scantling fit even for the Bombay market, might be annually supplied by such an arrangement during the next seven years. The selling price at Ferozepore for building timber of deodar, is 12 annas per cubic foot. I will warrant, should government be pleased to approve of my suggestions, the delivery at that point on the Sutlej of any quantity of prime wood at 4 annas per cubic feet.

But before sending down timber to be used in the Punjab, where it is exposed to the ravages of the white ants, I would recommend the precaution of rendering it impregnable to their attacks by the infusion of some antiseptic substance into the sap of the growing tree.

Fifteen days sufficed for the impregnation and destruction of the growing trees; they were felled, and on being sawn up, the sulphate of copper with which they had been destroyed was observed to have coloured almost every portion of the timber. Four logs were sent to Captain Johnson, Assistant Quartermaster-general at Umballah, who in the beginning of July had them buried, with four unimpregnated logs, in a spot swarming with white ants. They were dug up in November, having been four months underground; when it was found that all the unimpregnated timber, with the exception of one log of deodar, was more or less destroyed; whilst the impregnated logs, with the exception of one in which the infusion had not penetrated the "alburnum," and which was consequently slightly excoriated by the insects, were in perfect condition. The fact of the infusion refusing to pass by the alburnum is remarked by Lindley: 'Introduction to Botany,' vol. ii. p. 326.

The probable cost of thus insuring the durability of the timber will be half an anna per cubic foot if impregnated with sulphate of copper and salt, or one anna if with sulphate of zinc.

Before leaving this subject I am desirous of pressing on the notice of government the necessity for making arrangements for the purchase and preservation of the deodar forests of the Himalayahs, bordering the Sutlej, Pabur, and other rivers. These with scarcely an exception exist in independent states to which we accord protection. It is a remarkable fact that more than one of the chiefs of these states owe their positions to our generosity rather than to any right derived from birth, and yet there are no more rapacious dealers in any market when they find that the government are in want of any article they possess. Should government direct a revision of their sunnuds, with a view to increase the tribute they pay, these chiefs would represent their estates to be nearly worthless. But if within their chiefships the government should require a barren hill for a sanitarium, the price demanded would be such as might be asked were the ground as productive as the wheat fields of Kent.

The forests of the far Himalayahs are profitless to the chiefs, and consequently neglected. The natural grasses underneath are of more value to the villagers of the neighbourhood than the tall pines above, which shade them and check their growth. Fire strengthens the grass, and removes the offending giant trees; and thus whole forests fall before the improvident brand of the hill-man.

The Nachar forest shows a belt of dry sticks and blackened stumps, 500 feet wide and 2000 feet long, where but a few years back existed some 3000 noble deodars. But let a government official express a wish for but one tree, and the price demanded would be such as to startle the most uncompromising advocate of free trade. Far in the interior of one of these states I lately required for the public service a few trees of *P. excelsa* from a very extensive forest, for charcoal: and although the timber of this tree is absolutely worthless, the price demanded was equivalent to that obtained in Simlah for the best deodar. I observe as one of the causes of the failure of Mr. Edwards' scheme for floating down timber, that the Rajah of Bussahir charged government two rupees per tree for the common *P. longifolia*, cut in the virgin forests of Konawur, which even in the neighbourhood of the Simlah market would not have been worth half that price.

Were government now pleased to express a desire to cut timber in the Nachar forests, I feel confident, that however worthless they are at present to the Rajah of Bussahir, the sum he would demand would be almost prohibitory, as far as the success of the scheme financially considered. I would therefore earnestly solicit permission to ascertain accurately the extent and value of the best deodar forests on either side of the Sutlej and Pabur, and at once arrange with the chiefs the purchase of a certain portion of them (say as much as 50,000 rupees), at a fair valuation. The forests having once become the property of government should be properly guarded, and means for their extension adopted. The planting of the hill side above and below the Hindostan and Thibet road with fine timber trees, is another part of the same project which may be thought worthy of the attention of government.

24. I will now briefly describe the iron ore exposed by the road excavations, or lying in the vicinity of its course. It is first met with near Kundrelah, close to where the two great spurs of Simlah and the Chor bifurcate, and it extends at intervals over 200 square miles of the latter spur. The species is magnetic iron, and it occurs in very dark iron—black grains disseminated in veins throughout the mica schist. I believe it to be similar in its external, physical, and chemical characters to the magnetic iron ore of Norway and Sweden. In two districts, Kolkhai and Shiel, it has long been worked by the hill-men, and from its malleability is much prized in the Indian market.

Near Kundrellah, where the Hindostan and Thibet road lays open the mineral, the ore enters too intimately into the composition of the compact mica slate, in which it occurs, and bears too small a proportion to the matrix to afford a profitable return; but 9 miles to the eastward, and close to the Pabur river, the entire side of a mountain, rising 1500 feet from the valley below, and reaching an elevation of 7000 feet above the level of the sea, was found to contain numerous rich veins of magnetic ore disseminated amongst the mica schist, which was here of the most friable nature. A landslip on one face of the hill afforded the inhabitants of the neighbouring villages the means of procuring the ore without the expense of excavating. So disintegrated are the particles of ore, that on a stream of water being brought over the mineral veins, the shale is washed off, and the ore as a coarse granular black powder remained. The expense of procuring the ore in this state does not exceed 3 annas per cwt. The percentage of iron obtainable from it is 52·17.

Having obtained a grant of 5000 rupees for the experimental working of the mines, a locality was selected where ore, wood, water, and flux were obtainable at the least practicable cost. The result of the last few months' working has been the construction of the watercourse, the erection of necessary storehouses and workshops, the completion of one blast furnace and the semi-completion of two others on European principles, with several of native construction; the washing and storing of 170 tons of ore, and the burning and storing of a large quantity of charcoal.

The estimated cost at which (if working on an extended scale) we can turn out iron is 35 rupees per ton; but by the introduction of machinery—the air furnace or, better still, the hot-blast—I feel confident that the Himalayan ironworks of Shiel might be brought to produce iron at the same rates as those of Merthyr Tydvil and Glasgow, and of a superior quality.

25. Having stated the result of our operations during the past five years, I will now briefly state the work to be done.

With reference to the road between Simlah and the plains, I have nothing further to propose. Within six months I fully anticipate its completion to a minimum width of 15 feet, which is sufficient for general carriage traffic. Much of the road will be above 20 feet in width, but 15 will be the minimum within the parapet walls.

The extensive works connected with the Dugshai tunnel will not be completed for three years, but, as before stated, this will not affect the general usefulness of the line.

With the exception of the tunnel, I already possess funds sufficient for the completion of this part of the road.

The military road from Kussowlie to Buddee, to open out a direct communication between the Punjab and the military sanitaria, is under course of completion.

With respect to the road from Simlah to the Chinese frontier, I must consider it to terminate in the neighbourhood of the first Chinese village met with, Shipke, as beyond that we cannot work without the sanction of the Chinese government. Besides, as formerly stated, when once that point is reached, all obstacles to carriage by beasts of burden cease. Broad tracks formed from the most ancient times by the constant passsage of horses and other baggage animals, communicate with the cities of Central Asia and Western China; and the only difficulties they exhibit are those incidental to a thinly populated country, lying at a general elevation of 15,000 feet.

About 70 miles of very difficult road still remain unfinished; and to that which has been reported complete to 6 feet in width several improvements are required.

The monthly grant for these works has hitherto been limited to 3000 rupees. I have already solicited its increase to 6000 rupees, in order to insure the more speedy completion of the works. With this grant for a period of three years, I feel confident of finishing the entire line from Simlah to the Chinese territories, level almost throughout its entire extent, and broad enough for the transport of goods on mules and horses. I have further proposed the erection of staging bungalows at every 12 miles, at a total cost of 16,000 rupees.

David Briggs.

Simlah, January 1856.

METROPOLITAN MAIN DRAINAGE.

Captain Galton, R.E., and Messrs. James Simpson, C.E., and Thomas Blackwell, C.E., whom the First Commissioner of Public Works directed to consider the plans for the main drainage of the metropolis, have made their report on the system of drainage which they recommend, and the modifications in the plan of the Metropolitan Board of Works which their system will necessitate.

They consider it very inexpedient for the Metropolitan Board of Works to adopt any plan which is based upon the deodorisation or the utilisation of sewage; that if an attempt is to be made to utilise London sewage it should be done by private enterprise; and that, in any case, provision must be made for the continuous discharge of the liquid residue in case of deodorisation, or the occasional discharge of the sewage in case of irrigation, at some point where it would be unobjectionable.

They state their opinion—1st. Upon the best point of discharge for the sewage, that is, the outfall: 2nd. Upon the mode which they recommend for reaching that outfall; and, 3rd. Upon the modifications which should be made in the plan of the Metropolitan Board of Works for the internal drainage of London.

I.—Selection of the Points of Outfall.

After a careful consideration of this question in all its bearings, it is thought that the best mode of disposing of the sewage of the metropolis is, to place it where it will be rapidly and certainly mixed with large volumes of water, and be finally carried into the sea. The most effectual method of securing this object is to place the outfall at some point in a deep tidal river, where the range of the tide is considerable, where the set of the stream is strongest against the shore, and where its outward flow is assisted by the fresh water from a large drainage area.

There are two points on the river Thames which entirely fulfil these necessary conditions; viz., one on the north side, very near to the Mucking Lighthouse, in Sea Reach; and the other on the south side, at Higham Creek, in the Lower Hope. At both of these places the water near the shore is very deep, and the ebb tide very strong.

Tidal experiments were subsequently made at the above places, with the assistance of Captain Burstal, R.N.; and the results of a valuable series of tidal experiments have been received from the committee of gentlemen from Erith and Gravesend, made by Messrs. Homfray, their engineers, at the same place. Captain Bullock, R.N., has also been consulted upon the subject, who by his valuable surveys is thoroughly acquainted with the river Thames.

The results of these experiments are briefly as follows:—at both places the currents are very strong in the ebb tide, and a considerable period of slack water occurs during the flood; and unlike the upper parts of the river, where the tide is concentrated into one stream, the great expansion in the breadth of the river at Sea Reach causes great variations in the set of the currents at different parts; thus, while the ebb tide sets upon the northern shore of Sea Reach, the flood-tide sets upon the southern shore. This was shown by the fact, that floats which entered Sea Reach with the ebb tide set in towards the northern shore, and were not carried up the river again with the following flood tide; whilst a large volume of fresh sea water from the Nore comes up along the south shore at every tide. The strength of the current at both the above-mentioned places is sufficiently great to prevent any deposit of materials brought down by the sewers from taking place in the bed of the stream; and the great expanse of water, the continual accession of clean water, and the rapidity of current, would ensure the mixing of the sewage with water under the most favourable circumstances, and at a point in the river where the shores are almost uninhabited.

These are the only places in the river, either above or below, which appear entirely to fulfil the conditions essential to the object in view; and they are therefore selected as the points of outfall for the metropolitan sewage.

II.—Mode of reaching the Outfall.

In determining the mode of reaching the outfall, the first point for consideration is the velocity at which it is desirable that the sewage should flow in the channel to be provided.

With a view of obtaining reliable facts, to test the results of general experience, Mr. Blackwell carried out a series of experiments at Crofton, on the Kennet and Avon Canal. The locality chosen afforded the command of large volumes of water, and of all necessary appliances for conducting the experiments on a scale of sufficient magnitude to ensure the accuracy of the results.

These experiments confirm the opinion which was previously held, that provided a mean velocity of 2 ft. 6 in. per second be maintained in the channel during the daily period of maximum flow of the sewage, there will be no deposit in the channel; and that with the view of preventing injury to the bed of the channel it is inexpedient to provide a higher velocity than between four and five feet per second.

The velocity of all streams depends on the ratio between the inclination of the surface and the hydraulic mean depth of the stream; viz., the area of the cross section divided by the wetted surface of the channel at that cross section. Thus, by a proper adjustment of these quantities, a deep and wide stream with a small inclination may be made to flow with the same velocity as a narrow and shallow stream with a considerable fall.

The first principles to be observed in the drainage of the metropolis are that the sewage should be removed with rapidity and certainty, and that the district should be effectually freed from the risk of floods.

These would be most completely secured by removing the whole sewage by gravitation, without having recourse to artificial means for raising it. But the removal of sewage by gravitation from the low-level districts is only possible provided the present system is retained, in which the sewage flows through tidal outfalls; but this involves delay in the removal of the sewage, and necessitates its being discharged into the river at low water; and is therefore incompatible with the principles laid down, and with the purification of the river.

Hence artificial means for raising the sewage must be resorted to for the low-level districts*; but the use of these artificial means is attended with so many risks, even with the high perfection which machinery has attained at the present day, that it is of the first importance to reduce the areas from which the sewage is to be so raised to within the smallest possible limits.

The expediency of obtaining a large area from which to remove the sewage, without having recourse to mechanical aid, renders it imperative that the inclination of the channel by which the sewage is to be conducted to the outfall should be as small as possible; but it has been already shown that the necessary velocity can only be obtained with a small fall, provided the channel be large, and the volume maintained therein be considerable.

It is considered, for reasons stated hereafter, that it is desirable to remove the low-level sewage from the western districts on the north side, across the river to the south side. The total daily quantity of sewage and rainfall which it is intended shall be removed from the metropolitan district is 185,649,993 cubic feet, of which 98,832,144 is proposed to be removed on the north side, and 86,817,849 on the south side of the river. And the total quantity, including the sewage and rainfall from the additional districts, would amount to 109,290,132 to be removed on the north side, and 101,524,773 on the south side.

A channel capable of conveying the total amount of sewage and rainfall to be removed on the north side, at a velocity of $2\frac{1}{2}$ feet per second, would be 39 feet broad and 16 feet deep; and a channel capable of conveying at a velocity of $2\frac{1}{2}$ feet per second the total amount of sewage and rainfall to be removed on the south side, would be 37 feet broad and 16 feet deep. These channels would require a fall of 6 inches per mile; and in their execution the proportions would be to some extent adapted to local circumstances.

The above velocity could, however, not be maintained unless the channel was nearly full of water; but the amount of the maximum flow of the sewage during dry weather is little more than one-sixth of the quantity to be removed during rain. It is therefore proposed to obtain from the Thames at high water the necessary quantity to fill the outfall channels during those times when the flow of sewage is not sufficient to give the required depth and consequent velocity. This water would be admitted into the channels at the head, directly from the river, and from reservoirs formed to equalise the flow.

The average level of high water at Blackwall above high water at Mucking Lighthouse has been ascertained to be about 2 feet, and the tide begins to fall at Mucking Lighthouse at least an

* At Chicago, in the United States, the difficulties attendant upon a low level for drainage were overcome by raising the whole town 5 feet.

hour before high water in London; consequently, by the time high water obtains in London the tide has ebbed at the outfall sufficiently to give in ordinary weather a difference of level of nearly 4 feet.

The considerations which fix the point at which this outfall channel should commence are—

1st. That in order to secure perfect immunity from floods in this system, it is necessary that the level of the surface of the sewage in London in times of maximum flow during rain should stand above the highest possible tides. It is for these reasons considered expedient to select 5 feet above Trinity high-water mark as the level to which the sewage should gravitate in the metropolis during the period of maximum storm-flow.

2nd. It is not desirable that this large outfall sewer should approach nearer than to the outskirts of the metropolis. On the south side it would terminate in the marshes, close to Woolwich; on the north side the river Lea would be its proper termination, but inasmuch as the district between the river Lea and Barking Creek, north of the Victoria Docks, is being rapidly built over, it is proposed that it should not be carried beyond Barking.

The highest level of storm-waters in the outfall sewers at Barking and at Woolwich would be Trinity high-water mark, and a sewer would rise from this level, at an inclination of 1 foot per mile, to near Bow on the north side, and to the Ravensbourne on the south, where the highest level of storm-flow would be 5 feet above Trinity high-water mark; and to these points the sewage on each side of the river would gravitate.

The expediency of uniting the sewage of the northern and southern districts into one stream, by carrying the sewage from one side across the river, has been carefully considered; and the expediency also well considered of bringing up the outfall channel on one side of the river to the western part of the metropolis, and of concentrating the whole sewage into this one channel, at some point but little above high-water mark, near Battersea or Chelsea, whence it would flow by gravitation to the outfall. As an hydraulic question, the increased volume which would flow in one channel would be an advantage; and the last-mentioned plan would provide for the extension of the area from which the sewage would flow by gravitation, without having recourse to artificial means for raising it. But after reviewing all the circumstances, it is thought the construction of a sewer of the very large dimensions required for conveying the whole of the sewage in one channel, would be attended with great engineering difficulties, with uncertainty of construction, and with an increase of cost for works and compensations; and it is feared that, instead of simplifying the question, it would render it more complicated.

The engineering difficulties might, no doubt, be overcome by modern appliances; but considering the enormous extent of the districts, both on the north and south sides of the river, and considering further that the population of each is daily increasing in an accumulating ratio, the opinion is given that it is more expedient to make each system complete in itself, and to provide each with a separate outfall.

Also, bearing in mind the possibility of the application of sewage to economical purposes, an outfall channel along each bank of the Thames would admit of its more extensive application, and would offer greater advantages than the concentration of the whole in one stream.

Having caused careful surveys to be made and levels to be taken, on each side of the river, between the metropolitan boundary and the proposed outfalls; and having selected the lines which are considered most advantageous for the new outfall channels, with reference to the levels of the ground and to the nature of the strata which would be passed through, the lines are described as follows:—

On the North Side.

The main outfall channel would commence just beyond Barking, and, skirting along the marsh as far as Purfleet, would pass in a tunnel to Grays Thurrock; it would then continue through the marsh to a point near West Tilbury, whence it would pass in a tunnel, under the spur of land between East and West Tilbury, again into the marsh; and it would be continued in the marsh to the outfall near Mucking Lighthouse.

On the South Side.

The main outfall sewer would commence close to the boundary of the Ordnance property in the marshes below Woolwich, and be carried through the marsh in straight line to Erith, to the south of which it would pass, in a tunnel, and thence in a nearly direct line under the river Darent to Greenhithe. It would then be carried under the high land south of Greenhithe, by means of another tunnel, into the valley at the back of Northfleet; whence a third tunnel to the south of Gravesend would carry it into the marshes which extend to Higham Creek, the selected point of outfall.

A wide channel would lead from the Thames to the head of each main outfall sewer, and through this channel tidal water would be admitted into a reservoir during the flood tide, and also into the sewer, to assist the flow whenever it might be necessary.

The great extent to which the sewage will be diluted after the outfall channels have been fed with the tidal water at Barking and Plumstead will render it a comparatively innoxious stream. For this reason it is considered that it would be inexpedient to incur the expense of covering the channels, except in the neighbourhood of towns, buildings, and crossings of public roads. Efficient fences should be erected for the protection of the channels, and the communication between the lands on either side would be maintained by bridges.

The probable effect of these works upon the régime of the river has been considered, and the opinion is given that it will be inappreciable.

III.—The Modifications in the Internal System of Drainage of the Metropolis which the Alterations in the Positions of the Outfalls will necessitate.

The level from which the proposed outfall sewers will allow the sewage to flow renders it possible to intercept the sewage of an area in the metropolitan districts of about 33 square miles out of 50 on the north side of the river, and of about 48 square miles out of 69 on the south side, which is equivalent to 68 per cent. of the whole area. The sewage so intercepted would flow into the river by gravitation alone. This increase in the amount which can be intercepted in the high-level sewers necessitates some modification in the plan of the Metropolitan Board of Works.

To determine the exact position of the intercepting sewers in the metropolis would require a careful and special study of the various districts. Economy and public convenience require that the existing main sewers should be as little interfered with as possible. The principle of interception as laid down by the late Mr. Frank Forster, and subsequently followed up by Mr. Bazalgette in his present design, is (with the exceptions previously referred to in this report) correct, and must form the basis of any scheme of intercepting sewers through the metropolis.

The general indications of the line of sewers in the metropolis submitted are as follows:—

On the North Side.

The sewer connecting the metropolitan system with the northern main outfall channel would terminate at Bow, on the island formed by the branches of the river Lea; and to this point the following intercepting sewers would converge:—

1. A high-level sewer following generally the line of Mr. Bazalgette's high-level sewer.

2. A second high-level sewer, to answer the purpose of Mr. Bazalgette's middle-level sewer; and, having in view the nature of the ground through which it would pass, the area to be intercepted, and the necessity of avoiding crowded thoroughfares, it would probably be desirable that this sewer should commence at Bow, and follow generally the line indicated on the map by the Commercial-road, Houndsditch, and north of the city, to the valley of the Fleet at the foot of Holborn-hill; thence under Lincoln's-inn-fields, Long-acre, Piccadilly, Hyde-park, to Kensington; whence it could be continued, following generally the contour of the land, to intercept the sewage from Acton, Ealing, and Hanwell. The sewage of the spurs of high land which project between the several lateral valleys of the northern district should be carried into this sewer by means of subsidiary lines, according to the principle adopted by Mr. Bazalgette.

3. It is desirable, as far as is consistent with economical working, to keep the low-level districts independent of each other, and to prevent the sewage as far as possible from flowing through the thickly inhabited parts of the town. Having regard to these considerations, as well as to the difficulties of the work, it is thought unadvisable to construct the low-level sewer proposed by the Metropolitan Board of Works; but it is suggested that the sewage of the low-level districts in Hackney Marsh and in the eastern districts near the Thames should be

collected and raised by artificial means; whilst the low-level sewage west of Somerset-house should be carried back to nearly opposite Battersea, and then across the river, there to be raised by artificial means into a southern high-level sewer.

The sewage from the valley of the Lea and from East Ham and Barking would be discharged into the outfall sewer at the most convenient spot.

On the South Side.

On the south side the high-level sewer would follow generally the line of Mr. Bazalgette's southern high-level sewer, but it should be carried round the hill at Wandsworth, so as to intercept the sewage from that district. It would then be carried across the river Wandle, above the navigable portion, by an aqueduct, and continued so as to intercept the sewage from the upper parts of Wimbledon and Putney.

This sewer would receive near Wandsworth, as has been stated, the sewage of the low-level north-western districts. The principle of keeping the low-level districts, where practicable, independent of each other, and of not permitting a larger quantity of sewage than possible to flow through thickly inhabited parts of the town, induces the recommendation that a low-level sewer should be carried back from the Effra along the Battersea-road, and that the sewage should be raised into the high-level sewer at the same point as the sewage from the north-west low-level districts; and to raise also at that place the low-level sewage of Wandsworth, of Putney, and of the low-level districts west of the metropolis boundary, as well as the sewage of the valley of the Wandle.

The sewage of the low-level southern districts from the Effra to Deptford, the sewage from Greenwich, and any low-level sewage from the valley of the Ravensbourne, should be raised into the high-level sewer near the Ravensbourne.

It would probably be desirable that the sewage from Woolwich should be placed in the main outfall channel, near its head.

The horse-power provided for lifting the low-level sewage at the different stations is as under :—

	Horse-power.
At the river Lea, where a portion of the northern low-level sewage is lifted	610
At the river Wandle, where the remainder of the northern and a portion of the southern low-level sewage is lifted	2215
At the river Ravensbourne, where the remaining southern low-level, together with the low-level Greenwich district sewage is lifted...	1350

This power will be amply sufficient down to the time when the increase of population for which provision is made shall have attained the limit herein assigned, besides allowing an excess of 25 per cent. in case of partial failure of the machinery. The actual present requirements are only to the extent of little more than one-half of the above numbers.

It will be necessary to provide storm overflows for these sewers near the point of interception of all important main sewers; and all these storm overflows should be so constructed as to convey the water directly into the river without interfering with the low-level districts, and to discharge at all times of tide; to insure this conduits must be used capable of discharging under pressure directly into the Thames beyond the low-water mark, or the outlets of existing sewers may be made use of wherever applicable.

It will be desirable to provide against accumulation of sewage matter in those parts of the intercepted sewers below the points of interception. This may be done either by occasionally diverting the sewage from the high-level sewers through the lower districts, or by making arrangements to command occcasional supplies of water for the upper parts of the sewers, or by some other means. The new low-level intercepting sewers can be cleansed by the occasional admission of water from the river.

In order to prevent impediments to the flow of the sewage in the line of the main outfall sewer, it is most desirable that means* should be taken to prevent gravel, road material, &c. from entering the sewers, and it is proposed that the heavier and more solid matters should be separated in some convenient place, and be removed before entering the main outfall channels.

In the prosecution of these works considerable interference with the traffic in the public thoroughfares must be anticipated, as very large quantities of materials and surplus earth will have to be carted through the streets; and, independent of the obstructions which the excavations will cause, the works will probably necessitate the temporary stoppage of some of the thoroughfares, and the diversion of the traffic; and further, considering the magnitude and extent of the main sewers, the possibility of carrying them into effect without in some degree affecting the stability of contiguous buildings, is questioned.

The proposed sewers will in some cases involve excavations and tunnelling through uncertain and treacherous strata; and difficulties will be encountered with the existing sewers and the lines of gas and water pipes, which in some of the principal thoroughfare are so numerous and extensive, that it will be necessary to remove them temporarily, or alter their course during the progress of the work.

Considerable attention has been given to the subject of the mode of lifting the sewage out of the low-level sewers into the sewers gravitating from the upper districts; and it is considered that, in order to secure at all times permanent and efficient action, the nature of the sewage requires that the machinery should be of the most simple character. It is believed that the ordinary kind of pump is not adapted to raising sewage, and Mr. William Husband, C.E., has forwarded a very valuable and well-considered report, with a description of a screw pump, as well as a description of scoop wheels, erected by him in connection with the drainage of the Haarlem lake, in Holland. Mr. A. Slate also forwarded a drawing and description of a form of Persian wheel, which he proposes for adoption in the drainage of the metropolis.

Cost of the Proposed Works.

The following is an approximate estimate of the cost of the works in the metropolitan districts, and of the outfall channels, proposed by them.

	North side.	South side.	Total.
Intercepting and collecting main sewers in the metropolis ...	1,019,465 ...	1,273,500 ...	2,292,965
Outfall sewers connecting the above with the main tidal channels	350,000 ...	437,500 ...	787,500
Main tidal outfall channels ...	1,107,000 ..	1,249,800 ...	2,356,800
Totals	£2,476,465 ...	2,960,800 ...	5,437,265*

If the main outfall channels were carried to the point of outfall selected by the Metropolitan Board of Works, viz. B*, in Erith Reach, the cost would probably be,

	£
On the north side	1,694,465
On the south side	2,023,500
Total	£3,717,965

Hence the increased cost of continuing the outfall channels to Mucking Lighthouse and Higham Creek amounts to 1,719,300*l.*

Opinion is given that, taking into consideration the magnitude of the works, the peculiar difficulties of their construction, and the expediency of not causing too great a demand upon the market for labour and materials, five years, at least, should be allowed for their construction.

District Drainage.

Having described the works required for the main intercepting and outfall sewers, attention is drawn to the fact, that to render the work of drainage complete, much district drainage remains to be provided.

Many sites on all sides of the metropolis which are being rapidly built over were visited, and it was found that, as a rule, most inadequate attention is paid to the drainage of the building plots; many of them, even before they have been covered with buildings, having been surcharged with the sewage and refuse of adjacent houses. And it will be perceived, from an extract in the note† from the evidence given by Mr. Donaldson,

* Extract of a letter from Mr. Arntz, surveyor to the Westminster District Board of Works, dated 14 July, 1857. "The means adopted for preventing the surface refuse from getting into the sewers of the district, consist in the daily cleansing of every part of the district, together with great watchfulness to prevent the scavengers from sweeping slush down the gullies, and the making it a part of their contract to remove all deposit taken out of the gulley-pits. These measures have already greatly reduced the quantity of silt deposited in the sewers; and I hope by other steps, all of which cannot be taken at once, to reduce the quantity of solid matter in the sewers to such an extent as not seriously to impede the regular flow of the sewage."

* Exclusive of charges for superintendence, &c., which may be assumed at 4 per cent. on the outlay.

† Extract from Mr. Donaldson's evidence.—A large extent of the area to be drained is full of cesspools charged with decomposing fœcal matter; these are seldom cleaned out or emptied, so long as there is room to make a new one; consequently, in many places in Bermondsey, in Rotherhithe, and in Deptford and Greenwich, the ground is quite honeycombed with them. Now, at present, the ground being highly charged with water, all this foul matter is kept constantly saturated with water. Immediately

that he anticipates that permanent evil may result from the saturation of the ground with sewage.

The tardiness in carrying out drainage works has been to some extent necessary, pending the determination of the general plan of metropolitan drainage. But, as the execution of the works for the main drainage must occupy some years, it is important that the local drainage should not, on that account, be indefinitely postponed.

Ventilation of the Sewers.

The ventilation of the sewers in the metropolis involves questions of serious importance. The Metropolis Local Management Act contains provisions to prevent the effluvia of sewers from exhaling through gully holes, gratings, or other openings of sewers in any of the streets or other places. The gully gratings originally afforded openings through which the noxious gases generated in the sewers passed up into the streets, when, from an increase of flow in the sewers, or from other causes, these gases were forced out of the sewers.

The foul smells which were perceived at the gully-holes which are situated close to the foot pavement, led to a large number of them being trapped. The effect of trapping the street gully drains without providing other ventilation of the sewers, is, that the noxious gases generated in the sewers are forced into the houses when the flow of sewage increases, the syphon traps of waterclosets and sinks being the points at which the least resistance is presented to their escape from the sewers. The inhabitants are thus subjected to the poisonous influence of these gases; and the bad smells so frequently complained of in London houses are, in many instances, attributable to this cause. The gases also occasionally cause the death of persons employed in the sewers.

To obviate these evils, the plan has been partially adopted, where the gullies have been trapped, of providing in the middle of the street, untrapped openings into the sewers covered with iron gratings. These openings for the ventilation of the sewers in the centre of the streets, must consequently be endured until a better mode of ventilation shall be adopted, although the foul smells they emit are frequently very great nuisances.

Partial trapping of the gully-hole drains has been adopted by several of the district boards of works, in some cases in streets and places where the only openings for ventilating the sewers are either the gullies or the house drains; if therefore the gullies are trapped, it is obvious, from what has been stated above, that the foul air and gases will pass into the houses, and very serious consequences may ensue.

The epidemic at Croydon in 1853 was attributed to this cause by Dr. Arnott and Mr. Page in their Report on the Croydon sewers. And they observe, with reference to the absence of ventilation, that this important element of health and comfort which has been generally neglected in dwellings, and almost totally in sewers, must be soon introduced into every plan of sewerage.

When the legislature empowered the metropolitan and district boards of works to apply traps, coverings, or ventilation, to prevent the effluvia of sewers in the streets, it was certainly not intended that they should, by the means thus adopted, force foul air into the houses, and disregard the ventilation of the street sewers.

The proposed main drainage works, by ensuring a continuous flow in the sewers, will relieve many districts from the effects of the alternate compression and dilation of the air in the sewers; but great importance is attached to the ventilation of the sewers, and it is regretted that the time allotted to the inquiry was too short to permit of investigating the subject more fully.

IV.—Extent to which Districts adjacent to the Metropolis, which will be benefited by the proposed mode of disposing of the Sewage, ought to contribute thereto.

The next point submitted to consideration is, to what extent districts through which the main outfall channels would pass, can be fairly called upon to contribute towards the expense.

It has been urged with respect to the question of the sanitary state of the metropolis, that the drainage of the marshes for agricultural purposes could, by means of these outfall channels, be advantageously combined with the drainage of the metropolis. Several parts of the marsh lands which are drained at the present time by tidal outfalls, were inspected; these outfalls are generally well adapted to their object, but some are no doubt capable of being improved, so as to dry the marshes more effectually, if the occupiers of the marsh lands deemed any alteration advisable. But this is not a settled point; for whilst those persons who cultivate one class of crops desire that the land should be dry, the occupiers of land upon which green crops are grown appear to consider the amount of drainage ample already. As regards the sanitary question, although ague prevails to a considerable extent in the marshes, and on that account therefore further drainage would no doubt be beneficial to the health of the few inhabitants they contain, it is not considered that the health of the metropolis can be so much affected thereby as to make the more complete drainage a matter of public importance, irrespective of the wishes of the owners.

But in many places where collections of houses have sprung up on and adjacent to the marshes, the ditches formed for agricultural drainage have become polluted with sewage, and this sewage eventually flows into the Thames. As an instance, the court of sewers for the levels of Havering, Dagenham, &c. complain of the pollution of the marsh drainage by the extension of houses, the drainage from which passes into the open watercourses, and and is highly injurious to health.

The great facilities for travelling afforded by the railways and steamboats have given a great impetus to building, and to the spread of population along the banks of the Thames. The foul sewage from this population should not be permitted to flow directly into the Thames, but should be discharged into the main outfall channels at some convenient point on their course; and the inhabitants of each district benefited by the use of the main outfall channels should, in consideration of the use made by them of these outfall channels, be rated for the cost of their construction and maintenance in the proportion which the population of such districts may from time to time bear to the whole population using the main outfall channel, and to the expense of the portion of the channel so used.

With respect to the general question of the purification of the Thames, it is quite evident that a large tidal and navigable river passing through a country thickly inhabited, must be polluted to a certain extent; and that it is not possible in practice to exclude from the river the refuse from ships, barges, and other vessels navigating its waters; but a great portion of this contamination might and ought to be prevented, and the conservators of the river and the several district boards of works should be invested with more extended and comprehensive legal powers than they now appear to possess, in order that they may follow out fixed rules and regulations especially framed for protecting the river and preventing the fouling of the stream; an object of paramount importance as regards the sanitary state of the metropolis and the health and comfort of its inhabitants.

It must also be remembered, that the drainage into the Thames above the tidal portion comprises an area of 3700 square miles, and that much objectionable matter is discharged into the river and its tributaries from the towns and villages within that area. When these towns shall have become better drained, this pollution must increase, unless a means can be found for mitigating the evil. Doubtless, the easiest mode of disposing of sewage is to allow it to flow into a river; and so long as the amount put in the stream is small, this mode of disposing of sewage is unobjectionable; but when the quantity of sewage turned into the stream is in excess, the water becomes prejudicial to the districts on its banks: hence many rivers in populous parts of the country have been injured by being polluted with sewage discharged into them by towns near their source.

Conclusions.

I.

1. That the influence of the sewage on the river is pernicious.

2. That this sewage is derived partly from the population of the metropolitan districts, and partly from the population of other

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the deep drainage is completed, and the ground generally laid dry to the depth of 12, 14, or 15 feet, the gases from these putrid cesspools will rise to the surface, and escape into courts and alleys, and into the houses, and among the houses, where there is little ventilation, and serious consequences may result. The emanations from these cesspools laid dry will continue for a time, and then cease to be offensive or hurtful, so long as the ground is kept dry; but let a flood occur, and the ground become again saturated with water, again there would be an emanation of foul gases, first by evaporation from the ground, and then by fermentation, which would result from the contents of the cesspools being saturated with water, and then slowly drying again. And every severe flooding that took place, this evil would be repeated, and no doubt fevers would be engendered from it. Such a soil once laid dry, must be kept dry, or else it had better be allowed to remain as it is, thoroughly and permanently saturated with water. He would urge upon the authorities the necessity of causing *every cesspool to be emptied* before the main drainage be completed, as otherwise he had no doubt but that serious results will arise from the emanation of gases from these putrefactive matters when drained dry.

districts, occupying the same part of the main valley of the Thames, or of valleys subsidiary to that main valley; and that the quantity of sewage from the metropolitan district alone, flowing daily into the Thames at the present time, is 15,249,777 cubic feet.

3. That in order to purify the tidal portion of the Thames from sewage, it will be necessary to exclude from it, not only the sewage of the metropolitan district, but the sewage from these other adjacent districts.

4. That the plan of the Metropolitan Board of Works does not provide for the removal of a sufficient quantity of sewage from the metropolitan districts; that the amount of rainfall which it is contemplated by this plan to intercept from the river should be increased; and that the plan does not make adequate provision for removing from districts adjacent to the metropolis the sewage which flows into the river within the limits of the metropolitan district.

5. That the prospective population of the metropolitan district for which provision should be made, is 3,578,089, as compared with 2,362,236 in 1851; the population of the subsidiary districts being 401,000 as compared with 154,076 in 1851; the total prospective population being 3,977,532. That the only mode of estimating approximately the probable amount of sewage from the district is to assume a certain quantity per head of the population. That 7 cubic feet per head is the amount for which provision should be made; that it appears from experiments that half this quantity passes off in eight hours; and that no sewage should be permitted to flow into the Thames in or near the metropolis until it shall have been diluted with five additional volumes of rain water in the suburban districts; and that in the eight hours of the maximum flow of the sewage, provision should be made for removing ¼-inch of rainfall in the urban districts.

6. That the large population of the portion of the main valley of the Thames, occupied by the metropolitan district, has so diverted the natural springs, and so saturated the ground with sewage, that with the exception of the water from the Wandle, the Baveley Brook, the Ravensbourne, and the Lea, it is impracticable to preserve, to any useful extent, pure water from these streams to flow into the Thames.

II.

1. That no system of drainage is adapted for the metropolis, which does not relieve the low-level districts from floods, and that the system to be adopted must therefore provide for intercepting the upland drainage; and that, considering the expense and contingencies of raising the sewage by artificial means, and the risk of floods, the area from which the sewage can be removed by natural means should be as large as possible, and the area from which the sewage has to be removed by artificial means should be as small as possible.

2. That the sewage, when collected, must be removed with as little practical inconvenience or injury as possible, either to the inhabitants of the metropolis or to the inhabitants of the districts to which it is conveyed.

3. That the so-called deodorisation of sewage does not remove the highly putrescible soluble constituents from the liquid which passes off; and that, consequently, the liquid, after deodorisation, must be disposed of in the same manner as the ordinary sewage water; that it is not believed that the deodorisation of London sewage could be carried on without creating a nuisance; and that no plan would be effectual with the increased volume arising from rain.

4. That the value of the fertilising matter contained in London sewage is undoubtedly great; but that the large quantity of water with which it is diluted precludes the possibility of separating more than about one-seventh part of this fertilising matter by any known economical process; that a copious dilution of the sewage is necessary to the health of the inhabitants of the metropolis, and that therefore the sacrifice entailed by the dilution must be endured.

5. That the application of sewage to land, although it may give good results under favourable circumstances, and where it can be applied by gravitation over limited areas, cannot be expected to afford similar results in or near the metropolis, where it would have to be raised to a great height, and to be conveyed to considerable distances, as this entails a very heavy prime cost and very heavy annual charges; that even if irrigation be assumed to be remunerative, no system would be complete which did not provide either for the reception and application of the sewage at all times to the land, and for the subsequent removal of the liquid, or for its being placed in the river at some unobjectionable point, when not required for irrigation; that this would require, in addition to the arrangements for irrigation, other outfall sewers, almost as extensive and costly as would be required without irrigation; and that a means of placing the sewage in the river in an unobjectionable place would, under all circumstances, be required during rain. That, looking to the character of the districts near the metropolis, it would be extremely difficult to find large and detached areas where it would be possible, by agreement with individuals, to guarantee the constant reception of even a small quantity of the London sewage, while it may be a question whether irrigation on a large scale might not occasion danger to the health of the inhabitants of such districts by the pollution of the air of the district, as well as of its springs and streams.

6. That, under these circumstances, and having regard to the inexpediency of making the question of the effectual drainage of the metropolis dependent on commercial considerations, the only practicable mode of disposing of the sewage of the metropolis is to provide for its rapid removal from inhabited districts, and for its collection in main outfall channels, where private enterprise, under proper control, may be at liberty to utilise it; but that, when not required for purposes of utilisation, these channels should provide for its flow in the most expeditious manner into the sea.

III.

1. That it is not desirable, for the reasons stated in the report, that the sewage should be conveyed from both sides of the river through one channel to the outfall.

2. That the proposed outfall at B*, in Erith Reach, is objectionable, because it would not effectually prevent the sewage from returning within the limits of the metropolitan boundary; because it would have a deleterious effect on the health of the district; and because it would probably be prejudicial to the navigation.

3. That the best outfall on the north side is a place between Mucking Lighthouse and Thames Haven, in Sea Reach; and that the best outfall on the south side is Higham Creek in the Lower Hope.

4. That in order to intercept the sewage of a large area, a level should be adopted a little above that of the highest tides, namely 5 feet above Trinity high-water mark, as the level from which the sewage should gravitate at the river Lea on the north side, and at the river Ravensbourne on the south side of the Thames; that the sewage should flow from thence to main outfall channels commencing near Barking on the north side, and near Woolwich on the south side, which would conduct it to the outfalls; and that in these main outfall channels use should be made of tidal water near the metropolis to assist the flow, and to effect at the same time the dilution, of the sewage.

5. That the area from which the sewage would be so intercepted and removed, without having recourse to artificial means in the metropolitan districts, is about 81 square miles; and the area from which the sewage would be lifted is nearly 38 square miles.

6. That with reference to the other districts for which these sewers would provide, the population is very large; but that the actual amount of sewage which would be intercepted and removed, without artificial means, cannot be accurately defined without further levels.

7. That the cost of the main outfall sewers will be 3,144,300*l.*, and the cost of the internal system of intercepting sewers in the metropolitan district 2,292,965*l.*, and the total cost, 5,437,265*l.* That if the outfall channels were not carried beyond B* in Erith Reach, the expense would be reduced by the sum of 1,719,300*l.*

8. That taking into consideration the magnitude of the works, and the peculiar difficulties of construction, and having a due regard to economy, the works should occupy at least five years in construction.

9. That all towns and villages near the line of the main outfall sewers should discharge their sewage into these channels, instead of allowing it to pass through the marsh drains into the river.

10. That these districts and all districts round the metropolis

which make use of the main outfall channels, should contribute towards the cost of constructing and maintaining these channels in the proportion which the population of such districts may from time to time bear to the whole population using the main outfall channels, and to the expense of the portion of the channel so used.

11. That the pollution of streams by sewage, throughout the whole country, is an evil which is increasing with improved house-drainage; and that it is very desirable that the attention of the legislature should be directed to the subject with a view to devising means for remedying the evil.

In conclusion, if the Thames is to be completely purified, no plan less comprehensive than the one here suggested will effect this object. The estimated expense of this plan is considerable; and some improvement upon the existing state of things might possibly be obtained for a smaller outlay; but a diminution in the dimensions of the sewers does not proportionately diminish the cost of their construction; and moreover, the increase of population which is so rapidly taking place in every direction round the metropolis, would necessitate the extension of any less comprehensive plan than the one here suggested, at no very distant period.

BREAKWATERS, PIERS, AND HARBOURS OF REFUGE.

A RETURN has been made to the House of Commons of the names of places on the coast of Great Britain and Ireland which have been surveyed or reported on by order of the Admiralty, with a view to the formation of breakwaters, piers, or harbours of refuge, the works of which have not been commenced, and where the recommendations have not been adopted; and of the nature of the works recommended, the period required for completion, the estimate of total cost, and the outlay recommended per annum.

ENGLAND.

Hartlepool.—Report and design by the late J. Rendel, C.E., on the 16th March, 1855. Two piers recommended, one on the north, and the other on the south side of the bay; to enclose an area of 470 acres having a depth of 12 feet and upwards, and 325 acres having a depth of 18 feet and upwards, at low water of spring tides. Period required for completion, six years. Estimate of total cost, 800,000*l.*—Also reported on by E. K. Calver, R.N., March 31, 1855.

Teesmouth.—Report and design by the late J. Rendel, C.E., on April 4, 1855. Two piers recommended, one on the north, and another on the south side of the mouth of the river Tees. Estimate of total cost, 275,000*l.*—Also reported on by E. K. Calver, R.N., on May 31, 1855.

Redcar.—Report and design by W. A. Brooks, C.E., in 1832, and again in 1851, consisting of two piers and other works. The piers to enclose an area of about 195 acres with a depth of 12 feet and upwards, and about 130 acres with a depth of 18 feet and upwards, at low water of spring tides. Estimate of total cost, 340,000*l.*—The above design was reported on to the Admiralty by D. Stevenson, C.E., on February 15, 1851; and the site was surveyed by E. K. Calver, R.N., and plan sent to the Admiralty, in April 1851.—Further reports by W. A. Brooks, C.E., dated October 21, December 26, 1856, and February 20, 1857, with extended designs shown by plans.—The original plan of 1832 was reported on by Sir W. Cubitt, C.E., in 1835.

Bridlington.—A detached rubble stone breakwater proposed on the seaward side of the bay, to be placed on the Smithwick Sand; probable length, 5000 feet; approximate estimate, 350,000*l.*; to be completed in ten years.

Aldborough.—Designed by P. Bruff, C.E., in 1851. Promoted by private individuals, who applied to parliament for a private bill; and the Admiralty, under the powers given them by the Preliminary Inquiries Act, directed N. Beardmore, C.E., to report on the bill, which he did, March 9, 1852. Works proposed consisted of new entrance to the river Alde, with entrance piers. Period required for completion, ten years; estimate of total cost, 60,000*l.*

Newhaven.—Design for works by J. Walker, C.E., viz., an addition of 1000 feet to the West Pier, leaving a portion of it open; to move the East Pier 60 feet to the eastward, and to lengthen it 100 feet; to excavate the harbour and approaches to a depth of 7 feet, a width of 250 feet, and a length of 2000 feet. Estimate 150,000*l.*

St. Ives.—Report and design by Captain Vetch, July 31, 1847. A breakwater recommended on the north side, to shelter an area of 80 acres having 12 feet, and 56 acres having 18 feet and upwards, at time of low water. Period required for completion, seven years. Estimate of total cost, 174,400*l.*; outlay recommended per annum, 25,000*l.*

New Quay, Bristol Channel.—Report and design by the late W. Bald, C.E., in November 1848. A breakwater recommended on the north side of the bay, to give shelter to an area of about 515 acres having a depth of 12 feet, and 425 acres having a depth of 18 feet and upwards, at low water of spring tides. Estimate of total cost, 711,744*l.*

SCOTLAND.

Wick.—Report and design by Capt. Vetch, R.E., February 10, 1857. Two breakwaters recommended, one from the north shore of Wick Bay, and the other from the south shore, sheltering an area of 60 acres having a depth of 12 feet and upwards, and of 42 acres with a depth of 18 feet and upwards, at low water of spring tides. Period required for completion, seven years. Estimate of total cost by J. Coode, C.E., 175,175*l.*

Peterhead.—Report and design by D. Stevenson, C.E., on January 25, 1847. Formation of a harbour proposed in the south bay, having an area of 6 acres, with a depth of 12 feet and upwards at low water of spring tides. Estimate of total cost, 227,905*l.*

Elie, Firth of Forth.—The design consists of two breakwaters, one from the east, the other from the west side of the bay, sheltering an area of 60 acres of 12 feet and upwards, and of 20 acres of 18 feet and upwards, at low water of spring tides. Approximate estimate, 200,000*l.*

Dunbar.—The design, by Captain Vetch, R.E., consists of a breakwater connecting the outlying rocks, and sheltering an area of 70 acres of 12 feet depth and upwards, and of 60 acres of 18 feet and upwards, at low water of spring tides. Approximate estimate, 150,000*l.*

IRELAND.

Ardglass.—Report and design by the late J. Rendel, C.E., on May 17, 1852. Two breakwaters recommended, one on the east and the other on the west side of the entrance of the harbour, to shelter an area of 40 acres having a depth of 12 feet, and 35 acres having a depth of 18 feet and upwards, at low water of spring tides. Period required for completion, five years. Estimated total cost, 240,000*l.*; outlay recommended per annum, 48,000*l.*—Also reported on by Capt. Denham, December 1, 1851.

Carlingford Bay.—Reported on by Capt. Washington, R.N., on July 26, 1853. Proposed to dredge a channel, 800 yards long by 200 yards wide, and 20 feet deep at low water of spring tides; also to remove several detached rocks, as those called Helly Hunter, Morgan's Pladdy, &c. Period for completion of work, three years; estimate of total cost, 20,000*l.*—Proposed by Mr. Ramsay, C.E., and reported on, with estimate, in January 1854, to remove the bar by dredging. Period for completion of work not given; estimate of total cost, 23,046*l.*

Waterford.—Reported on by R. Lecky, C.E., January 28, 1854. Proposed work consisted of a cut, by dredging, 2000 yards long and 400 yards wide. Period required for completion, ten years; estimated total cost, 16,000*l.*—Reported on by Capt. Washington, June 1857, to dredge channel through Duncannon Bar or Flat, 1 nautical mile in length, 300 yards wide, and 20 feet deep at low water spring tides. Period for completion, two years; estimate of total cost, 20,000*l.*

ISLE OF MAN.—IRISH SEA.

Douglas.—Designed and reported on by Capt. Vetch, R.E., on November 25, 1856. A pier or breakwater recommended on the south-east side of the bay, sheltering an area of 27 acres, having a depth of 12 feet, and 16 acres having a depth of 18 feet and upwards at low water of spring tides; estimated sum in aid, 30,000*l.*

Port Erin.—Designed and reported on by Capt. Vetch, R.E., November 25, 1856. Proposed work consists of a breakwater on the south side of the Bay, 600 feet in length; estimated total cost, 15,000*l.*

THE NEW NATIONAL GALLERY.

The Commissioners* appointed "to determine the Site of the New National Gallery, and to report on the desirableness of combining with it the Fine Art and Archæological Collections of the British Museum," after some preliminary resolutions, say—

We now proceeded to collect materials for forming a judgment on the main question submitted to our decision; and on this point we must confess that we were embarrassed rather than aided both by consulting previously-recorded opinions, and examining many witnesses. For not only did we find, as might be expected, a great diversity of opinion, but, in some instances, we perceived that the same persons, and those of the highest authority, might be cited for opinions either totally different from each other, or much modified. Two examples of this contradiction may suffice. The committee of the House of Commons appointed in February 1848, to consider of the best mode of providing additional room for Works of Art given to the public, or purchased by means of Parliamentary grants, say:

"After careful deliberation, we unanimously concur in the opinion, that taking into account the commanding nature of the site occupied by the present building, to which perhaps it would be difficult to find a parallel in our own or any other capital;—its accessibility and nearness to the chief thoroughfares and centres of business, which are fed by what has been described in a well-known phrase as 'the fullest tide of human existence';—the aids to economy which, without sacrificing the beauty of effect which a new front and additional height may confer on the structure, would be furnished by the rare circumstance of only one ornamental front being rendered necessary, from the disposition of the ground, and by the means which are at hand for making use of the whole of the present interior, due regard being paid to the convenience of the Royal Academy, in providing suitable accommodation elsewhere;—the space for further enlargement, which, in the process of time, and concurrently with the exigencies of the collection, might be supplied by occupying the uncovered ground, now in the occupation of public establishments, in the rear of the present building;—for all these reasons, without presuming to indicate the precise period for the commencement of such a work, the determination of which may be governed by other considerations, your Committee would recommend that, whenever it is undertaken, the enlarged and improved National Gallery should be on the same site as the present; and for the completion of such a work, which ought not to be unworthy of the age, the country, and its own destination, they would gladly see the most eminent talent of the nation invited to compete in designing an appropriate and enduring monument."

Such was the unanimous recommendation of some of the most eminent members of that Parliament; but another Parliamentary committee, composed nearly of the same members, relying, as it appears, mainly on the report of commissioners who sat, a few weeks before, to inquire into the State of the Pictures in the National Gallery, on the 25th of July, 1850, reported as follows:

"Many plans have been suggested by architects of eminence, with the view of building on the present site a National Gallery not unworthy of the nation. Upon reviewing the evidence here collected, your Committee cannot, however, recommend that any expenditure should be at present incurred for the purpose of increasing the accommodation of a National Gallery on the present site. Your Committee are not prepared to state that the preservation of the pictures, and convenient access for the purpose of study and the improvement of taste, would not be better secured in a gallery further removed from the smoke and dust of London; but being in ignorance of the site that might be selected, the soil on which it might stand, and the expense which might be incurred, they cannot positively recommend its removal elsewhere."

It will be observed that, although the opinion given by the Committee of 1848 is positive, and that of the Committee of 1850 negative, yet they were not easily reconcilable, and afforded us but little assistance.

The same may be said of the recorded judgments of an eminent individual. Sir Charles Barry was examined before the Committee of 1848: he was thus questioned by the chairman, Lord Morpeth:—"Since you were last examined by the Committee, have you directed your attention to the site of the present National Gallery, with a view of ascertaining the capabilities of that building for the reception of additional works of art?" His answer was: "Yes, I have; and I am now prepared to report to the Committee on the subject. I am of opinion, that if the site of St. Martin's workhouse were purchased, an alteration were made in the form of the barrack yard, and a portion of Castle-street stopped; if the Royal Academy were located elsewhere, the portico and other projections beyond the line of the present front taken down, and considerable additions were made to the present building; a National Gallery could be obtained on the present site that would be an ornament to the metropolis, and afford accommodation equal to the requirements of the country for the national pictures for ages to come: I should add, the proposed additions to the present building would have the effect of entirely concealing the front of it. I have gone very minutely into the subject, and have prepared certain plans and diagrams to illustrate my propositions; and I shall have great pleasure in submitting and explaining them, if it be the wish of the Committee."

The whole tenor of Sir Charles Barry's evidence in 1848 is in favour of the site of the present National Gallery; but when examined by us on the 2nd of last April, and his former evidence being referred to, he said, "I would not hold to that answer now, because I have had opportunities since of examining very carefully the capabilities of the British Museum; I have considered also the advantages of the greater centrality of its position, and other matters which I was not aware of and did not consider when I gave that evidence. My opinion is now modified; and I have no hesitation in saying, that the site for the National Gallery, in my opinion, is the British Museum, in preference to that of Trafalgar-square."

We have referred to these striking differences of opinion of the same eminent persons at different times, to show the small amount of assistance we have received from consulting authorities on the matter in question, and also to suggest an excuse for any differences of opinion which the minutes of proceedings will prove to have existed amongst ourselves. And it may not be improper to add that our difficulties have not been diminished by the fact that our commission originates in a difference between a decision of a committee of the late House of Commons and a vote of that House itself, the vote in each instance having been carried by a very small majority.

At the outset of our deliberations it appeared that many sites might be considered worthy of especial notice; but on closer examination we found our choice to be limited to a very few. We felt that any encroachment on the royal parks would meet with general opposition; and we must add that it would, in our opinion, be most undesirable. This conviction excluded us from recommending the site of either of the royal palaces, supposing that such a proposal could with propriety be made; for no suitable structure could be raised on such a site without to a certain degree encroaching on the parks, either by the building itself, or by the requisite approaches to it. A suggestion was made in favour of the inner circle of the Regent's-park, by a witness who has given much attention to the subject (Mr. A. J. B. Beresford Hope, M.P.), but our resolution not to advise the erection of large buildings on any of the open spaces now used for public resort, as well as objections to the nature of the soil, induced us to exclude that site from our final consideration.

We could not adopt the proposal to remove the national pictures to the upper floor of the British Museum, although that plan came recommended to us by a high authority.

After these and other deductions, for which we do not think it necessary to give detailed reasons in this report, we found our choice, in fact, limited to two sites—the site of the present National Gallery, sufficiently enlarged, and the Kensington Gore estate.

The advantages and disadvantages of the Kensington Gore estate were stated in full and minute detail before the select Committee of 1853, and we examined some of the principal witnesses who then gave evidence on that subject.

So far as space for a building of great magnitude, with capacity for future enlargement, is concerned, this site is in our opinion undoubtedly to be preferred; and we cannot but conclude that the air must be on the whole less impure there than at Charing-cross. Whether it will continue to be so when the neighbouring land to

* Consisting of Lord Broughton, H. H. Milman, dean of St. Paul's, Messrs. R. Ford (who from illness was unable to act), M. Faraday, C. R. Cockerell, and G. Richmond.

the south-west and west shall be covered with buildings, and become a part of the metropolis, may by some be doubted.

We ought not altogether to overlook the fact, although it need not govern our decision, that the choice of this site would occasion a saving to the amount of whatever outlay might be requisite for the purchase of land elsewhere.

On the other hand, the site of the present National Gallery is, incontestably, more accessible—more in the way of all classes, and from long usage, more familiar to them, than any position in the outskirts of the metropolis. The surpassing merits of this site in this respect are fully set forth in the unanimous report of the Select Committee of 1848, to which we have previously referred. And in regard to capacity for enlargement, which seems to be the chief matter of doubt, there can be no impediments now which were not known to the eminently practical statesmen who composed the Committee and prepared the report of 1848.

In regard to atmospheric impurities it is, as has been previously admitted, inferior to the site at Kensington Gore; but additional care, the more general protection of the pictures by glass, which is strongly recommended by some of our more competent witnesses, architectural improvements in a new building, and recent legislation, which has done much to purify the metropolitan atmosphere, and may do more, would probably much improve its present condition. Considered architecturally, the site of Trafalgar-square stands by common consent without a rival; and the substitution of a building worthy of the British people for the present edifice would command universal admiration, and do honour to the age.

It only remains for us to state that, having duly considered the premises, we have decided by a majority of three votes to one (one of our colleagues having declined to vote) in favour of the site of the present National Gallery.

WESTMINSTER BRIDGE.

The Select Committee appointed "to consider the state of Westminster Bridge, and the course to be taken in relation to the works which have been suspended," and who were empowered to report their observations, together with minutes of evidence, to the House of Commons, have considered the matters to them referred, and have agreed to the following report:

"That having been informed by the First Commissioner of Works, that after considering the report of the judges appointed to report on the designs for the new public offices and the block plan, and taking into account the great expense that would be incurred if the site of Westminster Bridge was changed, it is not his intention to recommend that the site of Westminster Bridge should be altered,—the Committee proceeded to consider the present state of the existing bridge, and the alterations proposed to be made in the new bridge to meet the objections which have been taken for the mode of construction as originally proposed.

"The Committee learn that the precautions taken for securing the old bridge have been complete, and they recommend that the new bridge be proceeded with in conformity with the alterations in the mode of construction as set forth in Mr. Page's letter addressed to the First Commissioner, and dated 23rd July, 1857.

"The Committee have also carefully considered the important question of the headway of the bridge, and in connection with that subject the gradient of the roadway as now proposed, and the gradient which would be consequent upon raising the bridge. The Committee find that, according to the plan now proposed, the roadway on the Surrey side would be 1 in 45, and if the bridge was raised from 20 to 22 ft. the gradient would be 1 in 27. The Committee also find that on the Middlesex side the gradient as at present designed would be 1 in 57, and if the bridge was raised the gradient would be 1 in 45. The Committee are therefore of opinion that it would not be expedient to increase the height of the bridge."

The alterations suggested by Mr. Page are—

Lowering the piers already commenced to such a level as will place the heads of the wooden piles 15 or 18 inches below low-water mark. The works comprised consist in cutting down the timber bearing-piles (already driven) to a level of 19 ft. 6 in. below Trinity datum, or 18 inches below low-water springs; cutting down the granite facing, and refixing the iron ties. The expense of this in the piers and abutments already commenced will be 1980*l*.

New granite bases to the piers, rendered necessary by lowering the timber piles, the expense of which (with the requisite filling of stonework and brickwork over the piles), in the piers, &c., already executed, will amount to 922*l*. The expense of this arrangement in the other piers and abutments throughout the entire bridge is estimated at 4436*l*. He leaves the piers above these courses as in the former plan, taking them as brickwork faced with granite blocks, and with granite through-stones.

In the original design it was proposed to carry arched ribs above the roadway. This being much objected to, Mr. Page substitutes in their place the ordinary arched ribs of the bridge, and thereby effects a saving of expense.

It is proposed, to allow of expansion, to coat the external arches of the bridge with a non-conductor, the effect of which would be to limit the range of rise and fall. He provides against the scour of the river, by carrying the iron sheet piling down to 38 feet below Trinity datum. At the piers there will be 15 feet of ground above the points of the piles.

The arched ribs of that part of the bridge to be first opened rest on the first division of the foundations, but the first rib of the second half of the bridge will also bear on the same foundations, which have abundant resistance against considerably greater pressure than the bridge and its load. In case, however, there should be a settlement, or any difference of settlement between the two parts, the arched ribs of the bridge would not be affected, as the wrought-iron bearers between the ribs which carry the roadway plates would accommodate themselves to any irregularity of settlement, by the bolt-holes being slotted or elongated, so as to allow for a rise or fall of the bearers.

The following Evidence was given before the Committee.

Mr. J. Simpson.—Had examined the old Westminster Bridge several times since the Committee sat last year, and found it as nearly as possible in the same condition as it was last year. With regard to the large arched ribs as originally proposed, he believed the engineer had determined very early to omit them; they would have destroyed the uniformity of the structure, or its capability to support anything in a uniform manner—one would have held, while the other would have given way. He considered, that by cutting down the wooden piles, as now intended by the engineer, so that they shall be 15 or 18 inches below low-water mark, would entirely remove any objection to them. With respect to the settlement which might take place, as the bridge is to be built in two parts, he considered the provision made by the engineer quite sufficient to counteract any inequality of settlement. The engineer proposes to introduce braces of wrought iron, with slot holes, in reality they will have a means of motion: it is intended to rivet the whole of the covering-plates, and that will also admit of some subsidence. Provision has been made for a settlement of about an inch. With respect to an allowance for expansion of the cast-iron work, the engineer stated, that supposing a difference of 60° of temperature, the rise of the outer rib of the centre arch would not be more than half an inch above the main line, and the fall half an inch below it; and this rise and fall would be very gradual. He proposed however to coat the external arches of the bridge with a non-conductor, the effect of which would be to limit their range of rise and fall. To allow of the more easy rise of the arch, Mr. Stephenson had suggested cutting part of the angle iron of the upper flange of the wrought-iron ribs, and inserting a wedge. Either expedient would in his opinion accomplish the object, but he preferred the latter. He thought it would be possible, using the same iron ribs that are now proposed to be used, to increase the gradients of the bridge as well as the approaches to the bridge. It would all come up together; the inshore arches could be thrown down a little, and the roadway brought up to it, part of it being done by means of the piers, a large portion of which are not yet cast. If thought desirable there is time to make any alterations of that kind. He did not attach much importance to the headway of the centre arch being 22 feet, most of the steam boats navigate the side arches. As to the gradients of the approaches to the bridge, a gradient of 1 in 31 is fearful for metropolitan traffic. It should not be less than 1 in 50; if you can get 1 in 60 it would be much better—steep gradients are such an interruption to traffic. There is one view of the matter which perhaps has been scarcely sufficiently considered; taking the average, the tides are considerably below Trinity datum; they do not rise to Trinity. He had an account of the tides a little higher up the river taken for upwards of twenty years, showing the tides which have risen above Trinity datum, and they are comparatively small in number taking month after month. He considered that, in comparison of the water traffic, the traffic over the bridge is far beyond it in importance; and both together ought to be considered in preference to the appearance only of the bridge.

Mr. R. Stephenson, M.P.—As to the alterations proposed by the engineer in his letter of the 23rd July last, he perfectly concurred in the suggestions therein made. The headway of Chelsea Bridge is now 22 feet. Is most decidedly of opinion that the bridge ought to be kept as low as possible. The convenience or inconvenience is a comparison between two great thoroughfares. The traffic upon the river is pretty well accommodated with 20 feet headway for all ordinary barges, and for the ordinary passage of steamers. They have to lower their masts under any circumstances, and whether they lower them two or three feet more or less is immaterial. Thinks the traffic upon the river will not suffer at all by retaining the height of 20 feet; whereas, looking at the enormous thoroughfare over the bridge, where the gradients interfere very much, not only with the facility, but the regularity of it, thinks that ought to take precedence in the consideration of the question; and that the best possible gradients ought to be aimed at in any London bridge The river traffic will scarcely be damaged in a sensible degree by retaining 20 ft.; and it would make a difference of 1 in 27 instead of 1 in 45; that is a great addition. The original design was to raise Stangate or Bridge-street 1 foot. In that case the gradient would be 1 in 45, on the south side. If it is raised 2 feet, and the level of Bridge-street at Stangate is retained the same, as it ought to be, that is raising it 1 foot, and the gradient would be 1 in 27. The difference between 1 in 27 and 1 in 45 is most material, and it would diminish the capacity of the bridge for traffic in winter weather; for the traffic of goods, diminishing the capacity of the bridge for traffic one-third. St. James's-street is 1 in 25, and in winter time there is no heavy traffic there. When the Holyhead road was laid out under Mr. Telford, he regarded the limit of a trotting hill to be 1 in 32; a stage coach and horses could trot up 1 in 32. A railway crossing a turnpike road is compelled to make the headway 1 in 30.

Mr. T. Page.—If the height of the bridge remained as proposed, at 20 feet, the gradient upon the south side of the river would be 1 in 45; if altered, 1 in 27. If its height remained as proposed, the gradient of the Middlesex side would be 1 in 57; and if raised to 22 feet, it would be 1 in 45. The 20 feet, as at present designed, is the height above high-water mark in the centre arch. The height of the arches nearest the abutment is 16 feet; 14 feet above the springing line, and 16 feet above high-water mark. The heights of the arches are—16 feet next the abutment; 17 ft. 7½ inches for the next arch; 19 ft. 3½ in. for the third arch, and 20 feet for the centre arch. The steepest gradient upon the bridge itself is 1 in 57; that is a regular gradient from the side to the middle of the second pier, for the two first arches; it is then 1 in 75 from the centre of the second pier to the centre of the third arch; then 1 in 123 from the centre of the third arch to the centre of the third pier; and 1 in 362 over the centre arch. It is a circle joining two inclined planes, and the spans of the arches are set out to suit the proportion of roadway line. Is still of opinion, as stated in his letter of 23rd July last, that the sum of 206,000*l.* will be sufficient to defray all the expenses that may arise, and will cover the cost of the bridge, according to present market prices. It would require two years for removing the old bridge, and completing the new bridge, from the time of opening the first portion, and the first portion would be opened in a year from the recommencement of the work. Regarding the completion of that part of the bridge to be first opened, it would be a saving of time and expense if the work were done under his own direction without a contractor, most of the materials being now on the ground. His reasons for this are—First, there would be a saving of time in his being enabled to go to work at once with the men who have been employed upon the piers, and in using the materials which are on the ground, while a contractor was preparing for the remainder of the work from 2 feet above low-water upwards; and it would save complication in the charges of the contractor, and in allowances for contingencies in executing the work with which he would not be familiar, and he should be more satisfied of the work being properly done. It would be an advantage to the contractor in every way that at least the first portion of the bridge, the foundations of which are so near completion, should be completed under himself and his superintendents, so that the contractor, when he gives his tender, should give it for work above low water for the first portion of the bridge. Is of the same opinion with regard to the remaining part of the bridge, but if there were time for the contractor to consider the details of the under-water work for the remaining portion of the bridge, it might probably be let to him as advantageously both in point of time and economy as if it were done under his (Mr. Page's) own superintendence. Even if it should unfortunately happen that the second portion of the bridge is not so well done as the first; or that from some cause or other there is some settlement, and the individual who had performed his contract in an unsatisfactory manner, said that the person who designed the bridge had done a portion of the work, and that it was in consequence of the manner in which that portion of the work had been done that the failure had taken place. By extending the arrangements spoken of to one or two divisions beyond the half of the bridge, that objection would be done away with. That additional bay, suggested as being executed under his superintendence, would be done while the old bridge is being removed. He should prefer to put in the greatest length of pier possible; under any circumstances, he would only do up to a certain point, and the rest would be contracted for and put in by somebody else. He would have the first ribs of the second part of the bridge placed upon the foundation of the first portion, which is desirable. In the foundations, which are laid upon one principle, the piles driven down to one test, he did not apprehend any settlement at all; but if a settlement were apprehended, and the first ribs of the second part of the bridge are placed upon the first part of the foundation, all apprehension about settlement would be done away with. This additional part of the foundation could be put in as securely and as firmly as the rest; the only point would be the expense of double sheet piling. His proposal, in the first instance, was that he should lay in the whole of the foundations to a point not so far as the centre of the bridge, and that he should open that part upon which the foundations shall be so laid for the public. He now proposes, that instead of stopping short of the centre of the bridge, he should lay on the foundations to the centre of the bridge, but only throw open the portion at first contemplated; then to lay the foundations of the other half of the bridge, and place the superstructure not only upon the other half, but upon the portion of the first half of the bridge which had not yet had traffic upon it. He should prefer, if he had his own way, to execute the foundations complete from one end of the pier to the other, and then to open the first part of the bridge to the public, as proposed. But as he cannot execute the foundations from one end to the other, on account of the new piers coming in the way of the old piers in many instances, he should prefer, as an engineer, to carry on the first portion of the bridge to the centre line, and to allow the first ribs of the second part of the bridge to be bedded on the first part of the foundations, not to have two distinct halves. That is to say, having one portion of the foundation, over which the traffic is to go in the first instance, leaving another portion of the first foundations bare. Had no doubt whatever about that mode being best. Did not expect any settlement. Any settlement depends upon the force with which the piles are driven; the resistance of the piles in this case, and the light superstructure, would render a settlement most improbable. There is no greater headway in the arches of the new bridge than there is in the old, because the headway of the arches of the new bridge diminishes as the headway of the old arches. In the centre of the old bridge the headway is greater than it will be in the new, but not what may be called the "navigable" headway. The table appended to his report to the First Commissioner showed that the greatest number of sailing vessels passed under the arch with 20 feet headway. The traffic up the river keeps the Middlesex side, and the traffic down keeps the Surrey side; and from the time that the old bridge was built the channels were so divided by a bank between them. The dredging of the river would open a channel to the centre arch of the new bridge.

Sir Charles Barry also addressed the following letter to Sir B. Hall, chairman of the Committee:—"As chairman of the

Westminster Bridge Committee, I conceive it to be my duty to acquaint you, that in case it should be the determination of the Committee to recommend that the new bridge should remain in its present site, and be constructed in accordance with any modification of the design in part carried out, it would be of the greatest importance that no increased elevation should be given to the roadway. Any raising of it, however trifling, would not only seriously injure the effect of the New Palace at Westminster, and the public offices, &c. proposed to be erected in the neighbourhood of that edifice, but would be a great disadvantage to the traffic over the bridge; whilst any trifling benefit that might accrue to the traffic under the bridge is in my opinion imaginary, or really of little or no importance, especially when considered with reference to the permanent æsthetic as well as practical advantages of a low roadway in connexion with the low shores of the river with which it unites."

REGISTER OF NEW PATENTS.

ELECTRIC TELEGRAPHS.

EDWARD HIGHTON, Gloucester-road, Regent's-park, *Patentee*, January 26th, 1857.

Heretofore when electric telegraphs have been arranged so as to render it possible to communicate at the same time from and to each of the terminal stations by means of only one line wire and the earth, the influence of the current on the instrument at the sending station has usually been neutralised by dividing it into two halves or portions, which are caused to traverse the coils of such instrument in reverse directions. Now this invention consists in using an additional battery to neutralise the influence of the line current on the instrument at the sending station, and for this purpose the finger key is so arranged that, at the same time that the line circuit is made, a short circuit is completed in the opposite direction, which includes the additional battery and the coils of the instrument.

ELECTRIC TELEGRAPHS.

P. A. BALESTRINA, Brescia, Italy, *Patentee*, January 23, 1857.

The first part of this invention relates to a means of connecting the ends of submarine telegraph cables to the shore, and in protecting them from rubbing against rocks or on the shore. For this purpose the cable is passed through a series of cylindrical blocks of wood placed at short distances apart, around each of which a bar of steel is wound spirally, the blocks of wood being held together by chains. One end of the series of blocks of wood is fixed to the shore, and the other end to the cable. The second part of this invention consists in a means of joining the ends of two or more submarine telegraph cables together. For this purpose a cylindrical box is used, over which a suitable cover is bolted, on the top of which there is a hook for lowering the box into the water. The ends of the cables to be joined together are passed through small tubes fixed in the cylindrical box, and are held there firmly by a clamp, or by other suitable means, the openings through the tubes being closed perfectly water-tight. To the end of these tubes may be hinged a series of small tubes jointed together, so as to allow the cables to adjust themselves without forming angles. In the interior of this cylindrical box there is fixed another smaller box, in the sides of which there are a number of small holes, through which the ends of the telegraphic wires of the cable are passed, a communication being made between the wires opposite each other by clamping them between plates of copper. In order perfectly to insulate the different wires from each other, the interior of the box is filled with resin or other non-conducting material, leaving room for the movement of the upper plates of copper when it is required to unclamp the different wires, the box being covered in water-tight by means of a suitable lid. On the outside of the cylindrical box are a number of projecting arms, through the ends of which a circular bar passes, and when it is required to raise the box from the water an anchor is let down and made to catch in the bar. The third part of this invention consists in winding around the centre cord of submarine cables, on which the insulated wires are laid, a thin copper wire in long open spirals, in order to carry off the induced electricity from the insulating material.

PERMANENT WAY.

P. M. PARSONS, Duke-street, Adelphi, *Patentee*, February 7, 1857.

The object of this invention is to provide a simple and efficient means of remedying the objectionable rigidity which is found to exist in the permanent way of railways in which the sleepers or bearers are composed of iron, stone, and similar unyielding substances. For this purpose the patentee constructs such sleepers of a suitable form, and interposes in any convenient situation between the rail and the sleeper or bearer, or between the rail and the chair support, or fastening resting on or attached to the sleeper or bearer, or between the chair support or fastening which holds or supports the rail and the sleeper, blocks, packings, or wedges of wood, arranged and placed in such a manner that the end grain or fibre of the wood will be presented to receive or sustain the train or pressure caused by securing or supporting the rails or the weights imposed on them, so that the strain or pressure will be intercepted by, and transferred from the rail to the chair fastening, support, or sleeper through these blocks, packings, or wedges, in the same direction, or nearly so, as that in which the fibres of the wood lie.

STOVE GRATES OR FIREPLACES.

G. WRIGHT, Sheffield, *Patentee*, February 6th, 1857.

This invention relates to a novel description of fireplace, combining certain arrangements for the escape of the smoke and gaseous products of the fuel into the flue or chimney, together with the means of obtaining a more perfect control over the draught; also in so constructing certain portions of the same as to obtain a large radiating surface, and at the same time conceal the ashes and other solid products of combustion. The improvement consists in making (in addition to the ordinary valve or door at the back of the grate for the escape of the smoke) a portion of the radiating plate itself moveable, so as to give a large opening when required for any increased volume of smoke that may be produced at first lighting the fire, or at any other time afterwards, and to allow such smoke or gases to ascend the flue or chimney without obstruction. The valve or door of the flue also is so hung as to enable it to be opened or closed and remain stationary at any angle or given point that may be desired, so as to afford a greater or less aperture for the smoke, rarefied air, or gaseous products of combustion; in other words, the valve or door of the flue is so constructed and arranged as to check or increase as may be desired the draught up the chimney. The next improvement consists in the arrangement of a cast-iron plate or plates, placed upon the hearth so as to give increased radiating surface and at the same time to conceal or otherwise obstruct the view of the ashes that fall from the fire.

PURIFYING GAS.

RICHARD LAMING, Haward's-heath, Cuckfield, Sussex, *Patentee*, February 3, 1857.

The patentee claims distilling phosphorus from earthy compounds or mixtures containing phosphate of ammonia and carbonaceous matter. The combination of means described for obtaining simultaneously from the residue of the purification of gas by solution of sulphate of iron two products, namely, sulphate of ammonia and hydrated peroxide of iron, in a state of admixture with lime, magnesia, carbonate of lime, or carbonate of magnesia, or any two or more of them. Obtaining ammonia, and simultaneously combining it with the carbonic acid of impure gas, by introducing hydrosulphate of ammonia into the gas prior to or simultaneously with its entrance into dry purifiers charged with materials containing iron in any state, which enables it to abstract the sulphuretted hydrogen, and to undergo atmospheric revivification alternately with the subsequent removal from the gas of its ammonia and combined carbonic acid; but the patentee does not claim the washing or scrubbing of impure gas with the ordinary gas liquors, as practised for the purpose of making them more rich in ammoniacal compounds, even though the gas be afterwards passed through a material containing hydrated or revivifiable peroxide of iron. Converting solutions containing in large or small quantities an ammoniacal hydrosulphate, mixed or not with ammoniacal carbonate, into solutions either wholly or in part of free or caustic ammonia, by the agency of such oxides, or preparations, or mixtures containing chemically divided iron, as will abstract the sulphuretted hydrogen without saturating or fixing the bulk of the ammonia; also admitting water or watery solutions to drench what are known in gas works as porous mixtures of hydrated or revivifiable peroxide of iron while in the purifying vessels, preparatory to forcing through those vessels a current of air for the revivification of the purifying material which they contain. The purification of gas from ammonia or ammoniacal compounds by washing it in a scrubber divided by one or more double diaphragms, each so constructed that its lower part is a basin to sustain the acting liquid into which the upper and perforated part of the double diaphragm is immersed for distributing the liquid and the gas. Receiving the volatile products distilled from gas liquor or ammoniacal washings into a close vessel containing sulphate of iron in solution, together with either the subsequent separation and evaporation of the resulting liquid into sulphate of ammonia, and the mixture and peroxidation of the iron precipitate, or the evaporation by gentle heat of the mixed products of the distillation as described.

FLOATING DOCKS.

E. Clark, Gt. George-street, Westminster, *Patentee*, January 19.

This invention consists in arranging a floating dock so that it may be sunk in order to receive the ship, and afterwards, having received the ship, be floated by pumping the water from the space between the side of the ship and the interior side of the dock. By allowing the dock thus to rest on the bottom the patentee is enabled to dispense with the air vessels necessary when the dock is kept floating while receiving the ship as heretofore. He constructs for this purpose a pontoon or vessel consisting of an iron shell bolted to transverse girders or frames, built up of sheet and angle iron, and also to longitudinal ribs which connect these transverse frames. This vessel has blocks bolted on its bottom on which it rests when sunk, and its sides are higher than the draught of the largest ship it is required to dock. When the floating dock is to receive a ship it is sunk on a bottom suitably levelled, a gate which closes at its end is opened, and the ship is floated in; the gate then being closed and the ship suitably shored, the water is pumped out. If the dock is to be used in a tide-way it will not be necessary to make its sides so high as the draught of the ship to be docked, as it may then be sunk in water sufficiently deep to rise over its sides, provided only that its sides be uncovered for a sufficient time at low water to allow the dock to be pumped out, so as to float it. If the rise and fall of the tide be large it will not be necessary to provide a gate at the end of the dock, as the ship may be floated over and allowed to settle down into it as the tide recedes. The dock is furnished with a valve or opening to let the water run out.

Claim.—The construction of floating docks or vessels arranged suitably for receiving ships into or on them; of floating with such ships in or on them without air-vessels to keep them floating when filled with water. The constructing floating docks with transverse girders or frames connected together by longitudinal ribs. The constructing floating docks with sides less in height than the draught of the largest ships which they are constructed to dock. Also the constructing floating docks without gates.

SHIP RAISING MACHINERY.

E. Clark, Gt. George-street, Westminster, *Patentee*, January 19.

This invention consists in a method of arranging machinery for raising ships out of the water for the purposes of examination and repair. The patentee erects a series of columns in two parallel rows, at some suitable places where the water is sufficiently deep to float the largest ship which it is intended to raise; he erects these columns by adopting the system used in bridge constructions, of sinking wrought or cast-iron cylinders or cylinders with screws, and excavating from the interior of them. In connexion with each of the columns is a hydraulic cylinder and ram, which, by means of descending rods, is connected with a girder or girders extending to the corresponding post in the opposite row. Over this series of parallel girders, which he calls a gridiron, and between the two rows of columns, the ship to be raised is floated, and the pumps in connection with the hydraulic cylinders are set to work, so as to bring each girder to bear against the keel of the ship, which is then shored in the ordinary manner; or instead of allowing the ship to rest directly upon these girders, he prefers placing a strongly-framed platform upon the girders, in order more perfectly to distribute the weight of the ship over the girders, and the ship then reposes and is shored up upon this platform. Afterwards the pumps are simultaneously set to work, and the girders are lifted and prevented from again descending by closing the water in the presses, or by palls which fall into suitable teeth formed at intervals on the columns. On each side of the two parallel rows of columns before mentioned he drives piles, on which he builds workshops at or near the level to which the vessel is raised.

MOULDING OR SHAPING METALS.

Matthew A. Muir and James M'Ilwham, Glasgow, *Patentees*, January 15, 1857.

These improvements are especially adapted for moulding or shaping railway chairs, and for such manufacture the machinery and means are of the following kind:—The whole of the establishment in which these improvements are to be carried into practical effect is specially arranged for the purpose in all its details, from the melting furnace or cupola to the discharge of the casting from the mould. The floor of the moulding shop is paved or covered with cast-iron plates, laid level and at proper and regular distances asunder. Recesses are formed in the floor to receive the mechanical moulding apparatus employed in the process. This apparatus consists in each case of a rectangular open frame having a lower fixed platform or table disposed on a level with the floor. Side standards extend upwards from the level of this platform to carry guide eyes for the vertically-traversing spindles of a shifting and turning platform above. This shifting platform carries cranked end studs or pivots fitting into bearings in the two upper ends of the vertical sliding spindles already referred to, so that either surface of the platform can be turned uppermost by a single turn of the hand. The two sliding spindles have T heads, and the platform is so arranged that whichever way the platform is turned up it comes to rest upon the T heads in a perfectly horizontal position.

The two chair patterns are immoveably attached by their soles to the face of the platform and on that side to which the end pivots are cranked; and when the moulder commences operations he turns the platform, with its patterns thereon, round, so that the patterns stand side by side on the upper surface of the platform. The flask or moulding sand box is then placed over the patterns upon the platform, being attached thereto by suitable detachable latches or pins. These latches or pins consist in each case of a screwed stud passed right through the platform, and having a short transverse setting handle on each end, so that the adjustment can be easily effected from both sides of the platform. The lower edge of the sand flask has a rim upon it, and when the box or flask is to be fixed in position, the pins are screwed down to cause collar pieces to press hard upon the rim. The box is then rammed with sand in the usual manner, a slip of metal being put in for the formation of the turned-over lip of the higher arm of the chair's jaws, and a "chill plate" for the opposite or lower jaw.

Whilst this ramming is proceeding, the platform on which it takes place is in its lowest position, the operator having depressed it by means of a balanced lever action connected with a cross-shaft working the sliding spindles from beneath, and it is firmly held in its horizontal position by a self-acting spring detent or inclined hook-catch set upon the T head of one of the sliding carrying spindles. There is a fixed stud pin on one end of the platform, which, when the latter is turned down to this position, presses back the inclined upper end of the spring detent, and enters a slight notch in the detent just below the incline. This detent holds the platform with sufficient firmness to insure its stability during the operation of ramming, but it at once releases the platform when the workman commences to turn the latter round to its reverse position.

When the ramming is finished, the operator places a flat cover plate on the top of the box, and fixes it in position by a couple of bell crank lever hooks, and he then pulls forward his hand lever and elevates the platform so as to leave room beneath for the entrance of a small carriage, which is in readiness, and is drawn along the floor directly upon the stationary platform, which is on a level with it. The platform, with its patterns and rammed box, is then reversed upon its end pivots, and the whole is lowered upon the sliding spindles by means of the lever movement below, until the plate rests by what is now its lower end upon the carriage table, and the flask being detached from the platform by turning round or slipping out the retaining latches or pins, is allowed to rest entirely upon the carriage.

A second detent of what may be termed the weighted lever or pendulum kind is applied at the front of the apparatus for regulating the action of the platform at this stage. This detent has a notch in its upper end for holding a stud on the end of the platform at the level where its steadiness is especially wanted, but when the platform is again raised the pendulum action at once frees it. The lever action is then worked so as to elevate the platform to its highest position, drawing out the patterns from the flask and leaving the latter behind. The attendant then draws away the carriage with the moulded flask upon it, and an empty carriage succeeds it to proceed as before. The slip of metal for the higher limb of the jaw is then removed, and the moulded flask being conveyed on the carriage to the proper place, another attendant moulds and applies the sole to it, and the mould is thus completed and disposed in rows with others in a situation convenient for the operation of pouring in the melted metal.

In chairs where the trenail or spike holes in the soles have very little taper, as well as in other castings where cores are required, additional provision must be made for insuring a clear draw of the pattern from the same. This is accomplished by fitting to the platform loose weighted stud pins, one for each spike hole. These stud pins have a slight longitudinal transverse play in holes in the platform corresponding with the spike holes in the patterns, and they are retained on the reverse side of the platform by supporting brackets, whilst their inserted ends just reach to the base of the pattern sole, and thus form the ends for the spike hole cores. When the pattern is withdrawn from the mould, the play which these stud pins have, as the pins remain slightly behind and pressing by their weight upon the moulded sand cores, causes the moulded cores to clear freely and sharply. The carriage platform beneath the turning platform is cleared of loose sand after every moulding operation, by a sliding scraper worked by handles from the front. This scraper has inclined sides which answer for guiding the carriage to the right part when run in, whilst it also forms the stop for the inward run of the carriage.

Instead of moulding the main body of the chair alone in this apparatus, whilst the sole partition is moulded separately, a simple modification of the parts enables the moulder to mould the entire chair in the machine. Under one form of the arrangements adapted for this purpose, the side of the turning platform opposite to that on which the patterns are attached, is formed so as to answer for moulding the sole portion upon it, and hence, when the platform has been turned over with the main box thereon, the box for the moulding of the sole portion is laid upon this reverse face of the platform and rammed up with sand. The platform is then separated from the sole mould-box by lowering it whilst the sole mould-box is held up; and the main mould-box being released from the platform and clear of the patterns, the turning platform is withdrawn horizontally from between the two sections of the mould, which are then brought together by the action of the machine, and the mould is completed. In this modification provision must be made for the easy withdrawal of the turning platform, and the correspondingly easy return and reattachment of the same for the turning movement.

Instead of this plan of removing the turning platform, a swinging apparatus may be fitted up for swinging off the sole mould-box from the reverse face of the turning platform so as to deposit the sole mould upon the main box, which has been already withdrawn from beneath, clear of the apparatus for the purpose. This removal of the sole mould-box may be effected by an arrangement of swinging bracket arms worked either by back gearing or by a lever action from the front. In adapting this invention for general moulding, independent of railway chairs, where two separate sectional draws of the pattern are unnecessary, the turning over of one of the boxes or sectional portions may be effected by a suspensory rod or chain capable of traversing along an overhead beam or bar, and carrying bottom links or loops for catching twining pins on the box. One section can by this means be run along by its suspending chains to the point required, being raised and lowered as may be necessary for the turning over and deposit of the section upon its counterpart or corresponding box.

The melted metal is conveyed from the cupola in a vessel or holder, suspended or swung on pivots or stud centres, carried on a frame set on carriage wheels. The vessel on the carriage is disposed so as to be capable of running directly beneath, and close to the discharge duct of the cupola, so that the melted metal can be easily run into the vessel. The vessel is fitted with a tilting shaft and handles, and a locking detent on the carriage frame is arranged for the purpose of fastening the tilting-shaft to keep the vessel upright when full of melted metal. The carriage frame also carries a delivering spout, so that when the vessel is tilted the melted metal falls upon this spout, and is directly delivered from it into the mould. The vessels are each contrived to carry melted metal for casting six chairs, so that this number can be cast at one filling, but it is obvious that any other convenient number may be so cast. It will also be obvious to the practical founder that this apparatus and procedure, although hereinbefore described in their application in the manufacture of railway chairs, are equally well suited for casting other articles in metal.

Claims.—1. The general arrangement and construction of machinery or apparatus for moulding and casting articles in metal, as described.

2. The system or mode of moulding and casting articles in metal by means of the machinery or apparatus, as described.

3. The system or mode of preparing moulds for casting, in which the patterns are attached to or form a part of the moulding plate, the said moulding plate having vertical and rotatory transversing movements, as described.

4. The mechanical arrangement by means of which the flanks or mould covers are secured to the moulding plate, and the means by which the moulding plate is held or retained in a horizontal position, whether in its natural position or inverted, together with the arrangement for elevating the moulding plate, as described.

5. The mode of securing a clear draw of the pattern from the sand in moulds, the sand cores for trenail or spike and other holes, by the use of loose weighted stud-pins for acting upon the moulded sand cores of such holes.

6. The mode of depositing the flasks containing the prepared moulds upon carriages successively brought under the moulding plate, by means of which the operations of moulding and casting may be continuously carried on, as described.

7. The mode of using and applying chill-plates to moulds prepared by the aid of machinery, as described.

8. The arrangement of the parts forming the carriage for supporting the pot or vessel for holding the molten metal, by means of which the metal-holder may be tilted on either side of the carriage or firmly held or retained in a vertical position as long as required.

9. The mode of applying and using a mechanical skimmer, for preventing scoriæ or other impurities from flowing into the mould with the molten metal, as described.

10. The system of lubricating the axles or journals of the wheels of the metal-holder carriage by means of a sponge saturated with oil, and kept in contact with the axle or journal, as described.

LIME AND CEMENT KILNS.

J. Lark, Vauxhall-cross, Surrey, *Patentee*, December 23, 1856.

This invention has for its object improvements in kilns for burning materials in the manufacture of lime and cements. The kiln is of a conical form, closed in at top, leaving openings at the upper part of the kiln for feeding in the materials to be burned; and at the bottom there are four openings for withdrawing the charge as it becomes burned and cooled down. The construction of the kiln, except in respect to the air-flues and passages (between the lining and outer brickwork), does not materially differ from kilns which have before been constructed. A lining of firebricks is employed at such a distance from the inside of the outer masonry as to admit of the space being formed into flues or passages for receiving atmospheric air, and such lining is bonded into the outer masonry at suitable intervals. The space between the lining and the outer masonry is divided horizontally, and there are air-passages at the bottom, by which atmospheric air may pass freely into the space between the lining and the outer masonry.

There are other passages by which the air as it becomes heated may pass out; and the same may by suitable flues or pipes be conducted in any direction, in order to be used for heating and drying purposes; and the speed at which such heated air is allowed to pass off may be regulated by a suitable valve or valves in the flues or pipes which are in connexion with the lower space, between the lining and the outer masonry of the kiln. The upper space between the lining and the outer masonry of the kiln has openings which may pass from the upper part of the kiln into the space between the lining and outer masonry, and so that the heated air and products above the materials which are being burned may pass into such space and downwards through the upper space; and there are other openings where the heated air can pass away from the upper space, and be conveyed by suitable pipes or flues, and be used for heating and drying purposes; and the speed at which such heated air shall pass out of the upper space may be regulated by suitable valves applied to the pipes or flues employed to carry off the heated air from the upper space; or openings may be formed through the lining and through the outer masonry, so that the products may pass out.

In addition to the spaces between the lining and the outer masonry of the kiln, there is constructed a central hollow shaft, with an external lining constructed in such manner as to leave a hollow space between the lining; and the external surfaces of the internal hollow shaft and passages are arranged to communicate with the outer atmosphere, in order that a constant flow of air may take place into and from the hollow shaft, and into and from the space between it and the lining around it, and from such central space into the space at the upper part of the kiln.

Claim.—The construction of kilns with air spaces, as described.

PHOTOGRAPHY APPLIED TO THE ORDNANCE SURVEY.

By Colonel James, R.E.

Her Majesty's government having decided that the manuscript plans of the cultivated districts of Great Britain should be drawn on the $\frac{1}{2500}$ scale, or the scale of 25·344 inches to a mile; and that these plans, as well as the plans of the large towns, should be reduced to the scale of 6 inches to a mile, upon which the uncultivated districts are drawn, so as to make the maps of every county complete on one uniform scale, and again reduced to the 1-inch scale for the general map; it became a matter of the highest importance to introduce the most expeditious and inexpensive mode of reducing the plans from the larger to the smaller scales.

I therefore had experiments made last year, whilst I was in Paris, to test the practicability of accurately reducing plans by photography, and having satisfied myself that it was perfectly practicable to do so, I had two of the sappers who were with me instructed in the art of photography, and we have since so perfectly succeeded in making all the reductions by this process, that we now seldom use any other method.

The advantages derived from the introduction of this method will be readily understood by those who are at all conversant with the tedious methods of reducing plans of towns by the pentagraph or the eidograph, or by proportional compasses, or squares, or any of the methods formerly employed; and it is no exaggeration to say that the reduction of a plan of a large town on the $\frac{1}{500}$ scale, may be and is now made by photography, first to the $\frac{1}{2500}$ scale, and from this to the 6-inch scale, at one hundredth of the cost at which we were previously able to do this work; and, what is scarcely less important, the reductions are made and copies printed so rapidly by this process, that no delay takes place in the publication of the same district on the different scales ordered,—a most important consideration, when it is borne in mind that the survey is now proceeding at a rate of 1,500,000 acres per annum, and that in the conduct of so large a work the rapid closing up and the final disposal of the work as it is produced is essentially necessary to success in the conduct of it.

As proof of the facilities which photography gives us in making the reductions, I may mention that during the last week one man, with the assistance of a printer and a labourer, reduced 32,000 acres from the 25-inch to the 6-inch scale, and that he produced three copies of 45 sheets, or 135 impressions, in six days, besides some other work. One hundred draughtsmen could not have produced so much work. It must not be understood that we give the photographed reduced drawings to the public; one copy is handed to the engravers, another to the officer who has to insert the contours, and so on; and by this arrangement everything connected with publication proceeds *pari passu.*

THE ROYAL SCOTTISH SOCIETY OF ARTS.

Method of Causeway-laying, with a Model of a Regulating Gauge to be used in preparing the Foundation for the Paving Stones. By T. D. Bryce, Edinburgh.—The advantages are stated to be economy and utility, and durability, and comfort of a quick-drying street after rain, and no splash; and to accelerate the passage of the rain water to his improved surface gutters. That this would greatly modify the much complained of friction and jolting caused to wheel carriages. The model of a regulating gauge to be used in preparing the foundation for street causeway is made of a light wood, 30 inches long and 1½ inch broad, upon a scale of 1½ inch to the foot, and has a number of shifting perpendicular slides along each side, made of wood, and shod with zinc, and the number of inches marked upon each, to regulate to various depths and curves of street causeway, with attached thumb-screw nuts, to hold the slides in their required position. The one row of slides to be used for the ground foundation of the causeway, and the shifting slides upon the other side to regulate the surface form, or top of causeway, and would enable any roadmaker to make any new causeway of the exact form of any other street, and it would show the amount of difference of formation of the various streets; and, when applied by any workman, along with the author's new invented street parallel levels, would make the causeway of one uniform shape, with the greatest facility and unerring certainty, and a more enduring foundation than the usual present mode of street causewaying.

Improvement in the Construction of Condensers for Marine and other Steam Engines. By W. Cuthill, Glasgow.—It is proposed to have the steam condensed by means of a series of tubes traversing the condenser, which may be joined into one or more, fore and aft of the engine, and continued in both directions diagonally, through the ship's side, so that when the vessel moves forward the water will rush in at the fore pipe, through the tubes in the condenser, and exit by the aft pipe, and *vice versa* when the vessel moves backwards. Thus a constant flow of cold water will be kept up whenever the engines are wrought, which will keep the tubes always cool. This arrangement would in a great degree do away with the air pump, which absorbs so large a quantity of the power of the engine; and in consequence of no injection water being used, the boiler would always be supplied with fresh water, which would prevent the incrustation which, in sea-going vessels, is both injurious to the boilers and occasions a loss of fuel, in consequence of its being a bad conductor of heat.

Combined Pumps to raise Water without Clacks. By R. and W. Moore, Glasgow.—The pumps are so arranged that the water pumped by the first passes through the second to the surface. In like manner, the water for supplying the second passes through the first. The buckets are connected to bell cranks, and the one ascends while the other descends. When the first bucket makes its ascent, the water lifted by it passes through the lids of the second to the surface; again, when the second bucket makes its ascent, the water for supplying it passes through the lids of the first, and the water is thus kept in a continuous flow.

Refraction Protractor, and its application to the Designing of the Prisms employed in Lighthouse Apparatus. By J. M. Balfour.—The refraction protractor, which is founded on a proposition in Dr. Young's "Lectures on Natural Philosophy," is a very simple instrument for protracting at once the path of a ray of light after refraction at the surface of any transparent substance. It consists, in its simplest form, of an ordinary ruler, graduated in a peculiar manner. For more complex operations other rulers and guides are added; and by combining several of these instruments, the path of a ray of light through a refracting substance of any form may be traced, or the form of a prism determined, capable of acting in any required manner. The apparatus is peculiarly adapted to designing the prisms employed in lighthouse apparatus, a set of twenty-four prisms having been laid down by it in three or four days, which, if determined as they have hitherto been, could not have been calculated in less than a month.

Timber Boring Machine. By D. Ross, Helmsdale.—The auger is fixed to the end of a guide screw bar, working in a female screw, so as to force the auger into the wood to be bored. The screw bar forms the axle, on which there is a fly wheel of five feet diameter, worked by two men, and the carpenter sets the machine to the proper place, so as to bore in the proper direction. For smaller work he proposes a smaller wheel, to be driven by the fly wheel, the auger or bit being fixed to the end of the screw bar, which is on the axle of the smaller wheel. He estimates that two labourers and one carpenter will thereby be able to do the work of fifty carpenters.—Mr. Sang made some remarks tending to show that more time would be lost in the application and adjustment of such a machine to the boring of trenail holes in ships than in boring by the usual method, and that such a machine would require to be stationary, and the work brought to it, in place of it being moved to the work. He gave, as an instance, Mr. Fairbairn's rivetting machine, a most useful one; but then the boiler to be rivetted was swung in such a manner as that any part to be rivetted could be brought exactly opposite to the rivetting machine. This could not be done with a ship on the stocks.

Plan of Working Collieries, by which Explosions are impossible. By R. AYTOUN, V.P.—The author remarked that the common method of working a seam of coal is to sink a shaft upon the lowest level, to work all the coal in its neighbourhood, and when that is exhausted, to work the coal immediately above it, and so on till the highest level is reached, and the coal exhausted. In doing so, the workmen are constantly leaving behind them more and more of the old workings, or waste, as they are called, from which the coal has been extracted. This waste is the fertile source of explosions in all fiery collieries, for the void left by the coal becomes gradually filled with inflammable gas, from whence, by various accidents, it is diverted into the air courses, and, mingling with atmospheric air, soon reaches the explosive state. The plan proposed by Mr. Aytoun is to let the waters of the mine rise up gradually, follow the work as it proceeds, and take possession of the void made by the extraction of the coal. The waste being thus filled with water, can harbour no gas; but the gas, as it is generated from the coal, will at once enter the air courses, and in a few minutes be discharged into the open air. In order to accomplish this, we must give up the old practice of sinking the shaft down to the lowest level of the coal; for as this is to be filled with water as the work proceeds, the bottom of the shaft would be filled with water too, and the means of raising the coal and circulating air would be taken away. The shaft must therefore be sunk upon the highest level of the coal, and after cutting through the coal the sinking must be carried as low as the lowest level. A cross-cut mine is run from the bottom of the shaft to the lowest level of the coal, by which its waters can be all drained into the shaft, and raised to the surface by a steam-engine. From the point where the shaft intersects the seam, level drifts are driven in the coal right and left, to the boundaries till they reach the lowest level, along which a drift is also cut. A current is thus completed round the whole mine, which permits the atmospheric air, entering by the downcast division of the shaft, to course along its whole boundaries, and again emerge into the open air by the upcast division of the shaft, which is provided with a furnace or fan to assist the ventilation. The ventilation being now secured, the workmen proceed to take out coal, which they do from the lowest part of the field first, and working gradually upwards. The pumping is so regulated that the water is allowed to rise to within a short distance of the wall-face, so as to fill up the void occasioned by the extraction of the coal, and prevent the accumulation of gas in the waste. The rising of the water, which destroys that part of the air course which is now submerged, improves the circulation of air, inasmuch as it opens a shorter course for the air betwixt the wall-face and the surface of the water. Along the wall-face, also, there is a tramway, which is shifted forward as the work proceeds. The coals, as they are excavated, are taken along this tramway to the foot of the incline. In this plan of ventilation, besides getting rid of all accumulations of gas, there are other advantages; there are no stoppings, no buildings, no doors to regulate the air courses. In fact, from the hour of commencing the working of the coal to the desertion of the colliery, not the slightest attention need be given to the ventilation, with the exception of the furnace and brattice in the shaft.

Rooms of Refuge in Mines, to which Survivors of an Explosion may fly from the approach of the After-Damp. By R. AYTOUN, V.P.—Mr. Aytoun stated that rooms of refuge, where miners might shelter themselves from the after-damp following the explosion, had been proposed before; but had never been carried into effect, owing, it is believed, to the circumstance that no provision was made for the renewal of air in these rooms, after it had become deteriorated by the breathing of those who had sought shelter in them. To remedy this, Mr. Aytoun proposes to supply these rooms with fresh air from the surface, by means of an air-pump, driven by the steam-engine, and connected with a pipe laid along the whole course of the workings, from which branch-pipes lead into the different rooms of refuge. The main-pipe need not exceed 3 inches in diameter, and should be made of wrought iron. It should be conducted along the principal roads, and should lie on the pavement, along the side of the road, out of the reach of wagons and horses' feet. In this position it will be free from most accidents; but in order to prevent, as far as possible, all injury to the pipe, especially from falls of the roof, it is further proposed to protect it with timber throughout its entire course. In this way rooms of refuge may be provided with fresh air after an explosion, and be the means of saving many lives. The moment an explosion takes place the engineer will set the air-pump in gear, and pour down a stream of pure air throughout the whole extent of the workings. At the same moment, underground, the survivors of the explosion, no longer panic-stricken and helpless as heretofore, but full of hope and determination to save their lives if possible, will make for the nearest room of refuge, where they know they will be provided with a sufficiency of air to subsist until their friends at the surface shall have re-established the air-courses and come to their assistance. Nor is there much danger of their retreat to the rooms of refuge being cut off by the after-damp. The explosion, which produced that deleterious gas, has at the same time destroyed all the doors, stoppings, and other arrangements for carrying on the circulation of the air. There is, and must therefore be, a perfect calm in the workings. The after-damp, which originally was limited to the spot where the explosion took place, can only extend itself to other parts of the mine by the slow process of diffusion. There will thus be abundance of time to reach one of the rooms of refuge. These, consequently, may be placed at considerable distances from each other, which will have the double effect of reducing the number of rooms of refuge which require to be maintained in a state of efficiency, and of increasing the supply of fresh air which each of them is to receive.

THE GERRIANT SLATE COMPANY (LIMITED).

A COMPANY under the above name is formed for the purpose of working the valuable slate quarries on the farms of Gerriant and Berthllyd, extending over a surface of upwards of 300 acres, situate in the parish of Beddgelert, in Merionethshire, about 8 miles from the shipping port of Portmadoc. The vein lies directly in the run of the celebrated Ffestiniog range, and at a short distance to the eastward are the quarries so extensively worked by Lord Palmerston, Lord Powlett, and others. The slate is of a dark blue colour, free from spots or other blemish; of a fine grain, straight and even cleavage, very strong and light, and equal in all respects to the best Welsh slates. The vein is upwards of three-quarters of a mile in length, upwards of 150 yards in breadth; and from the circumstance of its running along the undulating side of a steep hill, several quarries may, if desired, be opened and worked at the same time, without interfering with each other. A railway is in course of construction from Portmadoc to certain quarries in the neighbourhood of Gerriant.

The capital is fixed at 12,000*l.* in 6000 shares of 2*l.* each; and this sum is considered to be amply sufficient for all the requirements of the undertaking. A deposit of one-fifth or 8*s.* per share is calculated to be enough to effect the primary object of making the property a paying investment; and the remainder of the capital will be raised in calls of 8*s.* at intervals of not less than four months.

NOTES OF THE MONTH.

THE bills for the construction of a new street from the end of King-street, Covent Garden, in a diagonal direction to the junction of Cranbourn-street, Long-acre, with St. Martin's-lane and Great Newport-street, as well as that for the extension of Upper Stamford-street from its intersection with the Blackfriars-road to High-street, in the borough of Southwark, adjacent to the Town Hall, have passed through both Houses of Parliament.

THE re-building of Covent Garden Theatre has commenced. Mr. Edward Barry, second son of Sir C. Barry, is the architect. Messrs. Lucas are the builders. The new building is expected to be completed at the opening of the season 1858. The style is Italian. On the south side, in continuation of the piazza, will be erected a conservatory.

THE select committee on the Chelsea New Bridge report their opinion that it is not desirable for the government to continue in possession of such a property as a toll-paying bridge, and they recommend that a bill be introduced to enable the government to dispose of the Chelsea bridge on such terms as the Treasury may determine, having due regard to the increased value of government property, if the bridge should be made wholly or partially toll free.

THE corporation of the city of London have laid certain plans before government, for the purpose of establishing a dead meat market on a portion of the area lately occupied by Smithfield market. The government have not assented to the plans, and they have been referred back, in order that other plans may be prepared.

THE People's Park, at Halifax, the gift of Mr. F. Crossley, M.P., was inaugurated on the 14th ult. It is situated on the western side of the borough. It has four entrances, and the whole is surrounded by palisades. The promenade is reached by means of flights of stone steps. In the centre of the terrace is a semicircle of steps, nine in number, and 27 feet in width. At the top of these steps a stone building is erected, 30 feet high, with arches in front, borne on pillars of stone. On each side of the building will be small fountains, and Grecian vases on pedestals. In different parts of the terrace are productions of marble statuary, of life size, eight in number, the work of Italian artists. Below the terrace is a stone basin, four feet in depth, and 216 feet in circumference, with a fountain in the centre. Lower down is a little lake, with a serpentine walk about it, and bridges over it—one formed out of rocks. At the south or south-east side of the grounds baths are to be erected by the corporation. The external part of the building is to be elaborately decorated. The park grounds, which are laid out with trees, shrubs, and plants, comprise about 12½ acres.

THE tenth annual meeting of the Builders' Benevolent Institution was held on the 30th July, Mr. Alderman Lawrence in the chair. Mr. Alderman Rose was elected president for the ensuing year.

THE Conservative Land Society have submitted to the Chief Commissioner of Woods and Forests a plan for the erection of a foot bridge across the Thames at Richmond, in connection with the railway bridge. Mr. George Morgan, their surveyor, proposes an outrigger to the railway bridge, with light spiral staircases on each shore.

EDINBURGH CASTLE is at present undergoing an initiatory overhauling, preparatory to considerable changes that are contemplated in the interior. Mr Billings furnished Government previous to the Crimean war with designs for the erection, on the site of the Mons Meg Battery, of a garrison church. These plans were so favourably thought of that preparations had even been made for carrying them out. The old garrison chapel was levelled with the ground, estimates for the new erection were taken, and a considerable quantity of the stone and wood to be used in its construction had been provided, when the outbreak of the Crimean war effectually stopped all further progress. Workmen, however, are again busily engaged at this spot. The old guardhouse beneath the battery has been taken down, and the face of the rock on which it rests has already been scarped to a considerable extent, so as to admit of a wall being carried up in its front. Government appear to have changed their mind on the subject, and what is now in contemplation is the erection of an extensive armoury on the ground that had been chalked out for the church. The plans, which are by Colonel Moodie, R.E., have been approved. The building is to form three sides of a square, and includes in its sweep the ancient chapel of Queen Margaret, which is to be retained in its integrity. Mons Meg herself has been removed from the front of the platform which she has occupied for the last 20 years, and at present lies carriageless on the rock near the old chapel. In attempting to back the carriage from the edge of the platform the wheels, which had suffered from rust and exposure, gave way, and the huge gun has had to be dismantled. Another set of wheels are being cast, and as there is an intention of erecting a new battery immediately to the east of her present quarters, and on nearly as high an elevation, this interesting relic of our national history, will by-and-by occupy a position as honourable as that of which she has been deprived. The present armoury, after the completion of the contemplated structure, is to be converted into a hospital. A church for the garrison has been designed by Colonel Moodie. The spot on which it is intended to stand is at present occupied by the north wing of the Castle-square, which will require to come down to make way for the new erection.

A NOVEL application of the steam jet, for the purpose of ventilating a coal mine, has been made by Mr. F. H. Pearce, of the Bowling Ironworks, near Bradford. The application is at present in operation in a pumping shaft, 120 yards in depth, the ventilation of which had been stopped by the water rising at the bottom of the pit during the time some alterations were being made in the pumps. The water having stopped the air-courses, the pit, to within a few yards of the top, became full of the gas known as black or choke damp, which appears to have been discharged freely from some old workings, and thus it was rendered an impossibility for the workmen to descend until the removal of the gas had been effected, and a constant current of pure air produced in the pit. Mr. Pearce has succeeded in maintaining so perfect a ventilation of the above mentioned pit, simply by allowing a small jet of steam to issue into the atmosphere at a few feet from the top of the pipes through which the water is forced up when the pumps are at work, that the pit can be worked with perfect safety; the workmen were enabled to descend 30 minutes after the steam had been turned into the pipes. The principle is exceedingly simple: the jet of steam issuing from the top of the pipes produces in them a partial vacuum, which draws the foul air up these pipes, and thence out of the pit with very great velocity. The cost of applying the steam jet in the above manner is very trifling; and this method of ventilation will doubtless be found a very safe and useful one in many instances, particularly in sinking deep shafts. In addition to other advantages, wood or any other kind of pipes may be used. It requires little or no attention, no machinery to get out of repair, produces a powerful current of air, and can be regulated at pleasure. As the steam is discharged into the atmosphere above the top of the pit, it does not interfere with the men working in the shaft.

CAPT. MANSELL, at the request of the Egyptian Viceroy, is at present engaged in a general survey of the coasts of the Red Sea, to the distance of some miles on either side of Suez. The departure of the commission appointed to select a spot in the vicinity of Suez for the erection of a slip has again been deferred until Captain Mansell's operations are sufficiently advanced to assist them in coming to a decision. It is believed that, owing to the shallowness of the water, no suitable spot will be found within twenty miles of the town.

THE opening of the Caen Canal took place on the 22nd ult. The canal shortens the distance to the sea upwards of three miles, as instead of 18 kilometres (11¼ miles) it is only 13 (not 8 miles). In addition, vessels of larger size, which hitherto could only ascend to the town at the very highest tides, can now come up at any season, the lowest depth of water being 12 feet. A port of refuge has also been established at Ouistreham, where in stormy weather vessels of from 500 to 600 tons can find shelter. The canal was opened by tolerance on the 20th of June, and its advantages became apparent. In the course of 40 days 162 vessels, of 13,500 tons, ascended the canal, which would give for the year at the very lowest from 130,000 to 135,000 tons. The freight for Caen, which was very considerable, has sensibly diminished.

OBITUARY.

On the 15th ult., Mr. Francis Edwards, of Hart-street, Bloomsbury, architect, aged 73.

On the 26th ult., at Staines, Mr. Thomas Uwins, R.A., surveyor of pictures to the Queen, in his 75th year.

COMPETITIONS.

The Directors and Committee of the Ulster Banking Company are desirous of receiving Designs for the elevations, &c. of a new Bank-house in Belfast. A plan of the block, and other information can be had on application to the secretary. Premium 100*l*. Designs to be sent in by the 7th instant.

The Newport Burial Board are desirous of procuring designs and estimates for the erection of two Chapels, Lodge Gateway, and for laying out the ground. The whole cost of the building, and laying out not to exceed 1,500*l*. Particulars can be procured by application to the clerk of the board. Premium 25*l*. Designs to be sent in by the 8th instant to John G. Clarke, clerk to the board.

The Cambridge Music Hall and Public Rooms Company is desirous of procuring Designs for the erection of buildings to be used for a music hall, rooms for various public purposes, and public baths and washhouses. Outlay not to exceed 7000*l*. Premium 50*l*., will be given if not employed to carry out the works. A sketch of the site and further particulars may be obtained of Messrs. Reed and Foster, solicitors, Cambridge. Designs to be sent in by the 26th instant.

Designs are invited for Bathing-places at the Eleven Foot, in Midsummer Meadow, Northampton, and at the lower corner of Balmsholme. Premium 10*l*. Information can be obtained of the town clerk. Designs to be sent in by October 1.

The Vestry of St. Mary's, Islington, wish to receive designs for the erection of a new Vestry Hall in that parish. Premiums 50*l*. and 20*l*. The building to be completed for a sum not exceeding 5500*l*. Building not to be in the Gothic style. Plan of the ground and particulars may be obtained at the vestry offices, 21, Milner-square, Islington. Designs to be sent in by October 3.

The municipal authorities of Bourdeaux have invited artists of all countries to submit designs for a Fountain of monumental character to be erected in that city. The choice of material is left open, and may be of several kinds; the cost is not to exceed 8000*l*. A premium of 240*l*. will be awarded, if a design of sufficient merit to justify it be presented. In addition, the sum of 160*l*. will be placed at the disposal of the jury, and be appropriated as they may decide. In the event of the execution of the selected design being confided to the author of it, he is to receive, independently of the selected design, an honorarium equal to the twentieth of the whole outlay. The designs are to be sent in by the 20th of November next.

The Corporation of Halifax invite designs for Public Baths to be erected there. Premium 50 guineas. Particulars may be had upon application to Mr. G. W. Stevenson, the borough engineer.

Drawings or models of designs are invited for the erection of a Memorial of the Great Exhibition of 1851. Premium 100 guineas. The time for sending in designs is extended to February 2, 1858. A scale of 2 inches to the foot is suggested, but not insisted on.

COMPETITIONS AWARDED.

For the Brotherton Memorial, the drawing No. 1, motto "Hyperion" (author, T. Holmes, architect, Manchester), has been selected, provided it can be erected and completed in a satisfactory manner for the sum specified in the conditions. The prize of 20 guineas has been awarded to the model No 65, motto "Beta" (author, Mr. Noble, sculptor, London). Special commendation has been expressed in favour of the following, viz. :—Model No. 17, motto "His were deeds, not words;" drawing No. 41, motto "For men to seek their own glory is not glory;" drawing No. 51, motto "Nemo;" and model No. 60, motto "C." The memorial is to be erected in the Salford Borough Cemetery.

The Judges appointed to examine the Models for the Wellington Monument have given their decision. The following are the names and addresses of the successful competitors, with the premiums awarded :—

First Premium, 700*l*.—No. 80.—W. Calder Marshall, R.A., 47, Ebury-street, Eaton-square

Second Premium, 500*l*.—No. 56.—W. F. Woodington, 22, Richard's-terrace, Lorrimore-road, Walworth

Third Premium, 300*l*.—No. 36.—Edgar G. Papworth, 90, Milton-street, Dorset-square

Fourth Premium, 200*l*.—No. 10.—Cav. Giovanni Duprè, Florence

Five Premiums of 100*l*. each.—

No. 12.—Mariani Folcini and Ulisse Cambi, Florence

No. 18.—Alfred Stevens, 7, Canning-place, Kensington

No. 20.—Mathew Noble, 13, Bruton-street, Berkeley-square

No. 21.—Ernestus Julies Hänuel, Dresden

No. 63.—Thomas Thorneycroft, 39, Stanhope-street

The plans of Mr. Edward Holmes of Birmingham, have been selected for the Foleshill New Union Workhouse, for which 47 designs were sent in. Also for the West Bromwich New Cemetery, for which 21 designs were submitted. Mr. Edward Holmes' designs were also chosen for the Medway New Union Workhouse.

Mr. H. Cooper's designs have been accepted by the Trustees of the Walsall Blue Coat and National Schools, Walsall.

The Bath and West of England Agricultural Society, at their Taunton meeting, awarded a premium of 10*l*. to Mr. T. W. P. Isaac, for his essay "On Roofing for Farm Buildings."

NEW PATENTS.

PROVISIONAL PROTECTIONS GRANTED UNDER THE PATENT LAWS AMENDMENT ACT.

Dated May 11.

1328. C. Hall, Knavestock, and T. Charlton, Brentwood, Essex — Improvements in agricultural engines and implements used therewith for ploughing and cultivating the soil

Dated May 22.

1442. B. Samuelson, Braffords House, near Brough, Yorkshire—Improvements in safety apparatus for giving artificial light

Dated May 29.

1522. P. A. le Comte de Fontainemoreau, London—Improvements in the construction of smoke-consuming furnaces, applicable to boilers. (Communication)

Dated June 10.

1622. F. Koehler, Finsbury-place—Improvements in gunpowder

Dated June 11.

1642. J. M. Paule, Alston, Cumberland—Improved means for ventilating coal and other mines

Dated June 15.

1675. W. Young, Queen-street, Cheapside—Improvements in lamps and burners

Dated June 16.

1676. C. B. Ochin, Paris—Improved metallic roofing slates

1682. J. Fowler, jun., Cornhill, and W. Worby, Ipswich—Improvements in ploughing or tilling land

Dated June 17.

1694. J. H. Whitehead, Southside, Saddleworth, Yorkshire—Improvements in pressing cloth

Dated June 18.

1706. J. E. Barton, Kidderminster—Improvements in winding worsted on to creel bobbins of carpet looms

Dated June 19.

1710. S. T. M. Sorel, Paris—New chemical compositions, producing either house paintings, cement, or plastic paste to be moulded

Dated June 20.

1728. B. Richardson, Wordsley Flint Glass Works, near Stourbridge—Improvements in manufacturing and ornamenting articles of flint glass

Dated June 22.

1744. C. D. Seropyan, New Haven, Connecticut, United States—A mode of preparing bank notes, bills of exchange, and other papers, to prevent counterfeiting, by photography and its kindred processes

Dated June 23.

1748. W. Symons, Dunster, Somersetshire—Improved means of communication between the passengers and guards of railway trains

Dated June 24.

1758. H. H. Fulton, and T. B. Etty, Great Queen-street, Westminster—Increasing the traction and bearing surface of carriage wheels

1764. G. Ireland, Birmingham—Improvements in raising weights, applicable to stamping or cutting metals and other similar purposes

Dated June 25.

1779. W. Green, Ebury-street, Pimlico—The letter announcer

1784. J. Arthington and H. Smith, Huddersfield—Improvements for the better illumination of the Davy lamp

Dated June 26.

1792. H. Glover, Lambeth—Improvement in pump buckets

Dated June 30.

1828. J. Alsop and E. Fairburn, Mirfield, Yorkshire—Improvements in machinery for the manufacture of bread, biscuits, and cakes

Dated July 1.

1836. G. Murray, Glasgow—Improvements in machinery or apparatus for propelling ships and vessels

Dated July 2.

1852. J. B. Meeus, Arlon, Belgium—Improved method of multiplying motive power, and transmitting it to a shaft or other mechanism

Dated July 3.

1854. M. Clark, Alexandria, Dumbartonshire—Improvements in the preparation of cloth for Turkey red dyeing

1856. C. Topham, Hoxton—Improved apparatus for raising and forcing liquids

1858. J. Fordred, Stoke Newington, Middlesex—Improvements in treating and purifying water

1860. J. E. Gardner, Strand—Improvements in illuminated clocks, and in the apparatus employed for lighting the same

1862. J. Agar and W. Agar, Bury, Lancashire—Improvements in watches and keys for the same

Dated July 4.

1864. R. Gibson, J. Gascoigne, and S. Gibson, Hunslet, Yorkshire—Improvements in boilers for generating steam

1866. M. Henry, Fleet-street—Improved machine for cleaning and crushing grain. (Communication from Messrs. O. Dugué)

1868. J. Grantham and H. Sharp, Liverpool—Improvements in working the valves of steam-engines

1870. J. Smith, Bradford—Improvements in flour-dressing machines

Dated July 6.

1872. W. Munt, Charterhouse-lane, Smithfield—A shank to be attached to all descriptions of buttons, to be called an eylot shank

Dated July 7.

1874. C. Faulkner and D. Faulkner, Birmingham—Improvements in gun and pistol barrels, and in cannons, and in furnaces for the same

1876. W. Dawes, Wellington, Shropshire—Improvements in the pistons of steam-engines

1878. R. J. Badge, Newton Heath, near Manchester—Improvements in railway chairs

1880. F. Bousfield, Hereford-terrace, De Beauvoir-town—Improvements in the manufacture of soap

1882. P. A. le Comte de Fontainemoreau, South-street, Finsbury—Improvements in apparatus for the manufacture of boots and shoes, which apparatus is also applicable for uniting other articles together. (Communication)

1884. P. H. G. Bérard, Paris—Improvements in manufacturing and applying concentrated collodion

1886. W. Smith, Kettering, Northamptonshire—Improvements in horse hoes and drills

1888. R. A. Brooman, Fleet-street—Improvements in vices. (Communication from M. Neuillies)

1890. R. A. Brooman, Fleet-street—Improvements in connecting carriages and wagons on railways. (Communication from M. Mouret)

Dated July 8.

1892. W. E. Jones, Glades-spring, Virginia, United States—Improvement in trees of riding saddles

1894. G. Green, Whitehorse-lane, Mile-end-road—Improvements in machinery for the manufacture of casks, barrels, and other similar articles

1896. J. J. H. Brianchon, Paris—Improvements in colouring and ornamenting glass, porcelain, earthenware, and other ceramic substances

1898. H. N. Nissen, Mark-lane—Improved method of making impressions similar to water-marks upon paper

1900. L. A. Bahn, Greek-street—Improvements in the manufacture and application of certain metallic alloys

1902. N. M. Cummings, Annmount, county Cork—Improved means for indicating the proximity of icebergs. (Communication from Lieut.-Col. J. S. Cummins, Robinson, near Montreal, Canada East)

Dated July 9.

1904. A. Dobson, Belfast—Improvements in machinery or apparatus to be used in bleaching, washing, starching, airing, and finishing fabrics, and in sizing yarns

1906. J. H. Swann, Glasgow—Improved machinery and steam-engine for crushing quartz and other hard substances, and for amalgamating

1908. J. J. C. de Clerville, Newman-street—Improvements in the manufacture of oil-cloth and imitation leather. (Communication from F. Abate, Paris)

1910. R. A. Brooman, Fleet-street—Improvement in propelling ships, boats, and other vessels. (Communication)

1912. W. Mann, City of London Gas Works—Improved arrangement of steam boiler gauge cocks, and registering apparatus connected therewith

1914. T. Lewis and H. Parish, Birmingham, and R. M. Roberts, Dolgelly, Merionethshire—Improvements in the separation and extraction of copper from its ores

Dated July 10.

1916. E. Eastwood, Burnley—Improvements in picker bands for looms

1918. T. Vicars, sen., T. Vicars, jun., T. Ashmore, and J. Smith, Liverpool—Improvements in the manufacture of bread, biscuits, and like articles, and in the machinery connected therewith

1920. D. Hope, Bishop Auckland—Improved method of preventing one train from running into another on railways

1922. R. A. Brooman, Fleet-street—Invention of and apparatuses for scouring or extracting oil and grease from wools and woollen fabrics, and for extracting gum and gummy matter from silk. (Communication)

1924. W. E. Newton, Chancery-lane—Improvements in the construction of furnaces and steam-boilers. (Communication from L. I. Molinos and C. Pronnier, Paris)

1926. W. Smith, Little Woolstone, near Fenny Stratford, Buckinghamshire—Improvements in steam-engines for giving motion to agricultural implements

1928. G. Dyson and T. Harrison, Tudhoe Iron Works, near Ferry Hill, Durham—Improvements in steam-engines

1930. J. Chanter and D. Annan, Bow—Improvements in furnaces when moveable bars are used

Dated July 11.

1932. W. J. T. Smith, and F. Talbot, Birmingham—Improvement or improvements in hair-pins

1934. J. Loach, J. J. Salt and B. Day, Birmingham—Improvements in metallic air-tight coffins, as also in the mode of covering, finishing, and ornamenting such like coffins

1936. P. A. le Comte de Fontainemoreau, South-street, Finsbury—Improved shoe and boot scraper or cleaner. (Communication)

1937. B. Denizot and C. Flippe, South-street, Finsbury—Improvement in the construction of railway breaks

Dated July 13.

1940. M. McKay and H. F. Osman, Essex-street, Strand—Improvements in apparatus for securing the points of railway switches

1942. J. L. Hinks, and J. R. Day, Birmingham—Improvements in locks and latches, and in attaching lock and latch knobs to spindles

1944. P. R. Smith, New York, United States—Improvements in fire-arms and ordnance

1946. W. E. Newton, Chancery-lane—Improved machinery for converting old rope or cordage into tow. (Communication from Goulley and Co., Honfleur)

1948. W. E. Newton, Chancery-lane—Improved construction of portable railway for steam traction engines on common roads or land. (Communication)

Dated July 14.

1950. S. Nye, Wardour-street—Improvements in chaff-cutting machines

1952. W. Wyatt, Bury St. Edmunds—Improvements in hay-making machines

1954. H. Hebblethwaite, W. Shuttleworth, and W. Tasker, Halifax—Improvements in preparing yarns for, and in machinery or apparatus employed in printing yarns for, carpets or other similar fabrics

1955. J. Webster, Birmingham—Improvements in safety valves

1956. W. S. Clark, High Holborn—Improvements in machines for harvesting grain and grass crops, and in the automatic delivery thereof. (Communication from A. H. Caryl, Sandusky, Ohio)

1957. J. Kingsley, Bedford-square—Obtaining or applying a primary motive power, namely, the water of a river, which causes a vacuum in an exhausting receiver, which may be transferred by tubes to other machines, causing water and ores to be raised from mines, likewise causing the steam engine to be superseded, water being cheaper than coals

1958. H. Smith and F. M. Smith, Porchester-square—Improvement in fire-arms

1959. G. P. Harding, Jewin-street—Improvements in the manufacture of hats, caps, and other coverings for the head
1960. T. Ashton, Abbey Mills, Morpeth, Northumberland—Improvement in teasing, scribbling, carding, and combing engines
1961. T. M. Smith, Hammersmith—Improvements in the preparation of materials applicable to the manufacture of candles
1962. W. H. Gauntlet, Middlesboro'-on-Tees—Improvements in thermometric apparatus

Dated July 15.

1963. F. Moulin, Lyons—Improved railway break
1964. W. J. Locke, Edgeley, Cheshire—Constructing an improved oil-can
1965. J. H. Quick, Pimlico—An improved hat
1966. E. Bertin, Aldgate—A new manufacture of fibre, suitable for the purposes to which hemp and flax are usually applied
1967. R. A. Brooman, Fleet-street—Improvements in the manufacture of hats, bonnets, and other coverings for the head. (Communication from M. Laporte)
1968. G. Walker and J. Clachan, Glasgow—Improvements in looms for weaving
1969. J. H. Johnson, Lincoln's-inn-fields—Improvements in machinery or apparatus for marking or imprinting characters on paper and other fabrics (Communication from S. W. Francis, New York, United States of America)
1970. H. Blandford, Sandridge Bromham, near Chippenham—Improved combination of apparatus for distributing manure
1971. J. H. Johnson, Lincoln's-inn-fields—Improvements in sewing machines. (Communication from J. E. A. Gibbs, Virginia, United States of America)

Dated July 16

1972. W. Jones, Pendleton, near Manchester—Improvements in moulding for casting metals
1973. J. Wright, Alfred-place, Newington-causeway—Improvements in the manufacture of gas
1974. J. Cox, Georgie Mills, Edinburgh—Improvements in apparatuses to enable persons to progress in swimming
1975. W. A. Gilbee, South-street, Finsbury—Improvements in the treatment of fatty matters for the manufacture of candles and night lights. (Communication)
1976. G. Defis, South-street, Finsbury—Improvements in preventing incrustation in boilers
1977. G. S. Matthews, Wardour-street—Improvements in railway breaks

Dated July 17.

1978. C. F. Vasserot, Essex-street—An apparatus for measuring and registering the flow of liquids. (Communication from F. F. Benvenuti, Paris)
1979. J. Avery, Essex-street, Strand—Improvements in steam-engines. (Communication from T. Maskell, Franklin, Louisiana, United States of America)
1981. J. Russell, Woodlands-road, Blackheath, H. W. Spratt, Granville-park, Lewisham, and W. Press, Stepney-causeway—Improvements in the construction, application, and use of machinery for propelling boats, ships, or vessels of any class or denomination
1982. W. Barwell, Birmingham—Improvements in casting metals
1983. T. F. Griffiths, Birmingham—Improvements in shaping metals
1984. J. H. Johnson, Lincoln's-inn-fields—Improvements in steam-boilers. (Communication)
1985. T. Clunes and J. Mackintosh, Aberdeen—Improvements in machinery or apparatus for bottling or supplying vessels with fluids
1986. A. Upward, Duncan-terrace, Islington—Improvement in the manufacture of coke
1987. S. Ramsden, Hunslet, Yorkshire—Improvements in the construction and fixing of window sashes
1988. T. Roberts and J. Dale, Manchester—Improvements in obtaining pigments from dye-woods, and in the application of a pigment to printing paper-hangings

Dated July 18.

1989. A. D. Lacy, Knayton, Yorkshire, and W. C. Homersham, Adelphi-terrace—Improvements in machinery for ploughing and cultivating land by steam or other suitable motive power
1990. J. Austin, Milliale Mills, Donaghadee, Ireland—Improvements in machinery or apparatus for ploughing or cultivating land
1991. W. Cliff, St. Martin's-le-grand—A new system of applying the air from the bellows and other means to the forge. (Communication)
1992. G. J. Wainbright and C. T. Bradbury, Dukinfield, Cheshire—Improvements in apparatus for diminishing the amount of waste in the use of cops for manufacturing purposes
1993. W. E. Newton, Chancery-lane—Improved machinery for cutting metals or other hard substances. (Communication)
1994. W. E. Newton, Chancery-lane—Improved construction of combined steam-boiler and radiator for warming apartments or buildings. (Communication)

Dated July 20.

1996. R. Bolton, Blackburn—Improved mode of weighting the yarn-beam in looms used in the manufacture of cloth by steam power
1997. G. J. Newberry, Straitsmouth, Greenwich—Improvements in window blinds
1998. F. H. Holmes, Blackwall—Improvements in magneto-electric and electro-magnetic machines
1999. H. Smith, Porchester-square—Improved agricultural implement for pulverising and cleansing land
2000. R. A. Brooman, Fleet-street—Improvements in the manufacture of pipes and tubes. (Communication)
2001. T. Restell, New Kent-road—Improvements in breech-loading fire-arms, and in fastening the barrels of fire-arms to their stocks
2002. W. E. Newton, Chancery-lane—Improved machinery for feeding flour and mixing and kneading dough for the making of bread and biscuits. (Communication)
2003. W. E. Newton, Chancery-lane—Improvements in reaping and mowing machines. (Communication)
2004. R. J. Mary'on, Hooper-street, Westminster-road—Improvements in the construction of propellers and in arrangements of engines for working the same for propulsion of ships or vessels
2005. H. V. Cowham, Skeffling, Yorkshire—Improvements in machinery for breaking or pulverising land
2006. J. Conway, Taibach, South Wales—Improvements in the production of copper rollers for printing calico and other fabrics
2007. S. Butler, Nottingham—Improvements in the manufacture of ornamental bobbin net, or twisted lace

Dated July 21.

2008. J. C. Arnall and G. Greenhow, Ferry-bridge, near Pontefract—Improvements in the manufacture of glass bottles and jars, and in the apparatus connected therewith
2009. G. Parsons, Martock, Somersetshire—Improvements in thrashing machines known as combined thrashing machines
2010. F. Warner, Jewin-crescent, Cripplegate—Improvements in ball and other cocks, and valves
2011. A. Scott, Charlotte-terrace, Copenhagen-street, Islington—Improvements in stops for gates and doors
2012. W. E. Newton, Chancery-lane—Improved machinery for manufacturing screws, or screw-caps, of sheet metal. (Communication)
2013. J. Mohr, Vienna—Improved machinery for propelling vessels

Dated July 22.

2014. W. G. Armstrong, Newcastle-upon-Tyne—Improvements in the mode of adjusting ordnance for fire by night or day
2015. J. Hall, Lancaster—Improvements in the mode of preventing incrustation in boilers
2016. A. V. Newton, Chancery-lane—Improved machinery for grinding and polishing stone, glass, and other materials. (Communication)
2017. J. Kirby, Bodicote, Oxon—Improvements in hay and other rakes
2018. H. Doulton, Lambeth—Improvements in the manufacture of earthernware drain and other pipes
2019. M. McKay, Hackney, and L. Rose, Holborn—Improvements in apparatus to be used in washing and scouring household linen and other textile fabrics

Dated July 23.

2020. J. King, Cannon-street—Improvements in the preparation of peat and peat coke or charcoal, and in machinery or apparatus for that purpose. (Communication)
2021. M. Clark, St. Mary Cray, Kent, and G. Bertram, Edinburgh—Improvements in machinery or apparatus for cutting paper
2022. W. Deakin and W. Phillips, Birmingham—Improvements in the manufacture of metallic pens and pen-holders
2025. W. Hudson, Burnley, and C. Catlow, Clitheroe, Lancashire—Improvements in looms for weaving
2026. E. Wilson, Worcester—Improved method of consuming smoke
2027. C. Norris, Halifax—Improvements in the manufacture of sulphate of alumina, and the application of the same so manufactured in dyeing, printing, paper making, and such like purposes.

Dated July 24.

2028. J. Needham, Piccadilly—Improvements in fountain pens
2029. J. Burrows, Wigan, Lancashire—Improvement in steam-engines

Dated July 25.

2031. J. Bennett, Pimlico—Improvements in boring-tools for wells, shafts, and like purposes
2033. J. S. Collins, Liverpool—Improvements in reefing and furling of ships' and other vessels' sails, and in the manufacture of the same
2034. J. Schönemann, Portland-street, Portland-place—Improvements in the construction of weighing machines. (Communication)
2035. F. Oetzmann and T. L. Plumb, Great Russell-street, Bloomsbury—Improvements in upright pianoforte actions

Dated July 27.

2036. J. Gedge, Wellington-street-south, Strand—Improvements in doubling machines. (Communication from G. Collé, Fouencamps, France)
2037. W. Williams, Dale, Pembrokeshire—Improved graving slips for the repairing of ships
2038. W. B. Williamson, Bradford, Yorkshire—Improvements in looms employed for weaving textile fabrics and fibrous materials
2039. J. W. Friend, Freemantle, Southampton—Improved meter for registering the flow of water and other liquids
2040. R. A. Brooman, Fleet-street—Improvements in motive-power engines. (Communication from P. and L. Larochette, Paris)
2041. N. Saintard, Paris—Improved break for railway and other carriages
2043. J. Ridsdale, Minories—Improvement in ships' scuttles
2045. B. Richardson, Wordsley, near Stourbridge—Improvement in the manufacture of articles in glass, so as to produce peculiar ornamental effects
2046. G. T. Bousfield, Loughborough-park, Brixton—Improvements in apparatus for retarding and stopping carriages on railways. (Communication)
2047. J. H. Bennett, Birmingham—Improvements in engines to be worked by atmospheric pressure or steam, or by both in combination, and also in steam generators to be used therewith
2048. P. Danvers, New York, and G. W. Billings, Plainfield, Union, New Jersey, United States of America—Improved means for rolling hoops and wheel tyres

Dated July 28.

2049. J. Higgin, Manchester—Improved method of drying garancine or other moist substances
2050. W. S. Clark, High Holborn—Improvements in automatic feeding printing press. (Communication from S. W. Wood and H. A. Bills, United States of America)
2051. E. Hallen, Cornwall-road, Lambeth—Improvements in the construction of bedsteads and similar articles to recline or sit on
2052. O. H. Smith, Thames Bank Distillery—Improvement in supplying steam to water to heat the same, and in preventing what is technically called priming of steam
2053. W. Hirst, Bath—Improvements in manufacturing felted fabrics
2054. G. T. Bousfield, Loughborough-park, Brixton—Improvements in apparatus for feeding water to steam-boilers. (Communication)
2055. P. Brunot, Paris—Improvements in springs for petticoats and other articles of dress
2056. R. Jackson, Glasgow—Improvements in protecting certain parts of the body from disfigurement by cutaneous diseases
2057. W. Proctor, Bristol—Improvements in the manufacture of sulphuric acid
2058. E. W. Baxter, Sydney-street, Mile-end—Improved mode of preparing glass labels, advertising tablets, and ornamental devices upon glass
2059. J. Dortet and A. B. Denis, Paris—Improved safety padlock
2061. T. Till and W. Gardiner, Birmingham—Improvements in preventing collisions on railways
2062. J. Clay, Birmingham—Improvements in saddles
2063. J. Bethell, Parliament-street—Improvements in the construction of ships and other vessels

Dated July 29.

2064. C. W. Siemens, John-street, Adelphi—Improvements in refrigerating and producing ice, and in apparatus or machinery for that purpose
2065. J. Bertwistle and D. Bertwistle, Padiham, Lancashire—Improvements in ventilating
2066. H. Kenyon, Manchester—Improvements in the treatment of certain compounds of silica, alumina, sodium, or potash, and the application of such compound in the processes of printing, dyeing, tawing, paper making, or in any other process in which the alumina of commerce is employed
2067. S L. Taylor, Cotton End, Bedfordshire—Improvements in steam-engines
2068. W. E. Jones, Birmingham—Improvements in the manufacture of iron plates, such as boiler plates, plates for ship building, and other similar purposes, and also in machinery for the manufacture of such plates
2069. W. G. Plunkett, Dublin—Improvements in the application of new materials to the manufacture of paper pulp and yarn for textile fabrics. cordage, &c.
2070. G. H. Cottam and H. R. Cottam, Old St. Pancras-road—Improvements in the manufacture of children's cots and metallic bedsteads
2071. J. Burnett, Newcastle-upon-Tyne—Improvements in the manufacture of chloride of lime, or bleaching powder

Dated July 30.

2072. W. S. Clark, High Holborn—Improvements in kegs for holding gunpowder and articles of a similar nature. (Communication from W. Green and W. Delaware, United States of America)
2073. J. Purcell, Mount-street, Whitechapel-road—Improvements in attaching or securing buttons to articles of clothing

2074. S. Coulson, Sheffield—Improvements in preparing solutions for coating with aluminium
2075. W. McKinley and R. Walker, Paisley—Improvement in the manufacture of moulds for forming the soles of boots and shoes
2076. T. Ivory, Edinburgh—Improvements in rotary and reciprocating engines
2077. J. Frearson, Birmingham — Improvements in feeding, cutting, shaping, and piercing metals
2078. H. Bauerrichter and G. Gottgetreu, Charterhouse-square—Improvements in the arrangement or adaptation of stereoscopic apparatus, and in boxes or cases for containing the same

Dated July 31.

2079. J. A. Limbert, Royal Navy—Improvements in marine engines
2080. E. Evans, Holywell, and G. P. Roskell, Stockyn, near Holywell, Flintshire—Improvements in reaping and mowing machines
2081. L. Cooke, Blackburn—Improvements in machinery or apparatus for preparing cotton, wool, or other fibrous substances to be spun
2082. H. B. Barlow, Manchester—Improvements in self-acting mules for spinning. (Communication)
2083. T. Forsyth, Manchester—Improvements in and applicable to slide valves for steam-engines. (Communication)
2085. A. Galy-Cazalat and A. Huillard, Paris—Improved apparatus for and mode of manufacturing sulphuret of carbon, animal charcoal, and carbonic acid
2086. T. Markland, Hyde, Cheshire—Improvements in power looms for weaving
2087. H. Genhart, Liege, Belgium—Improved apparatus for cleaning and sharpening knives, and cleaning spoons and forks
2088. W. Garnham, Bedford-terrace, Upper Manor-street, Chelsea—Improvements in pumping apparatus
2089. G. Inman, Susannah-street, Poplar — Improved construction of locomotive engine
2090. J. Beale, East Greenwich—Improved construction of rotary engine, applicable for pumping and measuring fluids, or for the production of motive power

Dated August 1.

2091. W. J. Harris, Greenwich—Improvements in the construction of dining and other tables
2092. C. Avril, Paris—Improvements in the mode of forming the printing surface of blocks, plates, cylinders, lithographic stones, or other similar bodies made use of for printing in colours
2093. R. Coleman, Chelmsford—Improvements in implements for ploughing, hoeing, and scarifying land, and in agricultural steam engines used for the traction of such implements
2094. G. F. Aroux, South-street, Finsbury—Improvements in seed drills
2095. J. Tatlow and H. Hodgkinson, Wirksworth, Derbyshire—Improvements in railway breaks and signals
2096. E. Maw, Doncaster Iron Works—Improvements in constructing railway crossings, points, and switches
2097. T. Rickett, Castle Foundry, Buckinghamshire—Improvements in implements for cultivating land
2098. W. Hopkinson, Huddersfield—Improvements in steam-engines
2099. A. J. M. Ramar, Broad-street, Golden square—Improvements in ornamental and portable fountains
2100. R. A. Brooman, Fleet-street—Improvements in circular sawing machines. (Communication from Messrs. Boccard and Cocqueval)
2101. G. B. Pettit and H. F. Smith, Oxford-street — Improved cap or cover for the glasses of gas and other lights
2102. J. Gray, Hill-street, Peckham—Improvements in doors for furnaces and fireplaces

Dated August 3.

2103. R. Davison and J. Lee, Limerick—Improving the edge or selvage of linen, cotton, woollen, silk, or any other cloth or fabric, while in the act of weaving
2104. J. Elce and J. Leech, Manchester—Improvements in self-acting temples for looms

Dated August 4.

2105. L. Duriez, jun., South-street, Finsbury—An improved apparatus for stopping horses
2106. R. Birch and R. Bradbury, Haughton, Lancashire—Improvements in machinery and apparatus for clearing and mixing hatters' furs
2107. E. A. Dumergue, Paris—A new description of fringes
2108. A. Prince, Trafalgar-square—A substitute for varnish, turpentine, and oil in the manufacture or mixing of paints and pigments, to be employed for coating or covering wood, metal, glass, and other substances, to preserve them from atmospheric influences and fire. (Communication)
2109. P. Macpherson, Edinburgh—Improvements in wheeled carriages or vehicles
2110. J. H. Johnson, Lincoln's-inn-fields—Improvements in sewing machines. (Communication)
2111. C. Iles, Birmingham—Improvements in the manufacture of thimbles
2112. W. C. Cambridge, Bristol—Improvements in the construction and working of endless travelling railways
2113. W. C. Cambridge, Bristol—Improvements in press wheel rollers or clod crushers
2114. A. V. Newton, Chancery-lane—Improvements in umbrellas and parasols. (Communication from M. Levy and F. H. Blajot, Paris)

Dated August 5.

2115. J. Littlewood and A. Schlumberger, Church, near Accrington, Lancashire—Improvements in producing printed or dyed colours from murexide on woollen fabrics or yarns, or mixed fabrics or yarns of wool and cotton
2117. S. Botturi, Paris—The making of movable chairs and seats of every kind and description, to be called "Botturi's movable chairs and seats"
2118. T. Lyne, Malmesbury—Improved field stile or gate
2119. T. Field, Spring-place, Kentish-town—Improvements in parasols and umbrellas

Dated August 6.

2120. S. Middleton and J. Lowes, Southwark—Improved apparatus for the extinction of fire in buildings
2122. A. Dalgetty, Manchester—Improvements in rotary engines and pumps
2123. D. J. Crossley, Hebdon Bridge, Yorkshire—Improvements in the treatment of certain textile fabrics called "pellones," used for saddle covers, and in the machinery or apparatus for effecting the same
2124. E. Rowland, Manchester—Improvements in steam-engines
2125. W. Gilmour, Dalbeth, Lanarkshire—Improvements in obtaining motive power
2126. T. Lawley, Wolverhampton—Improvements in ornamenting articles made of tin plate and of other bright metals
2127. J. Parker, Bradford—Improvements in the means of supplying or feeding steam-boilers with water, whereby a great saving of fuel is effected

Dated August 7.

2128. B. Lowissohn, Fenchurch-street—Improvement in the manufacture of soap
2129. J. Bradley, Radcliffe, Lancashire—Improvements in machinery or apparatus for engraving metallic cylinders or rollers employed for printing calico and other surfaces
2130. J. R. Scartliff, Wolverhamptom—Improvements in mathematical instruments
2131. A. V. Newton, Chancery-lane—Improvements in mules for spinning. (Communication)

Dated August 8.

2132. T. G. Shaw, Dartmouth-row, Blackheath—Improvements in washing and wringing machines
2133. W. I. Holdsworth, Halifax—Improvements in weaving woollen damasks. (Communication)
2134. J. Langford and J. Wilder, Birmingham—Improvements in signals and alarums
2135. I. Oschinsky, Old Broad-street—Improved soap, to which he gives the name of "rheumo-arthritii soap"
2137. J. Anderton, J. F. Rushworth, and J. Benn, Queenshead, Yorkshire—Improvements in machinery for moulding, cutting, and carving wood and stone

Dated August 10.

2138. T. G. Shaw, Dartmouth-row, Blackheath—Improvements in machinery for thrashing and separating wheat and other grain
2139. J. Bertram, Edinburgh, and J. L. Jullion, Foots Cray, Kent—Improvements in the manufacture of paper
2140. J. Roberts, jun., Whitechapel-road—Improving the combustion of fuel, and preventing the escape of fuliginous smoke from shafts and flues
2142. A. Tremeschin, King-street, Snow-hill—Improvements in curling tongs
2143. A. H. Renton, Buckingham-street, Adelphi—Improvements in apparatus for steering vessels. (Communication from H. Perie, E. Bellamy, and F. Stirling, jun., Bordeaux)
2144. P. A. Godefroy, King's Mead-cottages, New North-road—Improved method of de-sulphurising mineral-matrix, for the extraction of auriferous, argentiferous, and other metals contained therein

Dated August 11.

2145. G. Chambers, Cheapside—Improvements in separating cinders from ashes and economising fuel
2146. A. Lang, Kinniel Ironworks, Linlithgow—Improved machinery for feeding steam boilers
2148. W. L. Groundwater, Greenwich, and H. Prince, Grove, Great Guildford-street, Southwark—Improvements in pumps
2149. W. E. Newton, Chancery-lane—Improvements in pickers for looms. (Communication)

Dated August 12.

2150. T. Hardcastle, Bradshaw, near Bolton-le-Moors—Improvements in machinery for washing textile fabrics
2151. R. Wagstaff, Mottram, Cheshire—Improvements in machinery or apparatus for digging land
2153. W. J. Cantelo, Southwark—Improvements in the preseservation of vegetable matters
2154. W. A. Clark, West Malvern—Improvements in the construction of and mode of applying hot air and vapour baths

Dated August 13.

2155. W. Pritchett and S. Horrocks, Bolton-le-Moors—Improvements in apparatus to regulate the pressure of fluids, and to compensate for the expansion of steam and hot water pipes
2156. H. Collingridge, Oxford—Improvements in separating metallic substances for coffee, and in the apparatus employed for the purpose
2157. R. M'Adam, Baldoon, near Kirkinner, Wigtonshire—Improved apparatus to be employed in making cheese, and in drawing off liquids
2159. J. A. Bosworth Humberstone, Leicestershire—Improvements in machinery for grinding and crushing clay and brick earth
2160. G. T. Bousfield, Loughborough-park, Brixton—Improvements in sewing needles. (Communication)
2161. W. E. Newton, Chancery-lane—Improved machinery for cutting files. (Communication)
2162. J. W. Benson, Ludgate-hill—Improvements in the construction of bows or handles of watches, lockets, eye-glasses, and other articles requiring such appendages
2163. T. Eade, Ipswich—Improved breech-loading fire-arm and projectile to be used therewith

Dated August 14.

2164. J. Parkinson, Victoria Works, Bury—Improvements in the construction of pressure and vacuum gauges
2165. P. E. Laviron, Paris—Improvements in apparatus for curing smoky chimneys and for increasing the draft in them
2166. J. Tickle, West Bromwich — Improvements in metallic pistons for steam and other cylinders
2167. C. Gumm, Change-alley—Improvements in the construction of boats. (Communication)
2168. F. Lipscombe, Strand—Improvements in the mode of diverting the London sewage from the river Thames, and in discharging it into the sea
2169. S. Draper, Lenton, near Nottingham—Improvements in the manufacture of handles and fastenings for doors of railway and other carriages

Dated August 15.

2171. W. Smith, Manchester—Improvements in making soap
2175. W. S. Clark, High Holborn—Improvements in hay and hop presses, the same being applicable to compressing other substances of a similar nature. (Communication from P. C. Ingersoll and H. F. Dougherty, New York, United States of America)
2176. J. C. Hadden, Cannon-row, Westminster—Improvements in the construction of railways and of the carriages to be used therewith or thereon
2177. J. Buckley and T. Wrigley, Carr-hill, Saddleworth, Yorkshire—Improvements in self-acting mules or machines for spinning and doubling
2178 H. Pirotte, Liege, Belgium—Improvements in the construction of lathes for boring and turning

Dated August 17.

2179. A. Smith, Princes-street, Leicester-square—Improvements in machinery for, and in the method or methods of making wire ropes
2181 R. Talbot, Blackburn, and B. Croasdale, Witton, near Blackburn—Improvements in looms
2183. R. Hoe, Leadenhall-street—Improvements in bullion boxes, and in boxes used for carrying other valuable commodities
2185. W. E. Newton, Chancery-lane—Improvements in the valve arrangement of steam and other engines. (Communication)
2187. C. Reeves, Birmingham—Improvements in the manufacture of knives

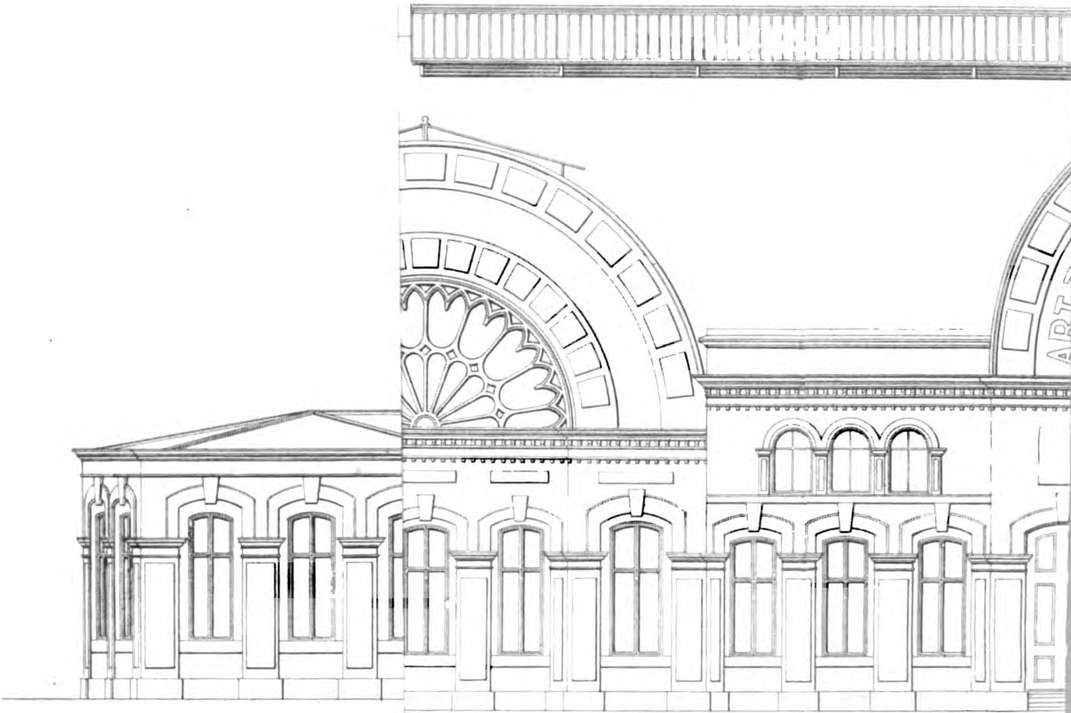
Dated August 18.

2191. C. Nightingale, Wardour-street, Soho—Improvements in and applicable to machines for tearing or reducing rags and other fabrics
2193. W. Young, Queen-street, Cheapside—Improvements in fireplaces or stoves

PATENTS APPLIED FOR WITH COMPLETE SPECIFICATION.

2023. J. J. Bouvert and F. I. J. Pascal, Paris—Improvements in smoke-preventing apparatus.—July 23
2214. A. P. Chamberlain, Paris—Improvements in machines for cutting corks and other substances.—August 20
2227. H. Hodges, New York, United States—Improvements in the manufacture of gunpowder.—August 22.

tion from observations with the box sextant and artificial hori- ardour. Since 1840, not a single year



OF THE BUILDING ERECTED

NCHESTER EXHIBITION OF ART-TREASURES OF THE UNITED KINGDOM.

(*With an Engraving, Plate* XXV.)

E building for the art-treasures at Manchester (of which we give four plates, embracing a principal elevation, a ground and longitudinal and transverse sections, the first of which are in our present *Journal*) was designed and executed under superintendence of Mr. William Dredge, C.E., for Messrs. Young and Co., the contractors. Mr. Edward Salomans architect to the committee, by whom the façade and architectural decorated details were designed. The specification will given at length next month.

ITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

Twenty-seventh Annual Meeting, held in Dublin, 1857.

OFFICERS.

President—Rev. HUMPHREY LLOYD, D.D., D.C.L., F.R.SS. L. & E., Fellow of Trinity College, Dublin.

Vice-Presidents—The Lord Mayor of Dublin; the Provost of Trinity College; Marquis of Kildare; Lord Talbot de Malahide; Lord Chief Baron; Sir William R. Hamilton, LL.D.; Lieut.-Col. Larcom, R.E.; Richard Griffith, LL.D., F.G.S.

General Secretary—Major-General Edward Sabine, R.A., V.P.R.S.;—*Assistant General Secretary*—John Phillips, M.A., F.R.S., Reader in Geology in the University of Oxford;—*General Treasurer*—J. Taylor. *Secretaries for the Meeting in Dublin*—L. E. Foot, Rev. Prof. Jellett, W. Neilson Hancock;—*Treasurer for the Meeting in Dublin*—J. H. Orpen, LL.D.

THE General Committee held its first meeting in the Board-room, Royal Dublin Society, on Wednesday, 26th August, for the election of Sectional officers, and the despatch of business usually brought before that body. The deputy-treasurer read the statement of accounts, from which it appeared that the receipts from the 6th of August 1856 to the 26th August 1857, amounted to 1760*l.* 0*s.* 6*d.*, and the payments to 1636*l.* 3*s.* 4*d.* The estimate of present property is as follows:

Balance in hand	£123	17	10
5000 Three per Cent. Consols at 91*l.* value ...	4550	0	0
Stock of Books in hand—viz., reports, catalogues of stars, &c., at the lowest price ...	2100	0	0
	£6773	17	10

The General Committee met again on Monday, the 31st, at 3 p.m., to determine the place of meeting for the next year. Mr. Phillips stated that invitations had been received from Manchester, Leeds, Newcastle, Waterford, and Oxford. It having been put to the vote, the Association decided to hold the next annual meeting at Leeds, Professor Owen being elected President, and the Rev. J. Hincks, Mr. S. Ward, and Mr. T. Wilson, the local secretaries. The meeting for 1859 will, it is understood, be held at Aberdeen, with the Prince Consort as President.

The Royal Dublin Society gave a grand fête to the members of the Association in their Botanic Gardens, Glasnevin, and the Royal Irish Academy held a conversazione at their house, when all the rooms were thrown open, together with the museum and library and place of meeting, recently erected from designs by Mr. G. V. Clarendon. The classification of the contents of the museum, which was made with so much accuracy, specially for the visit of the Association to Dublin, afforded (with the aid of the instructive catalogue compiled under the direction of Dr. Wilde) the visitors every possible facility and information in the examination of the varied collection. The hall of meeting was arranged with much judgment and taste, and for the entertainment of the company, stereoscopes, microscopes, &c., and admirable specimens of photography, ordnance maps, printing, engraving, curious articles of vertu, ancient gold ornaments, &c., were distributed along the tables, on which were also placed splendid gold candelabra. A good deal of attention was given to a number of the drawings hung along the library shelves illustrative of forty round towers and other buildings in every stage of preservation or decay, and to each drawing was appended the precise dimensions, ascertained by actual measurement, or by computation from observations with the box sextant and artificial horizon, with particulars of the architectural features of the towers, as well as of the ecclesiastical buildings found in conjunction with them.

The lord-lieutenant and the lord mayor each entertained a large party at dinner. Excursions were made to the Isles of Arran and to Parsonstown. The evening lectures were well attended, Professor William Thomson giving a discourse on the Atlantic telegraph, and Dr. Livingstone an interesting one on his discoveries in southern Africa. Altogether the meeting has been of a most satisfactory and brilliant character. The papers read have been most interesting, and in number far exceed our limits; we shall however continue our report next month.

The first general meeting was held in the Rotunda, on August 26th, at 8 p.m., when Dr. C. G. B. Daubeny, President for the past year, resigned his chair, and the Rev. Humphrey Lloyd, D.D., delivered the following address as President elect.

THE PRESIDENT'S ADDRESS.

Gentlemen of the British Association,—Before I proceed to the task which devolves upon me this evening, in virtue of the position in which your kindness has placed me, suffer me first to thank you for the high honour you have conferred. But highly as I esteem the distinction, it was not without hesitation that I accepted it; for no one can feel more strongly than I do myself how unfit I am for some of the duties connected with it, or how much more adequately they might have been performed by others. But I knew at the same time that it has been the desire of your council, when practicable, to select your President from among those local members who had served in the ranks of the Association, and had shared in its labours: and with such knowledge, and the consciousness that I had at least that humble claim, I felt that I had no right to dispute your choice. I do not know whether I may venture to interpret further your motives, and to assign another reason for your selection. Two and twenty years have elapsed since you visited this city. Upon that occasion my nearest relative presided, and I myself had the honour of serving as one of your local secretaries. Many concurring circumstances contributed to make that meeting an agreeable one; and if your council has thought fit on this occasion to associate the present with the memories of the past, the motive is at least a pardonable one. Gentlemen, this is to me a solemn occasion. Two and twenty years are no inconsiderable portion even of the longest life; and that man's moral nature is not to be envied, who can contemplate the distant past thus vividly recalled without emotion. These two decades have brought with them their own large measure of change. The body in which we are associated has grown up from youth to maturity; many of its honoured names are now sought for only in the imperishable records of their toils; the institutions which welcomed it here upon its former visit to this city have all received the impress of the changing times. And yet amid all this change we meet once more in the same city—in the same room,—to enter again on the same labours; our assemblage is now, as it was before, dignified by the presence of the representative of majesty; and I see around me, associated for this task, many of those who shared it before,—the men whose sagacity first perceived the want of such a society as this, whose energy supplied it, and whose wisdom directed its steps while it had need of guidance. I trust I may be forgiven for dwelling thus far on the peculiar circumstances under which we are here assembled; and I now hasten to discharge the task which the usages of this chair impose upon me, and proceed to lay before you as well as I am able a brief sketch of the recent progress of some of those sciences to whose advancement we are pledged by our institution. In doing so I gladly follow the practice which has of late become the rule,—that your President for each year should bring under your notice chiefly the recent additions to those departments of science with which he happens to be himself most familiar. It is plainly fitting that he who addresses you should speak, as far as he can, from his own acquired knowledge. Partial views are better than inexact ones; and provision is made for their completion in the annual change of your officer. In the present instance I derive the full advantage of this arrangement, inasmuch as the subjects upon which I could not thus speak have been most of them ably treated by my predecessor in this chair.

To commence then with *Astronomy*. The career of planetary discovery, which began in the first years of the present century, and was resumed in 1845, has since continued with unabated ardour. Since 1846, not a single year has passed without some one or more additions to the number of the planetoids; and in one year alone (1852) no fewer than eight of these bodies were discovered. The last year has furnished its quota of five; and in the present three have been found, one by Mr. Pogson of Oxford, and the other two by M. Goldschmidt of Paris. Their known number is now forty-five; their total mass, however, is very small—the diameter of the largest being less than forty miles, while that of the smallest, Atalanta, is little more than four. These discoveries have been facilitated by star-maps and star-catalogues, the formation of which they have, on the other hand, stimulated. Two very extensive works of this kind are now in progress—the Star-catalogue of M. Chacornac, made at the Observatory of Marseilles, in course of publication by the French government; and that of Mr. Cooper, made at his Observatory at Markree, in Ireland, which is now being published by the help of the parliamentary grant of the Royal Society. It is a remarkable result of the latter labour, that no fewer than seventy-seven stars, previously catalogued, are now missing. This no doubt is to be ascribed in part to the errors of former observations; but it seems reasonable to suppose that, to some extent at least, it is the result of changes actually in progress in the Sidereal System. The sudden appearance of a new fixed star in the heavens, its subsequent change of lustre, and its final disappearance, are phenomena which have at all times attracted the attention of astronomers. About twenty such have been observed. Arago has given the history of the most remarkable, and discussed the various hypotheses which have been offered for their explanation. Of these the most plausible is that which attributes the phenomenon to unequal brightness of the faces of the star, which are presented to the earth by the star's rotation round its axis. On this hypothesis the appearance should be periodic. M. Goldschmidt has recently given support to this explanation, by rendering it probable that the new star of 1609 is the same whose appearance was recorded in the years 393, 798, and 1203; its period in such case is 405½ years. The greater part of the celestial phenomena are comprised in the movements of the heavenly bodies, and the configurations depending on them; and they are for the most part reducible to the same law of gravity which governs the planetary motions. But there are appearances which indicate the operation of other forces, and which therefore demand the attention of the physicist; although, from their nature they must probably long remain subjects of speculation. Of these the spiriform nebulæ, discovered by Lord Rosse, have been already referred to from this chair, as indicating changes in the more distant regions of the universe, to which there is nothing entirely analogous in our own system. These appearances are accounted for, by an able anonymous writer, by the action of gravitating forces combined with the effects of a resisting medium,—the resistance being supposed to bear a sensible proportion to the gravitating action. The constitution of the central body of our own system presents a nearer and more interesting subject of speculation. Towards the close of the last century many hypotheses were advanced regarding the nature and constitution of the Sun, all of which agreed in considering it to be an opaque body, surrounded at some distance by a luminous envelope. But the only certain fact which has been added to science in this department is the proof given by Arago, that the light of the sun emanated—not from an incandescent solid—but from a gaseous atmosphere; the light of incandescent solid bodies being polarised by refraction, while the light of the sun, and that emitted by gaseous bodies, is unpolarised. According to the observations of Schwabe, which have been continued without intermission for more than thirty years, the magnitude of the solar surface obscured by spots increases and decreases periodically, the length of the period being eleven years and forty days. This remarkable fact, and the relation which it appears to bear to certain phenomena of terrestrial magnetism, have attracted fresh interest to the study of the solar surface; and, upon the suggestion of Sir John Herschel, a photo-heliographic apparatus has lately been established at Kew, for the purpose of depicting the actual macular state of the sun's surface from time to time. It is well known that Sir William Herschel accounted for the solar spots by currents of an elastic fluid, ascending from the body of the sun, and penetrating the exterior luminous envelope. A somewhat different speculation of the same kind has been recently advanced by Mosotti, who has endeavoured to connect the phenomena of the solar spots with those of the red protuberances which appear to issue from the body of the sun in a total eclipse, and which so much interested astronomers in the remarkable eclipse of 1842. Next to the sun our own satellite has always claimed the attention of astronomers, while the comparative smallness of its distance inspired the hope, that some knowledge of its physical structure could be attained with the large instrumental means now available. Accordingly, at the meeting of the Association held in Belfast in 1852, it was proposed that the Earl of Rosse, Dr. Robinson, and Professor Phillips, be requested to draw up a report on the physical character of the Moon's surface, as compared with that of the Earth. That the attention of these eminent observers has been directed to the subject may be inferred from the communication since made by Professor Phillips to the Royal Society on the lunar mountain, Gassendi, and the surrounding region; but I am not aware that the subject is yet ripe for a report. I need not remind you, that the moon possesses neither sea nor atmosphere of appreciable extent. Still, as a negative in such case is relative only to the capabilities of the instruments employed, the search for the indications of a lunar atmosphere has been renewed with every fresh augmentation of telescopic power. Of such indications the most delicate perhaps are those afforded by the occultation of a planet by the moon. The occultation of Jupiter, which took place on the 2nd of January last, was observed with this reference, and is said to have exhibited no hesitation, or change of form or brightness, such as would be produced by the refraction or absorption of an atmosphere. As respects the sea, the mode of examination long since suggested by Sir David Brewster is probably the most effective. If water existed on the moon's surface, the sun's light reflected from it should be completely polarised at a certain elongation of the moon from the sun. No traces of such light have been observed; but I am not aware that the observations have been repeated recently with any of the larger telescopes. It is now well understood that the path of astronomical discovery is obstructed much more by the earth's atmosphere than by the limitation of telescopic powers. Impressed with this conviction, the Association has for some time past urged upon her Majesty's government the scientific importance of establishing a large reflector at some elevated station in the Southern Hemisphere. In the meantime, and to gain (as it were) a sample of the results which might be expected from a more systematic search, Prof. Piazzi Smyth undertook, last summer, the task of transporting a large collection of instruments—meteorological and magnetical as well as astronomical—to a high point on the Peak of Teneriffe. His stations were two in number, at the altitudes above the sea of 8840 and 10,700 feet respectively; and the astronomical advantages gained may be inferred from the fact, that the heat radiated from the moon, which has been so often sought for in vain in a lower region, was distinctly perceptible, even at the lower of the two stations, with the aid of the thermo-multiplier.

The researches relative to the *Figure of the Earth*, and the *Tides*, are intimately connected with Astronomy, and next claim our attention. The results of the Ordnance Survey of Britain, so far as they relate to the Earth's figure and mean density, have been lately laid before the Royal Society by Colonel James, the superintendent of the Survey. The ellipticity deduced is $\frac{1}{299{\cdot}33}$. The mean specific gravity of the Earth, as obtained from the attraction of Arthur's Seat, near Edinburgh, is 5·316,—a result which accords satisfactorily with the mean of the results obtained by the torsion balance. Of the accuracy of this important work it is sufficient to observe, that when the length of each of the measured bases—in Salisbury Plain, and on the shores of Lough Foyle—was computed from the other, through the whole series of intermediate triangles, the difference from the measured length was only 5 inches in a length of from 5 to 7 miles. Our knowledge of the laws of *Tides* has received an important accession, in the results of the tidal observations made around the Irish coasts in 1851, under the direction of the Royal Irish Academy. The discussion of these observations was undertaken by Professor Haughton, and that portion of it which relates to the diurnal tides has been already completed and published. The most important result of this discussion is the separation of the effects of the Sun and Moon in the diurnal tide—a problem which was proposed by the Academy, as one of the objects to be attained by the contemplated observations, and which has been now for the first time solved. From the comparison of these effects Professor Haughton has drawn some remarkable conclusions relative to the mean depth of the sea in the Atlantic. In the dynamical theory of the tides, the ratio of the solar to the lunar effect depends not only on the masses, distances, and periodic times, of the two luminaries,—but also on the depth of sea; and this, accordingly, may be computed when the other quantities are known. In this manner Professor Haughton has deduced, from the solar and lunar coefficients of the diurnal tide, a mean depth of 5·12 miles —a result which accords in a remarkable manner with that inferred from the ratio of the semidiurnal coefficients, as obtained by Laplace from the Brest observations. The subject, however, is far from being exhausted. The depth of the sea, deduced from the solar and lunar diurnal tidal intervals, and from the age of the lunar diurnal tide, is somewhat more than double that of the foregoing; and the consistency of the individual results is such as to indicate that their wide difference from the former is not attributable to errors of observation. Prof. Haughton throws out the conjecture that the depth, deduced from the tidal intervals and ages, corresponds to a different part of the ocean from that inferred from the heights. The phenomena of *Terrestrial Magnetism* present many close analogies with those of the tides; and their study has been, in a peculiar manner, connected with the labours of this Association. To this body, and by the hands of its present general secretary, were presented those Reports on the distribution of the Terrestrial Magnetic Force which reawakened the attention of the scientific world to the subject. It was in the Committee-rooms of this Association that the first step was taken towards that great magnetic organisation which has borne so much fruit;—it was here that the philosophical sagacity of Herschel guided its earlier career;—and it was here again that the cultivators of the science assembled, from every part of Europe, to deliberate about its future progress. It was natural, therefore, that the results obtained from such beginnings should form a prominent topic in the addresses which have been annually delivered from this Chair; and the same circumstances will plead my excuse, if I now revert to some of them which have been already touched upon by my predecessors. It has been long known that the elements of the Earth's magnetic force were subject to certain regular and recurring changes, whose periods were, respectively, a *day* and a *year*, and which therefore were referred to the Sun as their source. To these periodical changes Dr. Lamont, of Munich, added another of *ten years*, the diurnal range of the magnetic declination having been found to pass from a maximum to a minimum, and back again, in about that time. But besides these slow and regular changes, there are others of a different class, which recur at irregular intervals, and which are characterised by a large deviation of the magnetic elements from their normal state, and generally also by rapid fluctuation and change. These phenomena, which are called by Humboldt "magnetic storms," have been observed to occur simultaneously in the most distant parts of the earth, and thus to indicate a cause operating upon the entire globe. But, casual as they seem, these effects are found to be subject to laws of their own. Professor Kreil was the first to discover that, at a given place, they recurred more frequently at certain hours of the day than at others; and that, consequently, in their mean effects, they were subject to periodical laws, depending upon the hour at each station. The laws of this periodicity have been ably worked out by General Sabine, in his discussion of the results of the British Colonial observatories; and he has added the important facts, that the same phenomena observe also the two other periods already noticed—namely, the annual and the decennial periods. He has further arrived at the very remarkable result, that the decennial magnetic period coincides, both in its duration and in its epochs of maxima and minima, with the decennial period observed by Schwabe in the solar spots; from which it is to be inferred that the Sun exercises a magnetic influence upon the Earth, dependent on the condition of its luminous envelope. We are thus in the presence of two facts, which appear at first sight opposed—namely, the absolute simultaneity of magnetic disturbances at all parts of the Earth, and their predominance at certain local hours at each place. General Sabine accounts for this apparent discrepancy by the circumstance, that the hours of maximum disturbance are different for the different elements; so that there may be an abnormal condition of the magnetic force, operating at the same instant over the whole globe, but manifesting itself at one place chiefly in one element, and at another place in another. I would venture to suggest, as a subject of inquiry, whether the phenomena which have been hitherto grouped together as "occasional" effects, may not possibly include two distinct classes of changes, obeying separate laws—one of them being strictly periodic, and constituting a part of the regular diurnal change; while the other is strictly abnormal and simultaneous. If this be so, it would follow that we are not justified in separating the larger changes from the rest, merely on the ground of their magnitude; and that a different analysis of the phenomenon is required. The effects hitherto considered are all referable to the Sun as their cause. Prof. Kreil discovered, however, that another body of our System—namely, our own satellite—exerted an effect upon the magnetic needle; and that the magnetic declination underwent a small and very regular variation, whose amount was dependent on the lunar hour-angle, and whose period was therefore a lunar day. This singular result was subsequently confirmed by Mr. Broun, in his discussion of the Makerstown observations; and its laws have since been fully traced, for all the magnetic elements, by General Sabine, in the results obtained at the Colonial magnetic observatories. The foregoing facts bear closely upon the debated question of the causes of the magnetic variations. It has been usual to ascribe the periodical changes of the Earth's magnetic force to the thermic action of the Sun, operating either directly upon the magnetism of the Earth, or affecting it indirectly by the induction of the thermo-electric currents. Here, however, we have a distinct case of magnetic action, unaccompanied by heat; and the question is naturally suggested, whether the larger diurnal change may not also be independent of temperature. The most important fact, in its bearing upon this question, is the existence of an annual inequality in the diurnal variation, dependent on the Sun's declination, recently pointed out by General Sabine. If we deduct the ordinate of the curve, which represents the mean diurnal variation for the entire year, from those for the summer and winter half-yearly curves respectively, the differences are found to be equal and opposite; and the curves which represent them are, consequently similar, but oppositely placed with respect to the axis of abscissæ. From this General Sabine draws the inference, that the diurnal variation is a direct effect of solar action, and not a result of its thermic agency.

The most important step which has been recently taken in this country, to advance the science of *Meteorology*, has been the formation of a department connected with the Board of Trade, for the collection and discussion of meteorological observations made at sea. The practical results of a similar undertaking in the United States are now well known. The charts and sailing directions, published by Lieut. Maury, have enabled navigators to shorten their passages, in many cases by one-fourth of the time, and in some even to a greater extent. The commercial importance of such results could not fail to attract general attention; and accordingly, when the United States government invited other maritime nations to co-operate in the undertaking, the invitation was cordially accepted. A conference was held at Brussels in 1853, at which meteorologists deputed by those powers attended; and a report was made, recommending the course to be pursued in a general system of marine meteorological observations. This report was laid before the British Parliament soon after, and a sum of money was voted for the necessary expenditure. The British Association undertook to supply verified instruments, by means of its observatory at Kew; and the Royal Society, in consultation with the most eminent meteorologists of Europe and America, addressed an able report to the Board of Trade, in which the objects to be attended to, so as to render the system of observation most available for science, were clearly set forth. With this co-operation on the part of the two leading scientific societies, the establishment was soon organised. It was placed under the direction of a distinguished naval officer, Admiral Fitz Roy; and in the beginning of 1855 it was in operation. Agents were established at the principal ports for the supply of instruments, books, and instructions; and there are now more than 200 British ships so furnished, whose officers have undertaken to make and record the required observations, and to transmit them from time to time to the Department. At the present time 700 months of logs have been received, from nearly 100 merchant ships, and are in process of tabulation. Holland is taking similar steps; and the meteorological institute of that country, under the direction of Mr. Buys Ballot, has already published three volumes of nautical information, obtained from Dutch vessels in the Atlantic and Indian oceans. For the purposes of meteorological science this system cannot be considered as complete, until observations on land are included. Most of the greater atmospheric changes are due to the distribution of land and water, and to the different effects of the sun's rays on each. Observation alone can furnish the data from which the effects of these agencies may be calculated; and we can therefore probably make no great advance in the knowledge of the meteorology of the globe, without a concurrent investigation of its two leading departments. Land observations exist in great numbers. In Prussia,—in Russia,—in Austria,—and in Belgium, such observations are organised under government direction, or at least with government support; in other parts of Europe, as in Britain, the labour is left to individuals or scientific societies. What is needed is to give unity to these isolated labours—to connect them with one another, and with the results obtained at sea; and the first step to this seems to be, to give them, in each country, that permanence and uniformity of system, which can only be insured in measures adopted by the State. Here, however, we encounter an objection, upon which it is necessary to say a few words. It has been objected to the science of Meteorology, as it is usually studied, that it proceeds upon a false method; and that, consequently, it has led, and can lead, to no results. I feel myself in a manner compelled to notice this grave objection, in the first place, because it proceeds from men whose opinions on this (or on almost any other scientific question) are entitled to the highest deference; and secondly, because this Association must bear no inconsiderable measure of the reproach, if it be well founded. First, then, as to *results*. I am free to admit that the number of those engaged in the *discussion* of meteorological observations is disproportionately small, and that the results obtained probably fall far short of what may be expected from the data already accumulated. But that the methods have led, and can lead, to no results, is, I think, sufficiently disproved by the labours of a single man—Professor Dove of Berlin. And if it be true that the course pursued in the science has yielded much fruit, in proportion to the labour bestowed on the discussion, it will hardly be deemed widely erroneous. Still, as it is possible that the methods pursued,—though not fruitless,—may be inadequate, it seems necessary to notice the objection somewhat more minutely. It is asserted, then, that the capital vice of the science of Meteorology, as at present pursued, is that it has *no definite aim;* that it ought to embrace an inquiry into the physical constitution of the objects with which the science is concerned, and an investigation of *causes* as well as *laws* of phenomena. It may be admitted, at once, in reference to this objection, that the physical constitution of the bodies whose changes we are investigating is a proper object of study to the physicist; but it does not seem to follow that it should necessarily be conducted by the same individuals who are in search for the laws of the phenomena, or even that the former knowledge is essential to the progress of the latter. The noblest of all the physical sciences, Astronomy, is little more than a science of *laws*—laws, too, of the simplest kind of change; and the knowledge of these laws is wholly independent of the physical constitution of the masses whose movements it studies. A similar observation may be made regarding the science of Terrestrial Magnetism; and the case is one which brings us still nearer to the question at issue, inasmuch as the laws which have been obtained—and they are numerous—have resulted from a method of inquiry altogether similar to that adopted in Meteorology. Time will not permit me to inquire whether there is not a misconception of a metaphysical kind at the root of this objection. I may observe, however, before leaving the subject, that there are two modes of studying the sequences of natural phenomena,—one in their relation *to time*, and which is best accomplished by observations at stated periods, and the other in the relation of the *successive phases of the phenomenon to one another*. Of these, the latter, although not wholly neglected, has not been so much followed as it deserves; and I cannot but think that it would, if more systematically followed, enrich the science of Meteorology with a new harvest of results.

The most important of the recent additions to the theory of *Light* have been those made by M. Jamin. It has been long known that metals differed from transparent bodies in their action on light, in this, that plane-polarized light reflected from their surfaces became elliptically polarised; and the phenomenon is explained, on the principles of the wave theory, by the assumption that the vibration of the ether undergoes a change of phase at the instant of reflection, the amount of which is dependent on its direction, and on the angle of incidence. This supposed distinction, however, was soon found not to be absolute. Mr. Airy showed that diamond reflected light in a manner similar to metals; and Mr. Dale and Prof. Powell extended the property to all bodies having a high refractive power. But it was not until lately that M. Jamin proved that there is no distinction, in this respect, between transparent and metallic bodies; and that all bodies transform plane-polarised into elliptically-polarised light, and impress a change of phase at the moment of reflection. Prof. Haughton has followed up the researches of M. Jamin, and established the existence of circularly-polarised light by reflection from transparent surfaces. The theoretical investigations connected with this subject afford a remarkable illustration of one of those impediments to the progress of Natural Philosophy which Bacon has put in the foremost place among his examples of the *Idola*,—I mean the tendency of the human mind to suppose a greater simplicity and uniformity in nature than exists there. The phenomena of polarisation compel us to admit that the sensible luminous vibrations are transversal, or in the plane of the wave itself; and it was naturally supposed by Fresnel, and after him by MacCullagh and Neumann, either that no normal vibrations were propagated, or if they were, they were unconnected with the phenomena of light. We now learn that it is by them that the phase is modified in the reflection; and that consequently no dynamical theory which neglects them or sets them aside can be complete. Attention has been lately recalled to a fundamental position of the wave theory of light, respecting which opposite assumptions have been made. The vibrations of a polarised ray are all parallel to a fixed direction in the plane of the wave; but that direction may be either parallel, or perpendicular, to the plane of polarisation. In the original theory of Fresnel the latter was assumed to be the fact; and in this assumption Fresnel has been followed by Cauchy. In the modified theories of MacCullagh and Neumann, on the other hand, the vibrations are supposed to be parallel to the plane of polarisation. This opposition of the two theories was compensated, as respects the results, by other differences in their hypothetical principles; and both of them have led to conclusions which observation has verified. There seemed therefore no means left to the theorist to decide between these conflicting hypotheses, until Professor Stokes recently, in applying the dynamical theory of light to other classes of phenomena, found one in which the effects should differ on the two assumptions. When light is transmitted through a fine grating it is turned aside, or diffracted, according to laws which the wave theory has explained. Now Prof. Stokes has shown, that when the incident light is polarised, the plane of vibration of the diffracted ray must differ from that of the incident; the two planes being connected by a very simple relation. It only remained therefore for observation to determine, whether the planes of polarisation of the incident and refracted rays were similarly related or not. The experiment was undertaken by Prof. Stokes himself, and he has inferred from it that the original hypothesis of Fresnel is the true one; but as an opposite result has been obtained by M. Holtzmann, on repeating the experiment, the question must be regarded as still undetermined. The difference in the experimental results is ascribed by Prof. Stokes to the difference in the nature of the gratings employed, the substance of the diffracting body being supposed to exert an effect upon the polarisation of the light, which is diffracted by it under a great obliquity. I learn from Prof. Stokes that he proposes to resume the experimental inquiry, and to test this supposition by employing gratings of various substances. If the conjecture should prove to be well founded, it will unfortunately greatly complicate the dynamical theory of light. In the meantime, the hypothesis is one of importance in itself, and deserves to be verified or disproved by independent means. I would venture to suggest that it may be effectively tested by means of the beautiful "Interference-refractor" of M. Jamin, which the inventor has already applied to study the effects upon light produced by grazing a plate of any soluble substance inclosed in a fluid. It is well known that the refractive index of bodies increases with their density; and the theory of emission has even expressed the law of their mutual dependence. That theory, it is true, is now completely overthrown by the decisive *experimentum crucis* of MM. Fizeau and Foucalt. It was therefore probable, *à priori*, that this law—the only one peculiar to the theory—should be found wanting. Its truth has recently been put to an experimental test by M. Jamin. Water, it is known, has its maximum of density at about 40° Fahrenheit; so that if Newton's law were true its refractive index should also have a maximum value at the same temperature. This has been disproved by M. Jamin, by observing the interference of two rays, one of which has passed through air, and the other through water; and thus the last conclusion of the emission theory has been set aside. It would occupy too much of your time were I to touch, even lightly, upon the subject of the chemical action of light, and the many beautiful and important discoveries of the art to which it has given rise. I may however mention, as one of the latest of the marvels of photography, that M. Poitevin has succeeded in producing plates in relief, for the purposes of engraving, by the action of light alone. The process depends upon the change in the affinity for water produced by the action of light upon a thin plate of gelatine which is impregnated with bichromate of potash.

In the whole range of experimental science there is no fact more familiar, or longer known, than the development of *Heat* by friction. The most ignorant savage is acquainted with it,—it was probably known to the first generation of mankind. Yet, familiar as it is, the science of which it is the germ dates back but a very few years. It was known from the time of Black, that heat disappeared in producing certain changes of state in bodies, and reappeared when the order of those changes was reversed; and that the amount of heat thus converted had a given relation to the effect produced. In one of these changes—namely, evaporation—a definite mechanical force is developed, which is again absorbed when the vapour is restored by pressure to the liquid state. It was, therefore, not unnatural to conjecture, that in all cases in which heat is developed by mechanical action, *vice versâ*, a definite relation would be found to subsist between the amount of the action, and that of the heat developed or absorbed. This conjecture was put to the test of experiment by Mayer and Joule, in 1842, and was verified by the result. It was found that heat and mechanical power were mutually convertible; and that the relation between them was definite, 772 foot-pounds of motive power being equivalent to a unit of heat—that is, to the amount of heat requisite to raise a pound of water through one degree of Fahrenheit. The science of thermo-dynamics, based upon this fact, and upon a few other obvious facts, or self-evident principles, has grown up in the hands of Clausius, Thomson, and Rankine, into large proportions, and is each day making fresh conquests in the region of the unknown. Thus far the science of Heat is made to rest wholly upon the facts of experiment, and is independent of any hypothesis respecting the molecular constitution of bodies. The dynamical theory of Heat, however, has materially aided in establishing true physical conceptions of the nature of heat. The old hypothesis of caloric, as a separate substance, was indeed rendered improbable by the experiments of Rumford and Davy, and by the reasonings of Young; but it continued to hold its ground, and is interwoven into the language of science. It is now clearly shown to be self-contradictory, and to lead to the result, that the amount of heat in the universe may be indefinitely augmented. On the other hand, the identification of radiant heat with light, and the establishment of the wave theory, left little doubt that heat consisted in a vibratory movement either of the molecules of bodies, or of the ether within them. Still, the relation of heat to bodies, and the phenomena of conduction, indicate a mechanism of a more complicated kind than that of light, and leave ample room for further speculation. The only mechanical hypothesis (so far as I am aware) which is consistent with the present state of our knowledge of the phenomena of heat, is the theory of molecular vortices of Mr. Rankine. In this theory all bodies are supposed to consist of atoms, composed of nuclei surrounded with elastic atmospheres. The radiation of light and heat is ascribed to the transmission of oscillations of the nuclei; while thermometric heat is supposed to consist in circulating currents, or vortices, amongst the particles of their atmospheres, whereby they tend to recede from the nuclei, and to occupy a greater space. From this hypothesis Mr. Rankine has deduced all the laws of thermo-dynamics, by the application of known mechanical principles. He has also, from the same principles, deduced relations (which have been confirmed by experiment) between the pressure, density, and absolute temperature of elastic fluids, and between the pressure and temperature of ebullition of fluids. The dynamical theory of heat enables us to frame some conjectures to account for the continuance of its supply, and even to speculate as to its source. The heat of the sun is dissipated and lost by radiation; and must be progressively diminished unless its thermal energy be supplied. According to the measurements of M. Pouillet, the quantity of heat given out by the sun in a year is equal to that which would be produced by the combustion of a stratum of coal 17 miles in thickness; and if the sun's capacity for heat be assumed equal to that of water, and the heat be supposed to be drawn uniformly from its entire mass, its temperature would thereby undergo a diminution of 2°·4 Fahr. annually. On the other hand, there is a vast store of force in our system capable of conversion into heat. If, as is indicated by the small density of the sun, and by other circumstances, that body has not yet reached the condition of incompressibility, we have, in the future approximation of its parts, a fund of heat probably quite large enough to supply the wants of the human family to the end of its sojourn here. It has been calculated that an amount of condensation, which would diminish the diameter of the sun by only the ten-thousandth part, would suffice to restore the heat emitted in 2000 years. Again, on our own earth, *vis viva* is destroyed by friction in the ebb and flow of every tide, and must therefore reappear as heat. The amount of this must be considerable, and should not be overlooked in any estimation of the physical changes of our globe. According to the computation of Bessel, 25,000 cubic miles of water flow, in every six hours, from one quarter of the earth to another. The store of mechanical force is thus diminished, and the temperature of our globe augmented by every tide. We do not possess the data which would enable us to calculate the magnitude of these effects. All that we know with certainty is, that the resultant effect of all the thermal agencies to which the earth is exposed, has undergone no perceptible change within the historic period. We owe this fine deduction to Arago. In order that the date-palm should ripen its fruit, the mean temperature of the place must exceed 70° Fahr.; and, on the other hand, the vine cannot be cultivated successfully when the temperature is 72° or upwards. Hence, the mean temperature of any place, at which these two plants flourished and bore fruit, must lie between these narrow limits, *i.e.*, could not differ from 71° Fahr. by more than a single degree. Now, from the Bible we learn that both plants were simultaneously cultivated in the central valleys of Palestine, in the time of Moses; and its then temperature is thus definitively determined. It is the same at the present time; so that the mean temperature of this portion of the globe has not sensibly altered in the course of 33 centuries.

The future of physical science seems to lie in the path upon which three of our ablest British physicists have so boldly entered, and in which they have already made such large advances. I may therefore be permitted briefly to touch upon the successive steps in this lofty generalisation, and to indicate the goal to which they tend. It has been long known that many of the forces of nature are related. Thus, heat is produced by mechanical action, when that is applied in bringing the atoms of bodies nearer by compression, or when it is expended in friction. Heat is developed by electricity, when the free passage of the latter is impeded; it is produced whenever light is absorbed; and it is generated by chemical action. A like interchangeability probably exists among all the other forces of nature, although in many the relations have not been so long perceived. Thus, the development of electricity from chemical action dates from the observations of Galvani; and the production of magnetism by electricity from the discovery of Oersted. The next great step was to discover that the relation of the physical forces was mutual; and that of any two, compared together, either may stand to the other in the relation of cause. With respect to heat and mechanical force, this has been long known. When a body is compressed by mechanical force, it gives out heat; and, on the other hand, when it is heated, it dilates, and evolves power. The knowledge of the action of electricity in dissolving the bonds of chemical union followed closely upon that of the inverse phenomenon; and the discovery of electro-magnetism by Oersted was soon followed by that of magneto-electricity by Faraday. With reason, therefore, it occurred to many minds that the relations of any two of the forces of nature were mutual;—that that which is the cause, in one mode of interaction, may become the effect, when the order of the phenomena is changed;—and that, therefore, in the words of Mr. Grove, one of the able expounders of these views, while they are "correlative," or reciprocally dependent, "neither, taken abstractedly, can be said to be the essential cause of the others." But a further step remained to be taken. If these forces were not only related, but mutually related, was it not probable that the relation was also a definite one? Thus, when heat is developed by mechanical action, ought we not to expect a certain definite proportion to subsist between the interacting forces, so that if one were doubled or trebled in amount, the other should undergo a proportionate change? This anticipation, it has been already stated, has been realized by Mayer and Joule. The discovery of the mechanical equivalent of heat has been rapidly followed by that of other forces; and we now know not only that electricity, magnetism, and chemical action, in given quantities, will produce each a definite amount of mechanical work; but we know further—chiefly through the labours of Mr. Joule—what that relation is, or, in other words, the mechanical equivalent of each force. The first step in this important career of discovery—though long unperceived in its relation to the rest—was undoubtedly Faraday's proof of the definite chemical effect of the voltaic current. The last will probably be to reduce all these phenomena to modes of motion, and to apply to them the known principles of dynamics, in such a way as not only to express the laws of each kind of movement, as it is in itself, but also the connexion and dependence of the different classes of the phenomena.

A bold attempt at such a generaliation has been made by M. Helmholtz. The science of thermo-dynamics starts from the principle that perpetual motion is impossible, or, in other words, that we cannot by any combination of natural bodies, produce force out of nothing. In mechanical force, this principle is reducible to the known law of the Conservation of *Vis Viva;* and M. Helmholtz has accordingly endeavoured to show that this law is maintained in the interaction of all the natural forces; while, at the same time, the assumption of its truth leads to some new consequences in physics, not yet experimentally confirmed. Expressed in its most general form, this principle asserts that the gain of *vis viva* during the motion of a system, is equal to the force consumed in producing it; from which it follows that the sum of the *vires vivæ*, and of the existing forces, is constant. This principle M. Helmholtz denominates the Conservation of Force. A very important consequence of its establishment must be, that all the actions of nature are due to attractive and repulsive forces, whose intensity is a function of the distance,—the conservation of *vis viva* holding only for such forces. It is usually stated, in mechanical works, that there is a loss of *vis viva* in the collision of inelastic bodies, and in friction, This is true with respect to the motion of masses, which forms the subject of mechanical science as at present limited; but it is not true in a larger sense. In these, and such like cases, the movement of masses is transformed into molecular motion, and thus reappears as heat, electricity, and chemical action; and the amount of the transformed action definitely corresponds to the mechanical force which was apparently lost. In the cases just considered, mechanical action is converted into molecular. But molecular actions of different kinds are themselves in like manner interchangeable. Thus, when light is absorbed, *vis viva* is apparently lost; but—not to speak of phosphorescence, in which the light absorbed, or a portion of it, is again given out—in all such cases heat and chemical action are developed, and in amount corresponding to the loss. Hence, the apparent exceptions to the principle are in reality confirmations of it; and we learn that the quantity of force in nature is as unchangeable as the quantity of matter. This, however, is not true of the quantity of available force. It follows, from Carnot's law, that heat can be converted into mechanical work only when it passes from a warmer to a colder body. But the radiation and conduction, by which this is effected, tend to bring about an equilibrium of temperature, and therefore to annihilate mechanical force: and the same destruction of energy is going forward in the other processes of nature. Thus, it follows from the law of Carnot, as Professor Thomson has shown, that the universe tends to a state of eternal rest, and that its store of available force must be at length exhausted, unless replenished by a new act of creative power. Mr. Rankine has attempted, in another method, to combine the physical sciences into one system, by distinguishing the properties which the various classes of physical phenomena possess in common, and by taking for axioms propositions which comprehend their laws. The principles thus obtained are applicable to all physical change: and they possess all the certainty of the facts from which they are derived by induction. The subject matter of the science so constituted is energy; or the capacity to effect changes; and its fundamental principles are—1st, that all kinds of energy and work are homogeneous—or, in other words, that any kind of energy may be made the means of performing any kind of work; and, 2nd, that the total energy of a substance cannot be altered by the mutual action of its parts. From these principles the author has deduced some very general laws of the transformation of energy, which include the known relations of physical forces.

I have occupied your time so largely with the sciences of one section, that I cannot do more than to advert to one or two topics connected with the others, which have struck my own mind; although, from my limited acquaintance with the subjects, I could not venture to say that they are the most deserving of notice. Among the most remarkable of the recent discoveries in *Inorganic Chemistry* are those of MM. Wohler and Deville, relative to silicon and boron. Each of these substances is now proved to exist in three very different states, analogous to the three known states of carbon, to which they are thus closely allied,—namely, charcoal, graphite, and diamond. The last of these states is of course the most interesting. Crystallised boron possesses a hardness, brightness, and refractive power, comparable to those of diamond; it burns in chlorine without residue, and under circumstances resembling those of the combustion of diamond in oxygen; it is not acted on by any of the acids, and appears to be the least alterable of all the simple bodies. I have been informed that its powder is already used in the arts, instead of diamond dust; and it seems not improbable, that when obtained by the chemist in crystals of larger size, it may rival the diamond as a gem.

The science of *Geology* appears of late years to have entered upon a new phase of its development—one characterised by a stricter reference of its speculative views to to the principles of those sciences with which it is connected, and upon which it ought to be based. The able Memoirs of Mr. Hopkins on what may be called Dynamical Geology, including the changes which have taken place in the earth's crust by the operation of internal forces, afford a remarkable proof of this; and we have another instance of the application of sound physical principles to this science in the explanations which have recently offered of the phenomena of slaty cleavage. A Report on this interesting subject was presented to the Association by Professor Phillips at its last meeting, and will be found in the volume just published. These sounder views originate, I believe, with himself and with Mr. Sharpe; but they have been enlarged and confirmed by Mr. Sorby, Dr. Tyndall, and Prof. Haughton. We have an interesting proof of the readiness of geologists of the present day to submit their views to the test of exact observation, in the measurements undertaken by Mr. Horner for the purpose of approximating to the age of sedimentary deposits. Of the geological changes still in operation, none is more remarkable than the formation of deltas at the mouths of great rivers, and of alluvial land by their overflow. Of changes of the latter kind, perhaps the most remarkable is the great alluvial deposit formed in the valley of the Nile by the annual inundations of that river; and here it fortunately happens that history comes to the aid of the geologist. These sedimentary deposits have accumulated round the bases of monuments of known age; and we are therefore at once furnished with a chronometric scale by which the rate of their formation may be measured. The first of the series of measurements undertaken by Mr. Horner was made, with the co-operation of the Egyptian government, around the the obelisk of Heliopolis, a monument built, according to Lepsius, B.C. 2300. A more extensive series of researches has been since undertaken in the district of Memphis; but Mr. Horner has not yet, I believe, published the results. The problems now to be solved in Palæontology are clearly defined in the enunciation of the problem recently proposed by the French Acadamy of Sciences as one of its prize questions, viz., "To study the laws of distribution of organic beings in the different sedimentary rocks, according to the order of their superposition; to discuss the question of their appearance or disappearance, whether simultaneous or successive; and to determine the nature of the relations which subsist between the existing organic kingdom and its anterior states." The prize was obtained by Prof. Bronn, of Heidelberg; and his Memoir, of which I have only seen an outline, appears to be characterised by views at once sound and comprehensive. The leading result appears to be, that the genera and species of plants and animals, which geology proves to have existed successively on our globe, were created in succession, in adaptation to the existing state of their abode; and not transmuted, or modified, as the theory of Lamark supposes, by the physical influences which surrounded them.

I must now pass from the results of science to the administrative measures which have been adopted by this Association for its advancement, and more especially to those which will be brought under your consideration at the present meeting. One of the modes in which this Association most effectively promotes the advancement of science is, you are aware, by the preparation and publication of Reports on the history and actual state of its several branches. With the help of these, original investigators may with little labour ascertain all that has been accomplished in each department, before they proceed to increase the store; and so not only prepare their own minds for their task, but also avoid the waste of time and toil which has been too often incurred in the re-discovery of the same truths. To further the same objects, it was proposed by Prof. Henry, of Washington, at the Glasgow Meeting of the Association, that a Catalogue of papers occurring in the transactions of Scientic Societies, and in the scientific journals should be prepared by the Association, the Smithsonian Institution undertaking to execute that paart of the work which related to American science. A Committee,—consisting of Mr. Cayley, Mr. Grant, and Prof. Stokes,—was appointed to consider this proposal, and their report was submitted to the Cheltenham meeting. The subject has since been under the consideration of the Council of the Royal Society; and a preliminary report has been drawn up by a sub-committee of that body, which will probably be brought before your committee at this meeting.

A still more important question has been for some years under the consideration of this Association, and the Royal Society—the question, namely, whether any measures could be adopted by the government, or parliament, that would improve the position of science or its cultivators in this country. The Parliamentary Committee of the Association have taken much pains in the attempt to arrive at a solution of this large and complex question. They consulted, in the first instance, several of the most eminent scientific men of this country; and in their first Report, presented to the meeting of the Association at Glasgow, they have analysed the replies obtained, and have recommended certain general measures founded thereon. The most important of the recommendations are the provision, at the cost of the nation, of a central building in London, in which the principal Scientific Societies of the metropolis may be located together; and the formation of a Scientific Board, to have the control and expenditure of the public funds allotted to the advancement of science. This report was brought under the consideration of your Committee of Recommendations at the last two meetings of the Association; and the opinions of the members of the General Committee have been since invited in reference to its suggestions. The Council of the Royal Society have likewise deliberated on the same question, and have passed certain resolutions on the subject, which may be considered as embodying their reply to the question above stated; and the Parliamentary Committee state that they are gratified by observing that most of the recommendations adopted in the Glasgow Report have, in substance, received the sanction of the official representatives of the most ancient and venerable of our scientific institutions. A copy of these resolutions was forwarded by Lord Wrottesley, as President of the Society, to Lord Palmerston; and motions have been made in both Houses of Parliament by Lord Burlington and Mr. R. Stephenson, for the production of the correspondence. The first of the objects above referred to—namely, the juxtaposition of the Scientific Societies of London in one locality—has been since accomplished by the grant of Burlington House for the use of the Royal, Linnean, and Chemical Societies; and the result affords a fresh instance of the readiness of her Majesty's government to listen to, and comply with, the suggestions of men of science, when deliberately and carefully made. I cannot but think that this important step is fraught with consequences affecting the promotion of science, and extending far beyond the external and obvious advantages which it insures to the Scientific Societies more immediately benefited.

Another mode in which this Association has materially aided in the advancement of science is through the instrumentality of its Observatory at Kew. The objects which are at present attained by that important establishment are, the trial and improvement of instrumental methods, and especially of those connected with the photographic registration of natural phenomena; the verification of meteorological instruments, and the construction of standard barometers and thermometers; the supervision of apparatus to be employed by scientific travellers, and the instruction of the observers in their use; and, lastly, the conduct of special experimental researches undertaken by members of the Association at its request. In all these various ways, the labours of the Kew Observatory have tended, in no small degree, to the advancement of the sciences of observation and experiment in this country; and the result is due, not only to the sagacity of the committee under whose management it is placed, but also, and eminently, to the zeal and talents of Mr. Welsh, the gentleman who has the immediate charge of the establishment.

There is but one other topic connected with the administration of the Association, to which I feel it necessary to invite your attention before I conclude,—I mean the change which has been made in the constitution of one of the sections, and which will come into operation at the present meeting. By a resolution of your committee, adopted at the last meeting, the scope of the Statistical Section has been enlarged, and it now embraces *Economic Science* in all its relations. I regard it as a fortunate circumstance for the Association, that this important change will come into operation under the presidency of the distinguished prelate, whose talents have been so long devoted to the advancement of this science, and to whose munificence we owe the formation of a school of Political Economy in the University of Dublin, which has already attained a high measure of celebrity. The section will have the aid, on this occasion, of more than one of those gentlemen who have filled the chair of the Whately Professorship, as well as of other members of the Statistical Society; and its proceedings will receive the countenance and support of many foreigners who have devoted themselves to the cultivation of Economic Science.

Gentlemen, suffer me now to thank you for the indulgent attention with which you have favoured me. I am conscious that the sketch of the recent progress of the Physical Sciences, which I have endeavoured to present, is but a meagre and imperfect summary of what has been accomplished; but it is enough, at all events, to prove that science is not on the decline, and that its cultivators have not been negligent in their high calling. I now beg, in the name of the local members of this body, to welcome you warmly to this city; and I pray that your labours here may redound to the glory of God, and to the welfare and happiness of your fellow-men.

SECTION G.—MECHANICAL SCIENCE.

President—The EARL of ROSSE.

Vice-Presidents—G. Rennie, R. Mallet, Sir J. MacNeill, J. Scott Russell, W. Dargan.

Secretaries—J. Thompson, W T. Doyne, H. Wright, Prof. Downing, A. Tate.

Committee—J. G. Appold, C. Atherton, P. W. Barlow, J. Barton, J. Beattie, Major Blaksley, Sir T. Deane, J. C. Dennis, W. Fairbairn, B. Fothergill, R. H. Frith, B. D. Gibbons, Dr. Green, T. Grubb, W. J. Hancock, S. W. Haughton, A. Henderson, G. W. Hemans, J. Hill, Prof. Jack, G. Lowe, J. M'Connell, J. Macgregor, G. M. Miller, J. Moffatt, Admiral Moorsom, J. R. Napier, J. Nasmyth, J. B. Neilson, P. Neville, J. Oldham, J. Owen, J. H Owen, W. J. Macquorn-Rankine, Rev. R. Robinson, C. B. Robinson, W. Smith, G. J. Stoney, B. B. Stoney, S. Ward, C. Vignoles, G. Wilkinson, T. Wilson, B. Woodcroft, Rev. Dr. Wooley, Lord Wrottesley.

Lord ROSSE said:—Ladies and gentlemen, as President of the Mechanical Section, I am sure that on the present occasion there will be many shortcomings on my part. However, there are very able assistants on both sides of me—gentlemen of high mathematical attainments, who have devoted themselves to the study of practical engineering. We can therefore proceed with confidence. The question has sometimes been asked, why is a Mechanical Section necessary? Would not all mechanical questions be discussed in the mathematical and chemical sections? The answer which may be at once given to that is, that it will be found eminently useful to have special sections for special objects. It is only under such arrangement that discussions can be effective in bringing out the truth. Unless a portion of the section is intimately acquainted with the subject in all its details—unless it is quite well up to the learning of the day, and unless the whole section has some little knowledge of the question brought forward, what hope can we have that discussion will be of advantage? This has been felt very strongly at the Royal Society, where there are no sections, and where the subjects are of a varied character, comprehending the whole range of mathematical and physical science. A paper is read there perhaps on some branch of pure mathematics, and very possibly there may not be a single person amongst the audience conversant with that particular branch of mathematics. No discussion takes place. Then follows some question of natural science; probably there are few in the room who have been working in that direction. There is a difference of opinion—a discussion takes place which is interesting to the naturalist, and of no interest whatever to the geologist, the physicist, and so on; so that at the meetings of the Royal Society discussions are not of very general interest, or really effective in promoting knowledge. Here, by the happy expedient of separate sections, a way is prepared for that effective system of discussion which originated with the Geological Society, and which has already accomplished so much. Of course, here, where the great object is to promote knowledge by discussion, surely it would be unwise to group together in one section a variety of subjects each requiring special information, special application of thought, and, I will add, perhaps special experience. In Section E, human ingenuity and knowledge is applied to the solution of mathematical and physical questions. Here, in Section G, you have human knowledge of a different kind—knowledge applied to engineering questions. However the question may be put in another point of view; and it may be asked, where the investigations are not abstract, but practical—where the results are very often immediate and profitable, is it necessary that the British Association should interfere at all?—will not private individuals, from motives of self-interest, devote themselves to the study of engineering science in its higher departments, without any adventitious aids?—will not public men make it their business to acquire a sufficient amount of general knowledge, so as to be able to know where to apply for engineering aid in times of difficulty? I believe that we cannot depend upon that. It is very often said that we are a practical nation, relying on experience and distrusting calculation. But experience is not always at hand. There are innumerable instances of first-rate mechanists who had sustained very heavy losses which a little elementary knowledge of science would save them. Some years ago I went to see the workshop of a gentleman near London, who was endeavouring to make an air-engine. He found, after going to great expense for instruments, that the objects for which he required them would be sufficiently satisfied in a few elementary books of science. A little knowledge would have shown him that what he sought was already made known. The gentleman who introduced me told me he believed he had already spent 100,000*l.*, and that a lady had speculated in the invention to the extent of 30,000*l.* I am afraid that from this cause public as well as private interests have suffered. Three or four years ago I was sailing in the harbour of Portsmouth, and I saw a number of fine looking ships laid up. I inquired of a sailor, and he said to me, "Such a ship is perfectly sound, but she rotted so tremendously that it was impossible to keep her masts in her." He pointed out another that sailed so slowly that she was perfectly worthless. It was rather doubtful whether all the information I got from the sailor was correct, when a little book fell into my hands containing papers on the results of the Exhibition of 1851. They were lectures by some men of the day. Amongst them was one by Rear-admiral Moorsom, one of the most scientific officers of the navy. He was painfully sensible of the fact that during the last war the ships of the French and Spaniards, for stability and facility of manœuvring, were superior to those of the English; and although eventually the skill of our seamen and their courage had succeeded in establishing the supremacy of England, yet it was at such a sacrifice of life as might be avoided had our ships more nearly approached to those of the enemy. He clearly traced that state of things to the ignorance of scientific principles which prevailed amongst shipbuilders. It is a fact that a person who published a scientific treatise on the subject died a working shipwright, so little was the attention which was paid to it. I have heard on some occasions the complaint made that engineering science had effected very little for us. We should recollect that engineers do not spring up at the spur of the moment, and it always requires a strong inducement to direct inventive powers. Have we never heard of official prejudice in this country? Besides, if any one invents anything what chance is there that it can be kept secret?—what chance is there that the enemy would not get possession of it? It is not by petty inventions that the engineering skill of England has been brought to aid the state in any contest. I believe if some of the most eminent civil engineers of England had been consulted in proper time, in conjunction with the military engineers,—I believe that means would be found by which the gigantic engineering resources of England could have been brought to bear on the struggle. It is certainly too much to say that Cronstadt could have been taken by contract. It is certain that wrought-iron will resist heavy ordnance, and further, it is a fact which nobody will deny, that the sea would be able to bear that weight. At the time there were actually French experiments in existence on the resistance of wrought-iron to shot—experiments which would be enough to afford correct data for the necessary calculations. There is little doubt that vessels might be constructed of such solid materials as would enable them to enter a harbour and take the batteries in reverse. This is not the place to enter into the minutiæ of such subjects; but when it is said that engineering science in England has added so little to our strength, I think we should call upon those who say so to show that engineering science was applied for in a proper time and in a proper manner. These observations may be a sufficient answer to the question, Why the Mechanical Section is necessary?

Mr. J. Scott Russell read the Report of the Tonnage Committee.

Mr. William Fairbairn read a report "On the Collapse of Tubes."

Mr. J. C. Dennis, of London, read a paper from Mr. J. Hartnupp, F.R.A.S., "On controlling the Movement of ordinary Clocks by Galvanic Currents."

Mr. G. Macgregor read a paper "On the Early Modes of Propelling Ships." The paper described the various methods adopted by the Egyptians, Assyrians, Chinese, and other nations for propelling ships and boats, up to the introduction of steam. Mr. Macgregor illustrated his description by a great variety of diagrams and drawings, copied from rare books in the British Museum and ancient sculptures found in different places.

Mr. Tate, one of the secretaries, read a communication from Mr. J. Beattie, "On Coal-burning Engines."—Mr. Miller, engineer of the Great Southern and Western Railway, bore testimony to the accuracy of the experiments detailed in Mr. Beattie's papers, and said he entertained a high opinion of the value of the invention.—Mr. Hemans, C.E., said the subject was one of the greatest interest and importance to railway engineers, proposing as it did to effect a saving of one million in one item alone in railway consumption. He hoped the invention would obtain a trial in this country, and that it might be the cause of giving a dividend in cases where there was none at present.—Mr. Barton, C.E., expressed a similar opinion as to the value of Mr. Beattie's invention.

Prof. Thompson addressed the section at some length "On the Machinery for laying Submarine Telegraph Cables."

Mr. Andrew S. Hart, F.T.C.D., made a few observations "On the effect of the Resistance of Water to an extended Cable."

Mr. H. Wright communicated a paper, by Palestrini, "On his Submarine Electric Telegraph Cable."

Mr. Charles Brooke submitted "A Plan for diminishing the risk of Injury to the Atlantic Cable by an Elastic Regulator."

Mr. W. S. Ward communicated a paper by J. Brackenridge, "On the Working and Ventilation of Coal Mines."

Mr. James Oldham read a continuation of a report read in 1853, "On the Rise, Progress, and Present Position of Steam Navigation in Hull."

The Hon. J. Wetherhead, United States, read a communication "On Superheated Steam."

Mr. J. J. Hayes read a paper "On a mode of rendering Peat economically available as a Fuel, and as a source of Illuminating Gas."

A communication was read from Mr. Thomas Silver, of Philadelphia, U.S., "On the importance of regulating the Speed of Marine Engines."

Mr. J. Neville, M.R.I.A., called the attention of the section to some facts "On the Flow of Water through Pipes and Water-channels generally."

Prof. Rankine read a paper "On the Principle of the Transformation of Structures."

Mr. J. Barton, C.E., described "The Principles upon which the Boyne Viaduct had been constructed."

Mr. Thomas Moy, of London, read a communication "On the Philosophy of the Wave-line System;" also, a paper "On Improvements in the mode of working Steam-engines."

Mr. B. A. Murray made some observations "On the Spinning of Silk from the Cocoon." He exhibited a model of the machinery by which the new process was effected, and stated that the silk spun in this manner was perfectly smooth, without a single knot in it from the beginning to the end, and therefore greatly superior to the article produced by the old system, besides which a vast saving of labour was effected. He had only just taken out a patent for the invention.

(Several of the above papers will be reported at length in our next.)

On the Want of Facts respecting the Performance of Vessels at Sea. By Rear-Admiral C. R. MOORSOM.

Having ventured to remark on the present incomplete position of naval architecture as a science, in a pamphlet which I have had printed for private circulation, I have since received communications from persons who are supposed to be authorities on the subject, which fully justify that remark; and I must say, that I am even staggered by finding how little is known at this day of the elementary facts which ought to be the foundation of all scientific deduction.

By "known," I mean publicly known and generally accessible. Individuals may possess specific information of a kind that might prove useful if open to the public; but if there be any one who possesses such data, founded on physical law and capable of being scientifically reasoned on, I do not happen to have met with him. Many empirical formulæ have been arrived at by practice, but admitted data and a common starting-point are wanting.

It is agreed that time, labour, and money would be saved, if in designing a vessel, the elements which compose the resistance were known. It is agreed that these can only be known by actual trial *at sea*, under the conditions with which a vessel is habitually surrounded. It is admitted that experiments may be so conducted as to determine the required elements. The question is, Who is to make them?

When the Chester and Holyhead Railway Company undertook to throw a bridge over the Menai Straits, which should give 105 feet of headway throughout its length, they had no reliable facts to warrant such an attempt. But they had reliance on the genius and skill of their engineer, and they authorised him to make a course of experiments to determine the form and proportions of that structure which now attests his ability and their well-founded trust, no less than their public spirit. These experiments cost the Company nearly 7000*l.*; and it was money well laid out. It saved time, labour and money, and also, what is more, possible failure.

Again also, when the London and North-Western Railway Company had to determine the most suitable engines for their rapidly increasing traffic, the directors employed two gentlemen of competent attainments to make a series of experiments on engines they had ordered of varying sizes and proportions, the cost of which experiments was nearly 3000*l.* But it was money spent to save money.

I am not aware of any one company contemplating the expenditure of some millions in vessels, and to whom therefore it would be worth while to institute experiments of a similar kind to those I have described; but the nation possesses a fleet whose aggregate cost (reckoning those only in actual service) cannot have been less than eight and a half millions, probably nearer nine millions sterling. In this sum I do not include the alterations and additions, the pulling to pieces and putting together again, which we know to have taken place. It is not easy to make out from the navy estimates what sum is yearly appropriated to building new vessels. But calculated as it must be to maintain the present numbers with vessels of a more costly description, it must be of so considerable an amount as to justify any reasonable expense that would tend to prevent the mistakes which are occurring, and the extra cost they entail.

Before describing the nature of the experiments required, it may be as well to state shortly the maxims or axioms, as to the resistance of water on a ship, of some of the principal authorities on naval architecture.

It is agreed that in still water, and without wind, and regarding only the part of the vessel at and below the load-water line, the direct resistance varies nearly as the square of the velocity.

In experiments made on a small scale with models, and on the vessels themselves, the power seems to vary from 1·7 to 2·28; but in the latter case there seems to be involved in the resistance of the water that of the air on the hull, masts, and rigging.

According to Romme, the resistance is determinable by the area of transverse section, *irrespective of form*, within such limits as are in use for ships.

Bernouilli and Euler concur in the resistance to a plane moving vertically being represented by the weight of a column of water whose base is equal to the plane, and height such as would by the force of gravity give the velocity of the plane; and from this is deduced the formula, $R = a \cdot w \cdot \frac{V^2}{2g}$.

Don Georges Juan holds that the resistance is of fourfold character, arising from the density of the fluid, the surface of impact, the square root of the immersion, and the speed.

Chapman, maintaining that the water divides at the greatest transverse section—that *before* being driven ahead, while that *abaft* follows the ship—lays down a rule for the resistance which it is not necessary to repeat here.

By the experiments of D'Alembert, Condorcet, and Bossut, the following axioms were established:—

1. That the resistances experienced by the same body, whatever be its figure, moved with different velocities through a fluid infinite in extent, are very nearly in proportion to the squares of the velocities.

2. That the perpendicular and direct resistances of several plane surfaces moved with the same velocity are very nearly proportional to the areas of the surfaces.

3. That the perpendicular and direct resistance of a plane in a fluid of infinite extent is nearly equal to the weight of a column of the fluid, of which the base is equal to the surface of the plane, and the height equal to that which is due to the velocity with which the impulse is given.

McConochie found by experiment that the resistances gradually diminished as the length increased *to a certain extent and in a certain proportion*, beyond which the resistance increased as the length of the body was augmented; so that there is a certain ratio of the length to the area of the opposed surface which gives the *minimum* of resistance.

The object of these experiments, made above fifty years ago, was to "reduce the forms of ships to some certain fixed principles, according to their respective duties, whether of war, commerce, or intelligence."

The experiments made by the Society for the Improvement of Naval Architecture between 1796 and 1798, conducted by Colonel Beaufoy, did not throw any greater light on the theory of resistances than is shown in the preceding summary, nor is there much more to be gathered of authentic data from other writers.

In the words of Mr. Wilson of the late Navy Office (written thirty years ago), "The common theory of the resistance of fluids, in its present state, is inapplicable to any practical purpose."

What advantages then have been obtained by these numerous experiments? We have learnt—"That the velocity of ships depends on the form at the after-part of the body as well as the fore-part." Also, "That while sharp bodies are less resisted in still water in a direct course, if the sharpness is given by great length, there is a maximum in this length by which the resistance is increased." We have, in fact, acquired the important knowledge of knowing how little we do know. Although, during the last twenty years, the form of vessels has received considerable modification, partly owing to the repeal of an absurd law, we are not much nearer the determination by any scientific process of the problem proposed to himself by McConochie, when he undertook the experiments to which I have referred.

A correspondence and negociation was carried on above twelve months between the government and the London and North-Western, and Chester and Holyhead Railways, and City of Dublin Steam-packet Companies, for vessels to run between Holyhead and Kingstown at the highest attainable speed without undue risk. The negociators differed in their views, from a speed made good of somewhat under 17 statute miles per hour, up to 21 miles; that difference involving sizes of vessel somewhere about as 2 to 3; of cost in outlay nearly in the same proportion; and in working expenses about as 3 to 5—these relations being irrespective of the increasing ratio of risk of accident and of consequential damage incident to the greater speed.

The most striking feature, however, in the case is the great difference in the size and proportion of the vessels, and in the power proposed by the several authorities who were applied to; the request being that they would state their views as to the size and power of the vessel best adapted to perform 65 statute miles in 3½ hours. The vessels differed in displacement from about 1550 tons to 3000; in proportion of breadth to length, from 9·37 to 11·6 per cent.; in draught of water to breadth, from 30 to 40 per cent.; and in nominal horse-power, from 550 to 1600. So wide a range as this is hardly consistent with a scientific knowledge of the size and form for "war, commerce, or intelligence" (despatch-boats).

The later modifications in the form of vessels have grown out of the use of steam power, and are in the direction of a proportionate increase of length, with a relative diminution of draught of water. But clipper sailing ships built on these principles have exceeded steam-vessels in speed.

It is now found that sufficient stability may be attained with a much smaller proportion of breadth to length than the old rules admitted. But the relations between length, breadth, and draught of water—between the area of transverse section and the displacement—between the angle of *entrance* and the angle of the *run*—and between the several sections of the fore and after bodies, are still matter of speculation when a vessel is to be built for any given service.

It is said that vessels designed upon "wave-lines" possess peculiar advantages. By "wave-lines" are understood the "hollow lines forming the entrance," which are to "correspond, as nearly as may be consistent with the form of a ship, to the form of a certain wave, capable of moving with the same velocity as the vessel." It is much to be wished that the manner in which this "certain wave" is generated could be defined, so that its properties as a curve might be calculated.

It may however be questioned, whether in any two vessels the length, breadth, draught of water, and displacement being the same, any "hollow lines" of the fore-body do actually increase the speed in a *sea-way* of one over the other whose lines may be of the usual form.

In 1841, thus wrote Mr. Scott Russell: "We believe there is no error which it may be possible to commit in steam navigation that has not already been perpetrated again and again......We regret that we cannot record in the present work that at this day the science of steam navigation is constructed, and can be presented to our readers."

Something has, however, been done since that day towards the construction of the science in question, and steps have been taken in the right direction, which, when followed up, may conduct us into the desired haven.

In 1845 a series of experiments was made with the *Rattler* and the *Alecto*, the first a screw and the latter a paddle vessel, the immediate object of which was to determine the comparative advantages of the paddle and the screw. Both indicator and dynamometer diagrams were taken to show the power applied on the piston and the thrust exerted on the screw shaft. But the trials of the *Rattler* not having been conducted so as to record all the attendant circumstances and disturbing elements, they are not conclusive.

In 1847-8 certain experiments were made with the French steam-vessel, *Pelican*, chiefly to determine the relations of the diameter, pitch, length, and number of blades of the screw, and its relations to the impelling power. By means of these and other experiments, that formula was established which, assuming the resistance to vary as the square of the speed, determines, by the power and transverse section on the one hand, or the power and two-thirds power of the displacement on the other hand, certain coefficients as expressed in the equation

$$K = \frac{SV^3}{P} \text{ and } K = \frac{D^{\frac{2}{3}}V^3}{P},$$

which are taken to represent the qualities of the vessel.

Now these coefficients, whether derived from the transverse section or the displacement, must represent three things,—viz., the resistance of the form, the resistance due to the slip of the screw, and the friction or absorbed power of the machinery; and it is only when the two latter are constant that any coefficient can represent the qualities of the vessel alone. But the slip and the absorbed power are not constant, unless under precisely similar conditions. Hence, a coefficient determined under certain conditions in smooth water cannot be the same in a sea-way.

To illustrate this I will take the trial of the *Rattler*, on the 1st April, 1845, when under steam alone, in smooth water, and before the wind, which was moderate. Her speed was 10 knots; indicator power, 368·8; area of transverse section, 300; displacement, 900 tons; thrust of the screw shaft, 9437 lb.; and slip of the screw, 11·2 per cent. The coefficient obtained in terms of the section with the speed in statute miles is 1250, and in terms of the displacement to the power of $\frac{2}{3}$ is 388·4.

Again, the results of a trial on the 31st March, when there was a strong west wind and some sea on, under steam alone, were,—speed, 8·8 knots; indicator power, 388; thrust of the shaft, 9263 lb.; and slip of the screw, 19·1 per cent.; giving for coefficients, 801·36 and 249 respectively. Here, under the altered conditions, but with the same displacement and transverse section, are coefficients of performance so widely different, as to be no guide as characteristic of qualities.

These two cases exemplify the necessity of taking into account in all experiments the force and direction of the wind and the sea, and the little dependence that can be placed on experiments in smooth water on a small scale with models. It must be borne in mind also, that two vessels of precisely the same form, but of different sizes, and of power proportioned, must have different coefficients.

It may be worth while to dwell shortly upon the conditions as to wind and sea of these two trials, and compare the specific resistances as measured by the thrust of the screw shaft.

Assuming that the resistance varies as the square of the speed, —if the conditions of wind and sea had been such in the second case as they were in the first, the speed of 8·8 knots would have been produced by a thrust of 7257·4 lb. instead of 9263 lb. Again, if the conditions of wind and sea had been in the first case as in the second, then the speed of 10 knots would have required a thrust of 12,945 lb. instead of 9437 lb.

In the first case the wind though moderate was aft, and added to the indicator power of 368·8, gave the actual power which produced the speed of 10 knots. In the second case the wind was ahead and strong, and there was also a head sea; the result was an increased resistance beyond that which would be due to smooth water and a calm. Therefore, the thrust was not in either case a measure of the specific resistance due to the form of the vessel, being in the first case less, and in the second case more, than is due to the respective speeds in smooth water and a calm. Therefore, also, the resistance did not vary as the square of the speed.

Some corroboration of this reasoning is derived from the trial of the *Rattler* on the 27th of June 1844, in the river Thames, when, her area of section being 274 square feet, displacement 870 tons, speed 10·074 knots, the indicator power was 428, or 59 more than in the trial on 1st April 1845, when, having a breeze of wind though without any sail set, her speed was the same within a small fraction. In this case the coefficient, in terms of the section, is 1004·5, and in terms of the displacement, 334. The sectional area and the displacement being greater on the 1st April 1845, than on the 27th June 1844, adds strength to the argument.

It is assumed in these experiments that the thrust of the screw shaft, as indicated by the dynamometer, is a measure of the specific resistance of the vessel. This however seems to me rather doubtful; and, to explain my doubts, I will refer to the trial on the 30th March, when the weather being calm and the water smooth, the speed of the *Rattler* was 9·2 knots; the indicator power, 334·6; the thrust, 8708 lb.; and the slip, 10·2 per cent.

The effective power, or total resistance which balanced the power on the pistons, was therefore 11,837 lb., of which 8708 is 73·56 per cent., leaving 26·44 per cent. for the effect of slip and absorbed power, which seems to me much less than under the actual circumstances would be produced. I should estimate the specific resistance at little more than 7000 lb., or about 59 per cent.

The experiments with the *Pelican*, though scientifically conducted, were without the use of a dynamometer. The trials were made in smooth water, and in a tide-way, and the vessel being only of about 258 tons displacement, the conclusions can be considered as applicable only under similar conditions.

Having alluded to empirical formulæ arrived at by practice, I may instance the cases given in the pamphlet I have had printed for private circulation; and I do so for the purpose of stating explicitly, that though the results both in speed and in power for a great variety of types approach very near the truth, the mode of arriving at those results, though based on the physical law described above, has merely been stumbled on by many years' practice of analysing and classifying all the authenticated facts that have fallen into my hands.

With this admission I may however say further, that if a similar method of investigation was applied to cases of experiments conducted at sea under a vast variety of conditions both as to form, size, and circumstances, it is my impression that rules might be established which would serve to determine much of what is now the subject of controversy, and go far to remove the reproach on the greatest maritime nation in the world which is contained in the following passage from an author I have before quoted: "It is admitted that out of every three steam-vessels that are built two fall very far short of fulfilling the intention with which they were constructed." If sixteen years may have produced any qualification of this truth, it is rather by the tentative process of successive attempts correcting preceding blunders than by any scientific design.

I have now said enough to show the want of experiments conducted towards a given end by appropriate means, and I might proceed further to give my own notions as to the end and the means; but I abstain from doing so, because I think these would be more satisfactorily settled by a few competent persons to whom the conducting of the experiments should be committed. Several vessels of different forms and sizes would be required, though not all at the same time; and months must be passed in the process. Such experiments can only be attempted by the government; and they ought to attempt them, for the greatest gainers will be the public.

I hope this sketch will prove sufficient to induce the British Association to bring their influence to bear on the obstacles standing in the way of a real and earnest attempt to solve the questions in issue, on a subject whose national importance cannot be exaggerated. Great Britain has the lead in steam navigation; but she cannot expect to keep it, without all that science and practical skill can do to improve both vessels and engines. Is that improvement to be effected by scientific efforts, on a system, — or by the spasmodic impulses of individual genius, sometimes hitting, but more often missing its aim ?

Mechanical Effect of Combining Girders and Suspension Chains.

By Peter W. Barlow, F.R.S.

My attention has been recently directed to this subject from having been required to investigate, as engineer of the Londonderry and Enniskillen and Londonderry and Coleraine Railways, the best mode of effecting a junction between the lines at Londonderry, to be combined with an improved road communication, for which an Act has been obtained by the corporation of the city; and the Commissioners having determined to advertise for plans, leaving the decision to Sir William Cubitt, an engineer justly occupying a position so eminent, and in whose judgment I had the greatest confidence, I determined to submit the result of my investigation to him; although the principle which I concluded would best meet all the circumstances of the case, viz., the suspension girder, was one with reference to which considerable prejudice had existed.

Sir William Cubitt, after devoting much attention to the subject, has fully sanctioned the principle, and recommended the Bridge Commissioners to carry out my design, with some modifications suggested by him; but as some doubts have been expressed as to the accuracy of my calculations of the weight of girder required to make a suspension bridge as rigid as a girder, they decided to refer the question to a second eminent engineer; and the subject is now under the consideration of Mr. Hawkshaw.

In order to verify my calculations, I have caused a series of experiments to be made, the results of which are of so much practical importance and so fully confirm my investigations, that I determined to lay them before the British Association, in order that the simple question of the mechanical effect of combining a girder with a suspension chain, on which no difference of opinion ought to exist, should be fully decided. But before describing these experiments I will make a few general remarks upon the systems which have been adopted in bridge constructions.

General Remarks upon the Construction of Bridges of Large Span.

Bridges may be divided into three classes—

1st. The Arch, a structure in which the supporting material is subjected to compression alone, but which contains no rigidity in itself.

2nd. The Suspension Bridge, in which the supporting material is subjected to extension alone, which also contains no rigidity in itself; and,

3rd. The Girder, in which the material is subjected to both extension and compression; of which there are two varieties, one which is subjected to diagonal strains, as the lattice, Warren, and tubular girders; and a second, in which all the strains are confined to the upper and lower webs, as in the bow and string; and Mr. Brunel's new girder, which is a combination of an arch and a suspension chain, each doing half the supporting duty.

This second variety is the most simple form, but has no more rigidity in itself than an ordinary arch or suspension bridge.

Of these three systems the girder necessarily requires, from combining compressive and extensive resistances, a much larger amount of metal than either of the other systems, which will be rendered evident by a simple investigation, and by reference to existing structures.

In an ordinary arch the compressive force is resisted by the abutments, which in no way add weight or strain to the metal; but, if the arch is converted into a girder, it can only be done by adding a tie-bar, the arch having then to support its own tie or substitute for an abutment in addition to its own weight.

In a suspension bridge the extensive force is resisted by back chains; and if these are taken away to make it a girder, a compression-tube or bar has to be used as a substitute for them (as in the Chepstow Bridge), which tube becomes in large spans, with its supports, by far the largest portion of the structure, and destroys the bridge by its own weight, the weight of metal being fully doubled to produce equal strength, and quadrupled to produce equal stiffness, if loaded equally all over.

The great difference in weight produced by this and other causes will be seen by comparing suspension-girder bridges with ordinary girder bridges; and I will take as an example the case of the two largest railway openings yet constructed—the Niagara suspension-girder bridge, and compare its weight of metal with that of the Britannia Tube.

The quantity of material in the Niagara Bridge, having a roadway and a single railway of three gauges in a span of 820 feet, is in round numbers 1000 tons; and the weight in the Britannia Tube of 460 feet span, 3000 tons, for a double line.

If the Britannia Tube had been made on the same principle as the Niagara Bridge, the quantity of material to give the same strength and rigidity would not have exceeded one sixth part of what has actually been employed.

So great a difference in the weight renders it obvious that the principle of an ordinary girder involves great extra material, and it became an interesting and important inquiry to ascertain the cause of this difference.

The view that has hitherto been generally adopted on this subject is that advanced by Mr. E. Clark in his work on the Britannia Tube; in which he states, speaking of the proposal to use the Menai Suspension Bridge for railway purposes, "With respect to the use of the present suspension bridge for the proposed traffic, it was found difficult to devise any means of sufficiently strengthening it that did not involve an almost entire reconstruction, and great difficulty was similarly found in attempting to render any suspension bridge sufficiently rigid for railway traffic by means of ordinary trussing. When the passing load is small compared with the weight of the chains and of the structure itself, there is indeed no difficulty; but the construction of a platform 450 feet long, sufficiently rigid for railway traffic, almost amounts to the construction of the tube itself."

Although unsupported by fact or experiment, this theory has been received and acted upon, not only by a large portion of the public, whose impressions of suspension bridges are derived from what had hitherto been constructed of insufficient strength, and without being combined with a girder, but it has been received and acted upon by engineers of eminence in this country.

These experiments however distinctly prove that a suspended girder, as designed for the Londonderry Bridge, is rendered equally rigid with less than $\frac{1}{3}$ of the metal required in the girder alone; so that the most important economy arises from the combination of the girder with a chain.

Experiments on Suspension Girders.

I have had the model which is now submitted to the meeting accurately made on a scale of $\frac{1}{35}$ part of the actual span, the length being 13 ft. 6 in. between the bearings,—a length exceeding that of the average of the models used by the Iron Commissioners in their experiments, and is amply sufficient (due allowance being made for the scale) to determine with accuracy the deflections on the actual girder; although the deflections of the chains will be somewhat more on the model than on the girder, from the weight not being sufficient to bring the surfaces into perfect contact.

The principal object of the experiments was to ascertain the deflection of the wave of a girder attached to a chain, as compared with the deflection of the same girder detached.

This being obtained, it was perfectly easy to arrive at the deflection of the wave of the Londonderry Bridge; because we have sufficient experiments on girders to enable a calculation to be made of what the Londonderry girder would deflect without the chain; which being obtained, and reduced in the ratio of the girder attached to the girder detached, gave the true deflection.

My first intention was to make the experiments with a girder which was a correct model of the actual bridge, which would have indicated $\frac{1}{33}$ of the actual deflection; but I found the deflection of the wave to be so small, that it was difficult to measure it with sufficient accuracy; and I therefore had a wooden box made of the correct depth, with the sides as thin as it would stand, viz., $\frac{1}{4}$ deal plank, in order to obtain greater deflection of the wave with the correct depth of the girder, and with the chain attached to it, as in the proposed bridge.

I could no longer obtain the actual deflection of the Londonderry Bridge by multiplying the experimental deflections by 33; but knowing that the deflection of a model on the correct scale would be $\frac{1}{33}$ of the Londonderry girder, and knowing by experiment what the model did deflect when unattached, the actual deflection of the Londonderry girder is obtained by reducing the observed experimental deflection in the ratio of the rigidity of the actual model to a true model, and then multiplying by 33.

The deflections of this girder, taken without the chains attached, with a weight of 168 lb. on the centre, was ·75 of an inch; with the chain attached, and with the weight placed $\frac{1}{4}$ from the high tower, it was as follows :—

lb.	$\frac{1}{4}$ from high tower. inch.	Centre. inch.	$\frac{1}{4}$ from low tower. inch.
56	·030	·010	·010
112	·060	·040	·010
168	·075	·040	·010
	Experiment 2.		
56	·030	·020	·000
112	·050	·040	·005
168	·075	·050	·005

The ratio of the deflection of the wave at $\frac{1}{4}$ the distance where the greatest amount arises when the chain is attached, to that in the middle when not attached, is as 1 to 10 only; but it was evident, from the large deflection at the centre, and from no rise occurring at the opposite end, that the girder was too rigid to indicate the wave, and that the deflection observed was greatly due to the chain not coming to its bearing.

I therefore decided, in order to magnify the wave, and make its amount more distinct, to have a girder made of angle-iron $\frac{1}{8}$ inch thick, and a quarter the depth of the former girder, but simply suspended from and not attached to the chain.

The deflection of this girder without the chains, with a load of 42 lb. placed on the centre, was 1·2 inches.

The deflections of the wave with the chain attached, and 227 lb. distributed over the girder when the weights were placed at $\frac{1}{4}$ from the high tower, were with

lb.	$\frac{1}{4}$ from high tower. inch.	Centre. inch.	$\frac{1}{4}$ from low tower. inch.
56	— ·10	— ·01	+ ·05
112	— ·20	— ·04	+ ·12
168	— ·28	— ·06	+ ·16

Experiment 2.—In this case the weights were placed $\frac{1}{4}$ from the low tower :—

56	+ ·06	— ·01	— ·12
112	+ ·15	— ·05	— ·25
168	+ ·18	— ·07	— ·36

The deflections here averaged ·32 inch with 168 lb., equal to ·08 inch with 42 lb., or $\frac{1}{15}$ the deflection of the girder without the chain.

The deflection of the Londonderry girder, deduced from the mean results of the deflections of the Boyne Viaduct and Newark Bridge and the Britannia Tube (see Appendix A), was 33 inches, with 100 tons in the centre; $\frac{33}{15}=2·20$ inches, the deflection here indicated in the Londonderry Bridge with 100 tons placed at $\frac{1}{4}$ the length of the girder.

It was still obvious, from the deflection at the centre and little rise exhibited in the wave, that the stretching of the chain to bring the metal surfaces to bear still sensibly influenced the result; and I had another wooden girder made, consisting of a plank $7\frac{1}{2}$ inches in width and $\frac{3}{4}$ inch thick, in order to still more magnify the wave, and to diminish the error from the stretching of the chain.

The deflection without the chain attached was 1·48 inch with 10 lb.

Experiments with the Chain attached.

With 56 lb. placed at $\frac{1}{4}$ from the high tower on the girder which was previously quite unloaded, the deflections were, at

$\frac{1}{8}$ from high tower. inch.	$\frac{1}{4}$ from high tower. inch.	$\frac{3}{8}$ from high tower. inch.	$\frac{1}{2}$ from high tower. inch.	$\frac{5}{8}$ from high tower. inch.	$\frac{3}{4}$ from high tower. inch.	$\frac{7}{8}$ from high tower. inch.
— ·31	— ·48	— ·32	— ·02	+ ·22	+ ·29	+ ·15

Experiment No. 2.—70 lb. being equally distributed over the girder, and 56 lb. at $\frac{1}{4}$ from high tower :

— ·28	— ·42	— ·25	+ ·04	+ ·23	+ ·28	+ ·20

Experiment No. 3.—150 lb. all over weight in same place :

— ·20	— ·35	— ·20	+ ·02	+ ·20	+ ·23	+ ·14

Experiment No. 4.—193 lb. equally distributed, 56 lb. as before :

— ·18	— ·31	— ·17	+ ·05	+ ·18	+ ·20	+ ·14

The deflection here indicated, with the model loaded with a weight representing 96 tons on the bridge (which experiment was several times repeated) was ·31 with 56 lb. = ·055 with 10 lb., or $\frac{1}{26}$ of the deflection of the girder without the chain; $\frac{33}{26}=1·27$ is therefore the deflection of the wave indicated by the experiment of the Londonderry Bridge with a load of 100 tons at $\frac{1}{4}$ from the tower.

To obtain the comparative rigidity of the experimental girder: we have here,—as 206 lb. : 10 lb. : : 1 in. : ·0485, the deflection of a true model with 10 lb.; $\frac{1·48}{·0485}$ or $\frac{1}{30·5}$ represents the rigidity of the experimental girder; $\frac{31}{30·5}\times 33 = ·335$, the deflection by a weight on the bridge of $56 \times 33^2 = 27$ tons. 27 : 100 : : ·335 : 1·27, the deflection as previously calculated.

This result being so much at variance with the general view of the subject, although very nearly in accordance with my calculations, I determined to verify it by a smaller girder, 6 inches by $\frac{3}{4}$ thick, which would render the wave still more visible; the observations being made with great nicety.

The deflection at the centre when not attached to the chain was 2·375 inches with 8 lb. Girder attached to the chains, 193 lb. being equally distributed over it: the deflection, with the weight placed $\frac{1}{4}$ from the high tower, was

lb.	$\frac{1}{4}$ from high tower. inch.	Centre. inch.	$\frac{1}{4}$ from low tower, inch.
56	— ·64	+ ·13	+ ·53

Experiment 2.—With 56 lb. at the centre of the bridge the deflection was — ·30.

The deflection of the wave here exhibited at $\frac{1}{4}$ of the length, with the bridge loaded to a weight equivalent to 100 tons on the actual bridge (which experiment was repeated several times with the same result), was 0·64 inches with 56 lb.; the deflection without the chains being 2·375 with 8 lb., or 25 times the amount.

In determining how far this result was effected by the resistance produced by the change of figure in the curve of the chain, I removed all the weights from the plank, and found the result as follows, with 56 lb. at $\frac{1}{4}$ from the high tower :—

$\frac{1}{4}$ from high tower. inch.	Centre. inch.	$\frac{1}{4}$ from low tower. inch.
— ·85	+ ·20	+ ·75

With 56 lb. placed $\frac{1}{4}$ from low tower :—

+ ·81	+ ·12	— ·86

From this experiment it appears that the deflection is decreased by loading the bridge to $\frac{1}{30}$ of that of the girder unattached, and if the chain were without weight it would be still further reduced; in practice, however, the weight on the bridge will much exceed that on a model, and $\frac{1}{25}$ will be the least amount that will arise, a result so at variance with the pre-conceived notions of many engineers, that it is to be expected in some instances it will be received with incredulity; but an investigation will show that the result is in accordance with the law $\frac{l^3 w}{b d^3 x}$ = a constant quantity.

If the girder were supported only in the middle, the deflection of the half-girder would be $\frac{1}{8}$, but as one half of the girder cannot deflect without the other half rising, from the action of the chain, it is reduced to $\frac{1}{16}$; but the girder is not supported at one point only, but at various points, which will still further reduce the deflection.

However, whether this view is precisely the correct one or not, the fact is established that the deflection of the wave of a girder attached to the chain, and loaded as in the actual bridge, will not exceed 1-25th of the same girder without the chain; from which we may estimate the weight of girder sufficient to produce in a suspension bridge or arch the requisite rigidity.

In order to show the importance of this result in the cost of bridges, I will compare the deflection and weight of metal in a bridge similar to the Londonderry Bridge, with a girder of equal span; in each case assuming that 3 tons per foot on the bridge will bring no strain exceeding 5 tons per inch on the metal.

	Tons.
The weight of chain such that 3 tons per foot on the girder will not exceed 5 tons per inch, is (see Appendix B) ...	150
The weight of girder sufficient to give no wave or deflection greater than 1·32 inch with 100 tons (see Appendix A)...	150
The weight of metal in cast-iron columns, so that the greatest compression with 3 tons per foot is 4 tons per inch (see Appendix C)	60
Weight of suspension bars, so that the tensile strain does not exceed 5 tons per inch with 3 tons per foot load (see Appendix D)	15
	375
To this has to be added the value of the cost of the anchorage of the chains, which in the Londonderry Bridge will be 15 per cent. of the ironwork of the main-girder portion of the bridge, so that I have added 57 tons to represent the value of the cost...	57
	432

To compare this weight with that of a girder alone of the same length and depth as that used, which would be equally rigid with the suspension girder, we have to multiply 150 by 25 = 3750 tons, or more than eight times the amount of metal; but it may be correctly argued that a simple girder would be made deeper, and it is therefore fairer to make the comparison with an actual girder, of which we have an example, nearly the same span, in the Britannia Tube.

The weight of the pair of the Britannia Tubes is 3100 tons, or more than seven times the amount,—a difference which will be received with surprise, but it is perfectly consistent with the fact that the Derry Bridge has nearly three times the depth, and has 2660 tons less of its own weight to support.

The weight of metal in the Londonderry Bridge does not, in fact, exceed that of the sides of one of the Britannia Tubes, without the top and bottom webs.

It should be observed, that the proportion of the cost of anchorage will vary under different circumstances, but in the case of the Londonderry Bridge it will be under 15 per cent.

It should also be noticed, on the other hand, as a set-off to the cost of anchorage, that the foundations will be increased in a girder bridge, from their having to support 3110 tons as compared with 432 tons in the suspension bridge, which will produce an amount of saving in average cases equal to the anchorage.

We will now compare the rigidity of the suspension bridge with that of the tube.

The deflection from one ton per foot all over the suspension bridge (see Appendix A) will be 1¼ inch.

The deflection of one of the Britannia Tubes from one ton per foot all over is 3½ inches.

The greatest wave that will be produced by a train of 200 tons covering one half of the Londonderry Bridge, the other portion being unloaded, will be readily found from the experiments.

The calculated deflection of the girder, with 200 tons all over, separate from the chain, is 41·25 inches (see Appendix A): $\frac{41{\cdot}25}{25} = 1{\cdot}65$, the greatest deflection of the wave, if simply suspended from the chain; but as the chain in the actual bridge is attached to the girder for nearly one-half the length, the rigidity will be much greater than here indicated.

It thus appears that the deflection of the Londonderry Bridge, with a suspended girder and loaded all over, equals the wave when the bridge is half loaded; and they are each about half the deflection of one of the Britannia Tubes when loaded all over with the same weight per foot.

It is necessary to explain that the estimate given of the deflection of the Britannia Tubes assumes that they act separately; when united at the top, they become in fact suspension girders, and the deflection is reduced. On the other hand, it has to be noticed that I have not taken into account the increased rigidity from uniting the girder to the chain, instead of simply suspending it, which will have a most material influence.

I will also call attention to the fact, that in estimating the deflection of the Londonderry Bridge I have treated the point of support as a fixed point, which is the case if all the spans are equally loaded; but in the event of one span being loaded and the adjoining span unloaded, the point of suspension will not be a fixed point, and the deflection will be greater than I have estimated.

Thus, with one span loaded and the second span unloaded, the girder bridge will show a comparatively better result than with the entire bridge loaded, but not to any sensible amount, as the same property which renders the suspended girder rigid will prevent the movement of the point of suspension.

The weight on one opening will create a disposition to straighten the chain in the adjoining opening, which will be resisted by the girder so effectually from being united with it, that little motion of the point of suspension will occur, even if no assistance were given by the tower.

We may make a similar comparison deduced from other large girders, of which the next largest actually erected is the Boyne Viaduct. Here the

Span is	264 feet
Weight of effective metal...	300 tons.

To find a girder of equal depth and rigidity of 440 feet span; we have—as $264^3 : 440^3 :: 300 : 1388$ tons, the weight of a girder being continuous, that would deflect 1·9 inch with 540 tons all over, or about ⅔ the rigidity of the Londonderry Bridge.

The Boyne Viaduct thus indicates a much more favourable result than the tube; and as the system would admit of greater depth, much less metal would suffice for this span.

A similar deduction may be made from the Newark Dyke Bridge, which has

Span of opening	240 feet.
Weight of metal	244½ tons.

Here we have—as $240^3 : 440^3 :: 244\frac{1}{2} : 1506$ tons, the weight required to construct a girder that will deflect 2⅔ inches with 240 tons; and indicates also a more favourable result than the solid-sided girder, but not equal to the Boyne Viaduct.

I must not conclude these comparisons without referring to Mr. Brunel's new system of combining an arch and a suspension chain, giving each half the duty.

There is no doubt, in the case of the proposed Londonderry Bridge, if the chain was reduced to half the section, and an arch of the depth of the chain was substituted, and the suspension rods extended to the arch, that theoretically with the same metal there would be equal strength and rigidity; but the real difficulty is the impracticability of such a construction—the metal in an arch of 451 feet span and 8 feet rise cannot be measured by the section, as in a chain, from the tendency to buckle and from having to contend with its own weight.

Thus, in the Saltash Bridge, which is now in course of construction on this principle, of 451 feet span, the depth is only 56 feet, or little more than ⅓ of the Londonderry Bridge, if of that construction; and thus nearly three times the metal is required to give equal strength, and nearly nine times to give equal rigidity, from the deflection varying as the cube of the depth.

It will be observed that there will be no difficulty in giving even a greater depth to a suspension bridge. The vertical pressure or weight of the bridge is small compared with the pressure on the arch of Mr. Brunel's girder, and as the height is only 88 feet no practical difficulty arises.

Concluding Observations.

The important practical results of the preceding experiments are—

1st. That in suspension bridges it is essential that the platform should be stiffened with a girder to prevent vertical undulation.

2nd. That the deflection of the wave of a girder attached to a chain similar to the Londonderry Bridge will not exceed 1-25th of the deflection of the same girder not attached to the chain.

3rd. That theoretically the saving of metal to give equal strength in a suspension bridge is only one-half of that of a girder; but as it can be made of great depth without practical difficulty, and as the deflection varies as the cube of the depth, a bridge on this principle of such span as the Londonderry Bridge may be made under average circumstances with at least one-fourth of the metal of an ordinary girder bridge having equal rigidity.

The results Nos. 1 and 2, although at variance with the general practice of engineers, are still in accordance with such experience as we possess.

Suspension bridges, with a few exceptions, have been not only built of small depth, without stiffening girders either vertically or horizontally, but the points of suspension have not been fixed, but simply resting on rollers, so as to give every facility for movement; and thus arises the motion generally complained of in suspension bridges.

Moreover suspension bridges have been built without any rule or supervision, and as they will bear their own weight however lightly constructed, they have been in most cases of insufficient strength, many now existing not having $\frac{1}{6}$ or $\frac{1}{8}$ the strength given in the Derry Bridge.

In a few cases where a girder has been used, the results accord with my experiments. The Niagara Bridge of 820 feet span has a girder very little deeper than the Derry Bridge, and is built of timber only; yet the deflection from a train is not more than 5 inches, as appears from the report of Mr. Roebling—an amount much less than my experiments would indicate, when it is considered that the girder is of timber only.

Another case is that of the Inverness Bridge, which has a wrought-iron parapet 3 ft. 6 in. deep, and is nearly represented by the small wrought-iron model. This bridge has been subjected to the test of a locomotive passing over it on a truck drawn by fourteen horses, which produced so little deflection, as appears from the report of Mr. Rendel, that a member of the Institution of Civil Engineers, when the subject was mentioned at the recent discussion, expressed his doubt of the fact.

It is, however, satisfactorily explained by the preceding experiments, which prove that such a parapet is sufficient to render a suspension bridge so nearly rigid, that no deflection would be observable without measurement.

There are other cases of suspension girder bridges, viz., the Montrose Bridge in Scotland, the Kief Bridge in Russia, and more recently, the Chelsea Bridge over the Thames at London, in all of which it is reported that objectionable movement is cured; and I am informed by Mr. Vignoles, the engineer, that the Kief Bridge has been passed over by Russian artillery at a gallop without any objectionable oscillation or deflection. In America suspension bridges have been used for aqueducts, the trough acting as a girder, the success of which proves that all vertical and horizontal oscillation has been cured.

I will conclude my paper by remarking, that it has been necessary in the preceding investigation to make reference to the existing works of eminent engineers. I am desirous to observe, that such comparisons have been essential to the elucidation of the question, and that I have no intention for one moment to detract from the engineering merit of these great works. The genius exhibited in overcoming the various difficulties which presented themselves during their execution must be evident to all, but more especially to those whose profession renders them acquainted with what had to be contended with.

At the time they were designed the popular objections to suspension bridges were much greater that at present, and no example existed of a railway suspension bridge. An engineer might then have been as little justified, under such circumstances, in adopting a suspension bridge for railway traffic, as he would now be in error in disregarding the experience which has since been obtained.

It is still, however, asserted, but without any assigned reason, that suspension bridges are not adapted for trains at speed; my own view on this point, from large experience in railway construction, from observing the effect produced on bridges crossed by contractors' wagons drawn by horses, and by experiments made on trains at speed with the Iron Commissioners, is, that road traffic gives as severe trial by troops marching in step, by herds of cattle, or by cavalry trotting or galloping, as the heaviest trains at full speed on railways.

This is not, however, the subject I now submit for discussion; the first step in the inquiry is the simple mechanical problem of the strength and deflection with stationary loads, on which no doubt should exist; and when it is remembered that the extension of the railway system is much governed by the cost of construction, of which the crossing of valleys and rivers forms so considerable an item, that in some cases a single bridge costs as much as 75 or 100 miles of line, I hope the inquiry will be deemed of sufficient importance by the Association to elicit a full investigation and discussion.

Appendix A.

Estimate of Deflection of the Londonderry Girder, from Experiments on the Boyne Viaduct.

The centre opening is 264 feet.
Weight of girder 300 tons.
540 tons all over produces a deflection of 1·9 inch.

The deflection, if of the length of the Londonderry Bridge, would have been $264^3 : 440^3 :: 1·9 : 8·79$.

To ascertain the deflection, if of the same depth as the Londonderry Bridge, we have

$$16·5^3 : 22·5^3 :: 8·79 : 22·289 \text{ inches.}$$

This assumes a weight per foot forward equal to the Boyne Viaduct. The Boyne Viaduct, if of the same length as the Londonderry Bridge, would weigh 512 tons. The following will therefore be the deflection if of the same weight as the Derry Bridge,

$$150 : 512 :: 22·289 : 76·078 \text{ inches,}$$

which is the deflection with 540 tons all over.

200 tons all over will therefore be 28·17.
100 tons in the middle . . 23·53.

Estimate of the Deflection from Experiments on the Newark Dyke Bridge.

Span 240 feet.
Weight of girder $244\frac{1}{4}$ tons.
Deflection with 240 tons all over, 2·75 inches.
As $240^3 : 440^3 :: 2·75 : 17$ inches.

The depth of the Newark Dyke Bridge being the same as the proposed Londonderry Bridge, 17 inches will indicate the deflection if it was equal in weight to the Newark Dyke Bridge; but the weight, if of the same length, being 450 tons, we have

$$150 : 450 :: 17 : 51 \text{ inches,}$$

the deflection with 240 tons all over.

With 200 tons all over, 42·5 inches.
With 100 tons in the middle it will therefore be 34 inches.

Estimate of the Deflection from Experiments on the Britannia Tube.

The Britannia Tube weighs 1600 tons, and deflects with 200 tons all over 1·25 inch.

The deflection of the Britannia Tube, if reduced to 150 tons, would be 12·5 inches.

The depth practically of the proposed Londonderry bridge is $16\frac{1}{2}$ feet, and of the Britannia Tube 28 feet.

$$16^3 : 28^3 :: 12·5, \text{ or}$$
$$449·21 : 2195·20 :: 12·5 : 60·7 \text{ inches;}$$

which has to be reduced in the ratio of the cube of the span

$$460^3 : 440^3 :: 48·75 : 53·08,$$

the deflection of the Londonderry girder with 200 tons all over.

The mean of the three results indicates 41·25 inches as the deflection of a girder of 150 tons loaded all over with 200 tons, and 33 inches when loaded in the middle with 100 tons; $\frac{44}{33} = 1·32$ will therefore be the deflection when attached to the chain.

Appendix B.

Dimensions of Londonderry Bridge and Calculation of Strains and Deflection.

Span between points of support	451	feet.
Length of the girder	440	,,
Depth at high tower	88	,,
,, side	59	,,
Centre catenary half horizontal length ...	246	,,
Side ,, ,, ,, ...	205	,,
Length half chain (centre)	266·2	,,
,, ,, (side)	215·5	,,

Strain on cables at high tower with 3 tons per foot load, assuming $\frac{1}{8}$th to be supported by the girder, and $2\frac{5}{8}$ tons by the chain, according to the formula—

$$T = \frac{w}{4x} \sqrt{4x^2 + y^2} = \frac{1200}{4788} \times \sqrt{4 \times 88^2 + 246^2} = 1031 \text{ tons,}$$

where x = the depth of catenary, y = the half span, w = the weight equally distributed, and T = tension.

Section of the cable at high tower, so that no strain exceeds 5 tons per inch ... ... 206 inches.

Strain on the cable at the side tower

$$\frac{1000}{4 \times 59} \times \sqrt{4 \times 59^2 + 205^2} = \quad \ldots \quad \ldots \quad 1000 \text{ tons.}$$

Section of cable at side tower	200 inches.
Horizontal strain	840 tons.
Section of iron at bottom of chain	168 inches.

Deflection from Expansion and Contraction.

This calculation assumes that the expansion between summer and winter is $\frac{1}{2000}$th part of the length, and that it produces a strain of 5 tons per inch.

The exact length of the chain, from the formula

$$z = \sqrt{y^2 + \tfrac{4}{3}x^2} \text{ or } \sqrt{246^2 + \tfrac{4}{3}88^2} \ldots \quad \ldots = 266{\cdot}16$$

where z = half length of catenary, y = half chord, and x = versed sine.

Add elongation of half the cable ... ... ·133

266·293

$$x = \sqrt{\tfrac{3}{4}z^2 - y^2} = \sqrt{\tfrac{3}{4}266{\cdot}293^2 - 246^2} = 88{\cdot}3.$$

The deflection therefore from the temperature will be ·3 of a foot, or 4 inches, a deflection much under ordinary suspension bridges, arising from the great depth, from which has to be deducted the expansion of the cast-iron towers, which will amount to half-an-inch. The same deflection of course indicates the effect of 3 tons per foot on the bridge, as this weight produces 5 tons per inch strain on the cable. One ton per foot all over will therefore cause a deflection under $1\frac{1}{2}$ inch.

Appendix C.

In the design for the proposed Londonderry Bridge ornamental cast-iron towers are proposed. As a mechanical question we must estimate them as cast-iron columns acting simply to carry weight, which, if they were so designed, would be as follows:

The weight to be supported by the high tower when the bridge has its extreme load is 1500 tons. To give 4 tons per inch we require 375 inches, or 3750 lb. per yard.

The high towers being 30 yards high, the weight of metal will be 50 tons.

The low tower will have 1320 tons with a full load: $1320 \div 4 = 330$ inches, or 3300 lb. per yard; the height being 20 yards, the weight will be 20 tons.

The mean of the two towers will require for direct strain ...	40 tons.
Add 50 per cent. for bolts and ineffective material	20 ,,
	60 tons.

Appendix D.

Estimate of the Weight of Suspension Bars.

The weight to be carried is 1100 tons. If we allow 5 tons per inch, the section required is 220 inches, or 2200 lb. per yard; the average length is 10 yards, and weight ...	10 tons.
Add 50 per cent. for ineffective metal	5 ,,
	15 tons.

A New Railway Signal. By Dr. Gray, Dublin.

Dr. Gray said that the pneumatic principle was adopted in the signal before the section, and he should observe that it was not new, as it was frequently applied for the purpose of signalling in one form or other. Some time ago, a Mr. Fitzgerald submitted to the traffic manager of the Great Southern and Western line an ingenious application of the pneumatic principle, which was a very close approach to success. He placed a tube along the whole line of the train, which terminated in a hand pump in the guard's van, and in a cylinder at the engine. In this cylinder a piston moved freely, its motion actuating a lever; and when the guard worked his hand pump, he exhausted the line of pipe, and of course the top of the cylinder; the piston was at once forced up by the atmospheric pressure, and carried with it the end of a lever which turned a steam cock fitted to a pipe from the boiler, and let on steam to a whistle. Thus at any time the guard at the end of the train could sound the steam whistle at the engine by this plan. It was worked for some weeks on trial, but was abandoned in consequence of the difficulty experienced in making couplings at once air-tight and facile for connecting or disconnecting the carriages when making up or taking asunder a train. Besides, when the guard was cut off by a severance of the train, the power to make signals was cut off, and no notice was given to the driver.

Mr. Dillon, however, conceived the idea that if a permanent exhaust could be maintained in a tube placed along the train, terminating in the same kind of cylinder, signals could be given with greater ease and certainty by the mere admission of air, so as to destroy the exhaust. The first experimental apparatus consisted of a brass cylinder with a piston and brass rod attached, placed in a box connected with a steam pipe from an engine, a long tube, and a hand pump. The exhaust, instead of turning the cock so as to let on steam, turned it so as to shut it off, and take a bar or semaphore out of view, and while the pump was worked it kept them so; but when the pump was stopped the exhaust ceased to be kept up, the lever fell, and the steam was let on the exhaust. Mr. Dillon had invited him (Dr. Gray) to assist him in making the mechanical arrangements necessary to reduce the idea to practical operation on a railway train, and the result was a small mahogany box, about eight inches by ten, and four inches thick, the full size requisite for the signal box on the engine. There was a circular opening through the box about five inches in diameter, and a red bar hung across the opening; a small tube, about $\frac{1}{2}$-inch diameter, projected from one side of the box, and a whistle and small semiglobular brass cap, with a small tube from its side, were fastened on the top. This box was placed on the engine in front of the driver, with the circular opening on a level with his eye. The red bar was the semaphore, and when it was out of sight it was an indication that all was right; when it was thrown across the field of vision it was a signal of danger. The box contained also the special form of cylinder and piston he had contrived, with the air tube at the upper side to connect it with the air tube that passed along the carriages to the pump in the guard's van, and a pipe below to represent the steam pipe passing from the boiler (on which the box was fastened) into and through the box, and terminating in the whistle on the top of the box. On the steam pipe, as it passed through the box, was placed a stop-cock, the head of which was the pivot of the semaphore or red bar. When the pump exhausted the tube and cylinder, the red bar would be lifted out of view, and in being lifted it would turn the cock so as to shut off steam. On being thrown down it would open the cock and let steam on to the whistle. From the axle of one of the carriages a belt was carried round a reducing pulley, and this pulley by a crank gave motion to a pump which maintained a continuous exhaust in the long tube and cylinder, so that the motion of the train itself was made to give the requisite motion to the pump, and keep the steam cock closed, the whistle silent, and the semaphore in the position that indicated safety. Attached to the box in front of the driver is placed a coil of gutta-percha tubing over 160 feet in length, and the other end attached to an air-pump in the guard's position. Connection having been made, and a stop-cock on a T-pipe having been placed near the guard's end, in order to simulate the steam passing from the boiler to the whistle a short tube of india-rubber is attached to a bellows, and connected with the whistle pipe, where it passes into the driver's signal box; the bellows is blown, and the whistle sounded, the red bar continuing to lie across the field of vision. On the blowing of the bellows being continued, and the air-pump simultaneously worked, the first motion of the pump, though a very small one, would withdraw the semaphore and silence the whistle, the semaphore seeming almost to rise in sympathy with the motion of the hand of the person who moved the pump, though separated from it by more than 160 feet of tube, together with other connections. The several motions having been continued, the semaphore continued up, and the whistle was silent (the normal condition of the signal when the train was in motion); but, on turning the signal cock near the pump, the exhaust being instantaneously destroyed by air admitted to the tube, the semaphore fell across the field of vision, and the whistle sounded, the signals being produced immediately upon the turning of the air-cock.

Dr. Gray explained the nature of the coupling-joint, by which the tube was connected from carriage to carriage. It was perfectly air-tight, and yet of such a character that it separated without injury on the occurrence of any severe strain sufficient to cause a severance of the train, and could easily be reunited. If any severance of the carriages occurred while the train was in motion, on the breaking of the train coupling-chains, the signal coupling-joints would draw out telescope like, and both ends of the tube being then fully opened, an automatic signal would be given to both guard and driver. The almost instantaneous sympathetic action between the pump at one end of the train, and the signal box at the other, was entirely due to the connection which rendered them air-tight, and the peculiar formation of the cylinder in the driving-box.

Dr. Gray stated that the apparatus had been operation for a considerable time on one engine on the Midland Great Western Railway. He exhibited one of the couplings with its flexible pendants, which hung between the carriages, and which, after having travelled some 60,000 miles on the railway, and been intentionally subjected to much rough usage, was as good as on the first day; and explained the nature of an improvement of Mr. Dillon's to allow of the carriages being renewed on the line. He also showed how, by the use of a two-way cock, the driver was prevented from shutting off steam from the whistle, so as to prevent the guard from using the signal; and also the arrangement that enabled the driver to communicate with the guard.

On the Specific Gravity of Submarine Telegraph Cables.
By Captain BLAKELY, R.A.

If a vessel sail in a straight line at a uniform speed on a sea perfectly calm, and drop a cable of a uniform size and specific gravity into the water, the latter will in the water form very nearly a straight line if a tension be applied from the ship equal to the weight of a piece of cable the length of the depth of water.

For example, a cable ½-inch diameter, and of 5 specific gravity, weighing $\frac{4}{10}$-lb. per foot in length when in water, paid out from a vessel moving steadily at the rate of 2⅔ miles an hour, or 3·91 feet per second, will form a straight line at an angle of 45°; the resistance of the water perpendicular to the cable due to this velocity being $\frac{4}{5}\,\frac{adv^2}{2g}\sin^2 45$, where $\frac{4}{5}$ is a coefficient assumed as an approximation to that representing the ratio of resistance to a surface like that of the cable compared with that of a plane surface,

a = area acted on.
d = about 70 lb. = weight of one cubic foot of water.
v = velocity.
g = force of gravity = 32·2 feet.

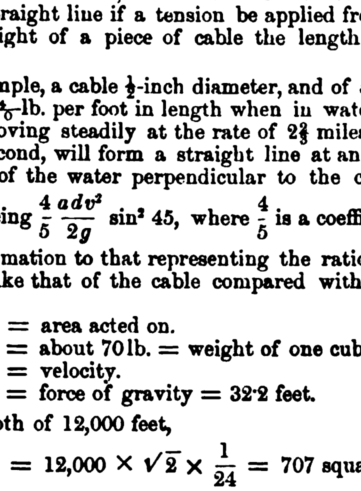
At a depth of 12,000 feet,

$$a = 12{,}000 \times \sqrt{2} \times \frac{1}{24} = 707 \text{ square feet;}$$

$$\text{then, } R = \frac{4}{5} \times \frac{707 \times 70}{64{\cdot}4} \times 15{\cdot}6 \times \frac{1}{2} = 4800 \text{ lb.;}$$

$$T = \text{tension} = R = 4800 \text{ lb.} = 43 \text{ cwt.;}$$

$$W = \text{weight of cable} = 4800\sqrt{2} = 6788 \text{ lb.} = 60{\cdot}8 \text{ cwt.}$$



As every portion of cable is acted on, as at A, by the three forces, R in the direction AR perpendicular to the cable, T in the direction AT of the length of the cable, and W vertically downwards,—there is no tendency to change the nature of the motion while these are proportional. In this particular case it is evident that $\sqrt{2}$, or 1·414 mile of cable at least must be paid out while the ship advances one mile, and that any relaxation of tension, or curving of the cable from any cause, would necessitate a still greater waste of cable.

A cable the same size, but only half the weight, would weigh in water about ·15 lb. per foot, and sink less rapidly, as $\sqrt{\cdot 15}$ to $\sqrt{\cdot 4}$, or as 1 : 1·62, and also as the square roots of the cubes of the cosines of the angles of inclination; so that if the ship advanced at the same rate, it need pay out much less cable. The tension requisite would also be much less (15 to 40 at least), and would in a great measure be supplied by the friction of such a length of cable against the water. A momentary relaxation of tension would also have less injurious effects.

Mechanical Structure of the Great Eastern Steam Ship.
By JOHN SCOTT RUSSELL.

Mr. Russell laid before the section some of the mechanical details of the construction of the great ship now building at his establishment at Millwall. The first point related to the peculiarity of her great size; the second, on which her merits or demerits as a piece of naval architecture depended, was the general structure or lines of the ship; the third point would be the distribution of materials in the construction of the ship, so as to obtain the safest and strongest possible structure with the minimum of materials; and the last point would be, to allude generally to the mechanical arangements for her propulsion. With respect to size, it was generally supposed that, as a practical ship-builder, he was an advocate for big ships. The contrary, however, was the fact. There were cases in which big ships were good, and there were certain cases in which big ships were ruinous to their owners. In every case the smallest ship that would supply the convenience of trade was the right ship to build. He came there as an advocate of little ships; and it was the peculiarity of the *Great Eastern* that she was the smallest ship capable of doing the work she was intended to do; and he believed that if she answered the purpose for which she was designed, she would continue to be the smallest ship possible for her voyage. It was found by experience that no steamship could be worked profitably which was of less size than a ton to a mile of the voyage she was to perform, carrying her own coal. Thus, a ship intended to ply between England and America would not pay permanently unless she were of 2500 or 3000 tons burden. In like manner, if a vessel were intended to go from this country to Australia or India, without coaling on going out, but taking her coals with her, she would require to be 13,000 tons burden. And turning to the case before them, it would be found that the big ship was a little short of the proper size. Her voyage to Australia and back would be 25,000 miles; her tonnage, therefore, should be 25,000 tons, whereas its actual amount was 22,000 tons. The idea of making a ship large enough to carry her own coals for a voyage to Australia and back again was the idea of a man famous for large ideas—Mr. Brunel. He suggested the matter to him (Mr. Russell) as a practical shipbuilder, and the result was the monster vessel which he was about to describe.

He had peculiar pleasure in laying a description of the lines of the ship before the present meeting, because the ship as a naval structure, as far as her lines were concerned, was a child of that section of the British Association. It was twenty-two years since they had the pleasure of meeting together in Dublin. On that occasion he laid before the Mechanical section a form of construction which had since become well known as the "wave line." The section received the idea so well that it appointed a committee to examine into the matter, with the intention, if they found the wave principle to be the true principle, to proclaim it to the world. The committee pursued its investigations, publishing the results in the account of their transactions; and from that time to the present he had continued to make large and small vessels on the wave principle; and the diffusion of this knowledge through the 'Transactions of the British Association' had led to its almost universal adoption. Wherever they found a steam vessel with a high reputation for speed, economy of fuel, and good qualities at sea, he would undertake to say that they would find that she was constructed on the wave principle.

He would endeavour to explain what were the principles of the wave line as distinguished from the older fashioned modes of building, and how they were carried out in the big ship. All practical men knew that the first thing a shipbuilder had to think of was what was called the midship section of the vessel; that was, the section which would be made if the vessel were cut through the middle, and the spectator saw the cut portions. Mr. Russell here pointed out a diagram of the midship section of the *Wave*, a small vessel about 7½ tons burden, which was the first ever constructed upon that principle. Now the first thing to be done in building a steam vessel was to make a calculation of the size of the midship section in the water. In sailing from one place to another it was necessary to excavate a canal out of the water large enough to allow the whole body of the ship to pass through. The problem was, how to do that most economically; and this was effected by making the canal as narrow and as shallow as possible, so that there would be the smallest quantity of water possible to excavate. Therefore it was that the shipbuilder endeavoured to obtain as small a midship section as as he could; and that had been effected in the case of the big ship, whose midship section was small,—not small absolutely, but small in proportion. In increasing the tonnage of a ship, three things had to be considered, the paying power, the propelling power, and the dimensions.

Mr. Russell then entered into a calculation to show that while he doubled the money-earning power of a ship by increasing its size, he only increased its midship section by 50 per cent. For instance, a ship of 2500 tons burden would have 500 feet of excavation through the water to do; the big ship had 2000 feet of excavation: and the lineal dimensions of one were to the lineal dimensions of the other as 1 to 2·1. The excavation to be done by the big ship in relation to that to be done by the small ship was as 4 to 1, but the carrying power was as 10 to 1. To propel the big ship they had a nominal horse-power of 2500, while to propel the smaller vessel there was a nominal horse-power of 500; so that the big ship would be worked quite as economically as the small one. Referring again to the wave line, he would suppose that it was given as a problem to any one to design a ship on the wave principle. The first thing to be done was to settle the speed at which the ship was intended to go. If the speed were fixed at 10 miles an hour, a reference to the table of the wave principle would show, that in order to effect that object the length of the ship's bows ought to be about 60 feet and that of her stern about 40 feet. If a larger vessel were required, say a ship of 130 feet long, there would be nothing more to do than to put a middle body of 30 feet in length between the bow and the stern. Having then made the width of the ship in accordance with the midship section agreed upon, it would be necessary to draw what was known as the wave line on both sides of the bow, and the wave line of the second order on both sides of the stern. Constructed in this manner, and propelled by the ordinary amount of horse-power, the ship would sail precisely 10 miles an hour. They could go slower than 10 miles an hour, if necessary, and in doing so they would economise fuel, in consequence of the diminished resistance of the water; whereas there would be a vastly increased resistance if an attempt were made to drive the steamer more than 10 miles an hour.

For the speed at which it was intended to drive the *Great Eastern* it was found that the length of her bow should be 330 feet, the length of her stern 230 feet, of the middle body 120 feet, and of the screw propeller 10 feet; making in all 680 feet in length. The lines on which she was constructed were neither more nor less than an extended copy of the lines of all the ships which he had built since he first laid the wave principle before that Association. It was his pride that he had not put a single experiment or novelty into the structure of the vessel, with one or two exceptions, which he had adopted on the recommendation of men who had had practical experience of their efficacy. The wave principle had never in a single instance deceived him as to the exact shape a vessel ought to be in order to accomplish a certain rate of speed, and he had therefore adopted it in the construction of the big ship.

He would next refer to the mechanical construction of the big ship, the arrangement of the iron of which she was made, and the object of those arrangements. It was much to be desired that our mechanical science should make progress by the simple adoption of what was best, come from where it might; but he was sorry to say that iron ship-building did not grow in that manner. They commenced by servilely imitating the construction of wooden ships, thereby incurring a great deal of unnecessary labour and expense. There was this great difference between the strength of iron and of wood, that whilst the latter was weak crossways and strong lengthways, or with the grain of the timber, iron was almost equally strong either way. This had been clearly ascertained by experiments made by Mr. Fairbairn and Mr. M. Hodgkinson, at the request of the British Association, in whose 'Transactions' the results were published to the world. The consequence was, that the ribs or frames used to strengthen wooden ships were rendered unnecessary in iron ship-building; and acting on this principle, the *Wave* (in the construction of which he was assisted by two Irishmen) was built of iron entirely, with bulkheads, and had not a frame in her from one end to the other. He was ashamed to say that he did not always practice what he preached. He was compelled against his will, by the persons for whom he built, to pursue the old system; besides which there were laws of trade, Acts of Parliament, and Lloyd's rule, to which he was obliged to conform. Thus, if he did not put a certain number of frames in the ship, a black mark would be put upon her, and she would not be allowed to go to sea. But whenever he was allowed to build according to his judgment, he built in what he considered to be the best way. And he believed that in what he was now placing before the section he was laying the grounds of meeting the British Association that day twenty years, and finding that the mode of mechanical construction which he proposed had been as universally adopted as the wave principle, because of the publications of the British Association.

Mr. Russell then proceeded to give an elaborate description of the old method of constructing an iron ship, contrasting it with the improved style which he pursued at present. Instead of the mass of wooden rubbish, which did not strengthen the ship, and involved enormous expense, he placed inside the iron shell as many complete bulkheads as the owner permitted him to do, and then constructed in the intermediate spaces partial bulkheads, or bulkheads in the centre of which holes had been cut for the purposes of stowage. The deck was strengthened by introducing pieces of angle iron, and other contrivances; and as an iron ship when weak was not weak crossways, but lengthways, he strengthened it in this direction by means of two longitudinal bulkheads; and the result was a strength and solidity which could not be obtained in any other way. The *Great Eastern* had all these improvements, and in addition the cellular system, so successfully applied in the Britannia Bridge, had been introduced all round the bottom and under the deck of the ship, giving the greatest amount of strength to resist crushing that could be procured. A great deal of alarm had been expressed by some persons as to the launching of the ship sideways; but these apprehensions were groundless. The ground sloped from where the vessel now stood at a steep incline of 1 in 12, and when the supports were withdrawn, if everything were in proper order, she must necessarily slide down safely into the water. As he had already observed, there was nothing new in the ship but her great size and cellular construction. It was true, she would be propelled both by a screw and paddles, but there was no reason to doubt that they would work harmoniously. He wished he could tell them how fast she would go, but that was the secret of the owner of the ship.

On the Laying of Submarine Telegraph Cables.
By Sir James Murray.

Sir James Murray stated that about forty years since he made the hold of a vessel air-tight, in Belfast Lough; and having cut an aperture near the keel, allowed the vessel to fill with water, which being again forced out by air pressure, raised the vessel; and by keeping the hold filled with compressed air, he prevented the water from again entering, so that the vessel sailed over the lough with that large opening in her bottom. In order to reach the shore out and in by this submarine entrance, to fix air-pumps and gas generators, and to secure its water-proof wainscots, Sir James contrived a horizontal passage from the vessel to an air-tight chamber of equal atmospheric pressure at the shore, with valves, in a horizontal tube or tunnel also charged with air of a pressure equal to that in the vessels at each end. This passage was an embryo Thames Tunnel, or rather, a tubular conduit under (not over) the Menai Straits,—a well-known principle then applied to a novel purpose, viz., a horizontal diving-bell between two chambers charged at that time with air of about 60 lb. pressure to the square inch.

Many circumstances connected with the subaqueous tunnel above described caused Sir James to believe that were the trans-atlantic cable enclosed in a proper tube attached to the steamer's stern and keel, like the spinal canal of a fish, several advantages would result.

1st. A protecting canal, affording long curves or gradients, which can be rendered of the most suitable specific gravity for such a depth from the ship as would enable the rope to rest upon denser water, say, 20 or 30 fathoms down, and in quieter strata of sea.

2nd. Adding 4 or 5 inches to the circumference of the cable without augmenting its gravity—where gravitation or strain are so fatal to the top—would relieve the neck of the cable from sudden jerks, bends, or pulls, that have recently proved so fatal to a rope oscillating as a heavy weight in a heaving sea.

A series of copper or galvanised iron pipes, 4 or 5 inches in diameter, each 5 or 6 feet long, will be found to answer (experimentally). The ends should be flanged on vulcanised rings, interposing a short thick hose, 3 or 4 inches long, as a vertebral joint, to admit of a little bending downwards at such incline as may be safest in the sea. Where this tube receives the rope at the keel, there is a proper, soft, elastic stuffing box, through which the rope descends in a funnel of oil. The degree of circular pressure of this collar is graduated by a scale, easily adapted to expedite or detain the rope's transit correctly, and at the same time to keep this spinal canal air-tight, so that whilst the rope passes down like the piston of a steam engine through its collar, the air pumped into the spinal canal cannot escape, but will push the water fathom after fathom towards the deep extremity of the pipe, and thereby regulate, poise, and support the top of the rope, without any wrench or strain near its neck.

The cable's weight is spread over and divided among numerous *friction rollers*, strongly bolted across the tube, and supporting the rope like drums or wheels at the descent of a train. A pump in the steamer drives air into the tube, under the collar, whilst a mercurial gauge points out the number of fathoms of air sent in, and of water pushed down the pipe. A rise of 30 inches of mercury indicates, say 6 fathoms; 100 inches index 20 fathoms, at which depth the sea will be about four times denser than at the surface. There the rope (when no longer in its scabbard) will be better supported, and less drawn down or twisted by storms or waves.

The dip or incline of this proposed tube is so small as to offer little resistance to the sailing of the steamer. The tubular case bears equal pressure from the water within to balance that of the water without, and can be made to incline at any angle according to the quantity of water expelled or admitted. If most of the water be expelled from the pipe it will keep a more horizontal direction;—the longer the column of water allowed to rise within the tube the more perpendicular will be its dip, at such angle as the mercury indicates in the gauge and the operator desires.

Continued Report on the development of Heat in Agitated Water. By G. Rennie, C.E.

Mr. Rennie, in alluding to his former papers on the subject, read before the section last year at Cheltenham, stated that the subject of the mechanical or dynamic force required to raise a given quantity of water one degree of Fahrenheit had long been the object of the research of philosophers, ever since Count Rumford, in his celebrated experiments on the evolution of heat in boring guns when surrounded by ice or water, proved the power required to raise 1 lb. of water one degree, and which he valued at the dynamic equivalent of 1034 lb. M. Moya was the first who announced that heat was evolved from agitated water. The second was Mr. Joule, who announced that heat was evolved by water passing through narrow tubes, and by this method each degree of heat required for its evolution a mechanical force of 770 lb. Subsequently, in 1845 and 1847, he arrived at a dynamical equivalent of 772 lb. These experiments had since been confirmed by other philosophers on the continent.

In the present paper Mr. Rennie stated that his attention was called to the subject by observing the evolution of heat by the sea in a storm,—by the heat from water running in sluices. He therefore prepared an apparatus similar to a patent churn, somewhat similar to that adopted by Mr. Joule, but on a large scale. In the first case he experimented upon 50 gallons (or 500 lb.) of water, inclosed in a cubical box, and driven by a steam-engine, instead of a weight falling from a given height as in Mr. Joule's experiment; secondly, on a smaller scale, by 10 lb. of water inclosed in a box. The large machine or churn was driven at a slow velocity of 88 revolutions per minute, and the smaller machine at the rate of 232 revolutions per minute; so that the heat given off by the water in the large box was only at the rate of 3½° per hour, including the heat lost by radiation; whereas the heat evolved by the 10 gallons of water contained in the small box, agitated at 232 revolutions, was 56° Fah. per hour. Thus the temperature of the water in the large box was raised from 60° to 144°; and the temperature of the water in the small box to boiling point. As an illustration, an egg was boiled hard in six minutes. The mechanical equivalent in the first case was approximate nearly to that of Mr. Joule, but in the latter case it was considerably above his equivalent, arising, very probably, from the difficulty of measuring accurately the retarding forces.

On the Construction of the 36-inch Mortars made by order of the Government during the late Russian War. By R. Mallet.

Mr. Mallet said the problem to be solved was the best mode of dealing with masses of earth and masonry in fortifications which were so large as to resist ordinary ordnance.—How could the range of projectiles be so increased that the ships employed in throwing could be comparatively out of reach of the guns of the fortress? He found that the largest shells used in modern warfare were 13-inch shells, weighing from 180 to 200 lb., containing 9 lb. of powder, and having a maximum range of 4700 yards. Such a shell penetrated about 3 feet into a mound of earth, but was incapable of piercing a wall of masonry 20 inches thick, save by reiterated blows. It occurred to him that if they could project a shell of much greater weight, containing more powder, and with an enormously increased projectile power, they would be enabled to effect the demolition of fortifications with greater ease and rapidity. He therefore proposed a shell of 3 feet diameter, which would contain about 500 lb. of powder, and have an increased range. Such shells entering into the midst of a fortification would act like a mine or series of mines, exploding with great force and causing an immense destruction of masonry. He calculated that a shell of that description would have a penetrative power into compacted earth of 15 feet, and that the range might probably be increased by as much as twice that of the 13-inch shell. It appeared a necessary condition to this problem that the mortar should be constructed in several pieces, because so large an instrument could not be forged without sustaining flaws in the process of cooling.

Mr. Mallet then proceeded, by means of diagrams, to describe the general construction of his gun, but would not enter into a disquisition on the subject, as it involved abstruse mathematical considerations in order to deal with it with any degree of accuracy. As regarded himself he had to express the obligations that he owed to Dr. Hart, for the able and efficient way in which he aided him with his profound mathematical abilities in considering the question. He might just mention on the general question of wrought-iron, that he believed it to be the material for artillery, and which possessed many advantages in comparison with other materials. If a gun two tons weight of cast-iron cost 1*l*., another gun the same weight of bronze would cost 10*l*.; of wrought-iron, 15*s*. or 16*s*., and of steel about 2*l*. A wrought-iron gun would be but one-fifth the weight of a bronze gun. Other elements, such as wear and tear and cost of transport, remain to be considered.

Improvements in Ordnance. By Capt. Blakely, R.A.

In introducing the subject the author said that a 16-inch shot would present but 16 times the surface to the action of the air (to retard it, or make its flight inaccurate) as a 4-inch shot, and would weigh 64 times as much; it would therefore be retarded and blown out of its course but $\frac{16}{64}$ or $\frac{1}{4}$ as much. Large guns require more strength than small ones, as the powder occupying in each the same proportional space, the small shot moves in, say $\frac{1}{300}$ of a second, a certain number of inches, the large shot in the same time moving fewer inches, so that at the end of that time the gas in the small gun would have much more proportional room to expand in, and would therefore press less on the gun than in the large one. Added to this, the large shot would require more time to get its velocity, and the pressure must remain on the gun so much longer. May not the TIME a material can bear a tension be an element worthy of experiment? A piece of india-rubber requires a pressure even ten times greater than will ultimately break it to be applied during a certain time, and if before that time has expired the pressure be removed, the substance remains uninjured. May it not be so with cast-steel, for instance,—that it has the power of bearing an immense strain for a long period, but beyond that strain it cannot bear much for even $\frac{1}{100}$ second? and may not cast-iron bear a pressure during $\frac{1}{100}$ second which, if continued during ½-second, would destroy it? The author states that the sudden and short strain caused by the explosion of gunpowder is less, *not more*, injurious (as generally thought) than an equal strain applied gradually, but left longer.

A 32-pounder is the limit of cast-iron guns of the present shape,—any larger than that being unsafe with a full charge (see Sir Howard Douglas on 'Naval Gunnery'). Adding thickness to the metal would give little additional strength. Professor Barlow calculates that a cylinder 1 inch thick, and 1 inch in internal diameter, when strained, stretches only ⅓th as much in proportion outside as inside, the cross section remaining equal; so that the interior diameter being stretched to $1 + \frac{1}{1000}$, the exterior, instead of becoming $3 + \frac{3}{1000}$ (as it would if the outside layer *put out* an equal strength to the inner, according to the law *ut tensio sic vis*), becomes only $3 + \frac{1}{3}$ of $\frac{3}{1000}$, or $3 + \frac{1}{3000}$.

$$\text{The cross section being } \left(3 + \frac{1}{3000}\right)^2 = 9 + \frac{1}{500}$$
$$- \left(1 + \frac{1}{1000}\right)^2 = 1 + \frac{1}{500}$$

The difference (8 round inches) being the same as when not strained, or $(3^2 - 1^2)$.

If with the present thickness the outside does but ⅓th its duty, we can expect but little additional strength from adding to it. Prof. Barlow argues that the strength decreases as the squares of the distances from the centre. The same law puts a limit to the size of brass or cast-steel guns, or of wrought-iron if in one welded mass. Mr. Dundas, of Dundas, in 1855, made a beautiful gun of staves of wrought-iron hooped; but though the workmanship was exquisite, water got through with a pressure of 3 tons. Of course the gas of powder would also have penetrated, and separated the staves.

Capt. Blakely suggests for guns up to 10 inches a shape very like the present, but the outside at the breech strengthened with two layers of thin wrought-iron cylinders put on very hot and hammered. One made by him in that manner stood 605 rounds all with double charge, and the last 158 rounds loaded to the muzzle. This is evidently greater strength than is required for anything under 10-inch guns. Above that size, he thinks that, with a cast-iron cylindrical centre, either rod-iron wound round at a great heat and welded layer over layer, but each in cooling taking a permanent strain, or else iron wire wound round it, each layer having a greater initial strain than the one under it, would be the best construction. All the fibre is thus obtained in one direction, and the outside takes its share of the strain.

Mr. Armstrong, of Newcastle, made a gun of a solid steel centre, with bar-iron coiled round it and welded. This gun has stood some thousands of rounds. Mr. Brunel thinks so highly of wire that he was getting a gun made, when he heard of a patent for it, and desisted. Captain Blakely discovered, in 1855, that Mr. J. Longridge, C.E., agreed very nearly with him in opinion, having arrived quite independently at his conclusions, and since then they have been working together. Some cylinders they had experimented upon were placed before the section: the strain cannot have been under 56 tons per inch on some of them, reckoning brass and wire, or at least 70 tons per inch on the wire, as there the strength lay. This would make very serviceable field 8-inch howitzers, which need not weigh over 8 cwt. each.

On the Adaptation of Suspension Bridges to sustain the Passage of Railway Trains. By C. Vignoles, C.E.

The subject was comprised under the following heads:—First, the maximum load to pass the bridge; second, the velocity of the train; third, the strength of the chains; fourth, the rigidity of the platform; fifth, prevention of undulation, vibration, and oscillation. The novelty of the author's inquiry in the matters he adduced was confined to the question of the rigidity of the platform. He instanced the bridge over the river Dnieper, at Kieff, in Russia, erected according to his designs, and stated that the successful resistance of the well-braced platform of this bridge to the effect of hurricane winds had been long remarkable. It was completed about four years ago, just before the commencement of the Russian war, and at a time when he little thought the result of his exertions would so soon be used in facilitating the military operations of the Russians against the allied forces. He alluded to the severe tests which it had successfully withstood, in the conveyance of armies with heavy ordnance, and he came to the conclusion that the adaptation of suspension bridges to railway purposes is quite practicable; recommending, at the same time, that the speed of the trains, when passing, should be kept moderate, as compared with ordinary speed on railways.

On the Form of Entrances to Tidal Basins. By B. Stoney.

On examining the entrances of the numerous floating docks and tidal basins which had been constructed up to the present period, it was found impossible, owing to the great variety of their form, to reduce the principles upon which they appeared to have been constructed to any one definite or precise rule. Some dock entrances were formed at right angles to the river, a few sloping upwards against the stream, and others again sloping downwards, which latter form not only tends to prevent deposits, but greatly facilitates the entrance and departure of vessels. He objected to the entrance being at right angles to the stream, on the ground that though equally adapted for vessels coming from the interior of the country or from the sea, the number of vessels which entered a dock from the upper part of the river bore a very small proportion indeed to those whose traffic was seawards. It was usual to place the entrance at or near the centre of the dock or basin, which was parallel to the river; but when the entrance was thus placed, vessels lying at either side of the entrance had to be warped at a considerable expense of time and labour into a position suitable for passing through.

The chief points to be aimed at in constructing a dock or tidal basin were,—1. Facility of ingress or egress. 2. Freedom from silting up. To these may be added,—3. Economy of quay room; and, 4. Facilities for the land traffic in connection with the shipping. These requisites were, he believed, in a great measure fulfilled by the form of basin and entrance which he now advocated, viz., a lozenge, or trapezium, or rectangle, whose width was equal to the breadth of two vessels together, with sufficient space between them for another vessel to turn with facility, say from 350 to 400 feet between the walls for vessels of ordinary length. The entrance was at the lower end, and sloped so that a ship or steamer could pass from the river into the dock without warping, or any such annoyance or delay. Similarly on leaving, a vessel when once her head was turned round could pass through with as much ease as at entrance, and without risk of being carried by the current against the lower pier head.

Proceedings of Various Sections.

Report on the Temperature of some of the Mines in Cornwall. By R. W. Fox.

If we arrange the mines in the order of their respective depths, including those only in which experiments were made in the *rocks* or *lodes* at their *deepest* levels, the following will be the ratios in feet in descending from the surface, in which the temperature was augmented 1° Fah. from 50°, the mean temperature of the climate.

Description.	Depth.	Excess of Temperature above 50 deg.	Increase of 1 deg. in descending	Rock.
	Feet.		Ft. in.	
Par Consols (tin part)	768	24°	32 0	Killos
Botallack (copper and tin)...	1128	29°	39 0	ditto
Par Consols (copper part) ...	1248	34°	36 7	ditto
Dolcoath (copper and tin), in 1822	1380	26°	53 0	Granite
Levant (copper and tin), in 1822	1530	24°	63 7	ditto
Levant, ditto ditto, 1822...	1530	37°	41 3	Killos
Levant, ditto ditto, 1822...	1530	34°	43 7	ditto
Tresaveau (copper), 1837 ...	1572	32° 5′	48 4	Granite
Dolcoath (copper and tin), in 1827	1632	23°	71 0	ditto
Dolcoath (another lode) 1827	1632	29° 5′	55 0	Granite
Tresaveau (copper), 1853 ...	2112	40° 5′	52 1	ditto

On comparing the results obtained in Dolcoath in 1822 and 1827, it appears that the temperature was increased only 3° 5′ in one level with an increased depth of 252 feet, giving a ratio between the stations of 1° increase in 72 feet; and in another level the temperature was actually 3° less than in 1822, although 252 feet deeper than the mine was then. These experiments were made with great care, and the exceptional case may probably be due to the hardness and compactness of the lode in the deeper level, and the diminished quantity of water. The depth of Tresaveau was increased 540 feet between 1837 and 1853, and

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the temperature 8° 5′ in the deepest level, or in the ratio of 1° in 63 ft. 5 in.

I have not included in the table the results recently obtained in the United Mines, or Fowey Consols, the experiments not having been made in their *deepest* levels; but the hot spring at 116° at the depth of 255 fathoms, in the United Mines, gives a ratio of 1° increase in 23 ft. 2 in.; and the rock at 82° 5′ in another level, also 255 fathoms deep, gives 1° in 47 feet. In 1853 the bottom of the United Mines was 275 fathoms below the surface, and the rock 94°, or in the ratio of 1° in 37 ft. 5 in. At Fowey Consols, the rock in a level 288 fathoms deep was at 93°, or in the ratio of 1° increase in 40 ft. 2 in.

Widely as the ratios differ from each other in different mines, and in different parts of the same mine, the results tend to confirm the statement that the temperature in general increases less rapidly in deep mines than in those which are of inferior depth; and this is more especially observable when experiments are made from time to time at the bottom of a mine as the depth increases, unless the results be modified by an increase of water coming from greater depths.

It is not however to be inferred that the diminishing ratio of temperature in descending into the earth extends to an indefinite depth; it may, on the contrary, increase rapidly at depths where the circulating water has little or no influence. A copious spring of warm water gushing from a vein is hailed by the miners as a favourable indication of the proximity of ore, and so is a pervious or "hollow" lode; but the former clearly results from the latter, the warm water rising from greater depths through the lode.

These subterranean springs are often nearly as free from saline matter as those occurring at the surface; in some I have found common salt and chloride of lime, and most especially in water taken from the deep levels of Poldice and Wheal Unity, and the hot spring at the United Mines, although they are all several miles from the sea.

On the Chemical Composition of an Ancient Iron Slag, found at Lochgoilhead, Argyleshire. By JOHN J. J. KYLE, Edinburgh.

This paper had reference to a discovery made by the author, during the summer of 1856, of a quantity of iron scoriæ or furnace slag, as also portions of charcoal, and other remains indicative of the existence, at some remote period, of an ancient ironwork or "bloomery," on the shores of Loch Goil, in Argyleshire. The slag referred to, which the author has submitted to analysis, yielded him the following results :—

Silicic acid	29·60
Alumina	5·60
Lime	2·80
Magnesia	3·72
Protoxide of iron	56·52
Sulphide of calcium	1·00
Loss, with traces of manganese and phosphoric acid	0·76
	100·00

Referring to the large amount of protoxide of iron entering into the composition of the slag, the author stated his belief that the process of manufacture adopted in this bloomery was in all probability that known as the direct or Catalan process, in which the ore is reduced by the action of the fuel, without the intervention of any flux, and giving rise to the formation of a silicate of iron, which from its great fusibility would readily admit of being run off at a comparatively low temperature. It having been long remarked that ancient scoriæ found on elevated positions almost invariably contained a large proportion of iron, whilst those found on less exalted districts had but little of that metal in their composition, it had hence been inferred that the former indicated the more ancient seats of the iron manufacture; as, prior to the introduction of bellows as a means of forcing air into the burning fuel, open and exposed situations would be best adapted for furnace operations, seeing that the natural currents of air could have more ready access to the combustible than in sheltered localities; although, even by the adoption of this expedient, the operators of these early times would be unable to command a temperature sufficiently intense to enable them to employ a flux such as lime, with the view of removing the silicic acid of the ore, owing to the difficultly fusible nature of the calcareous silicate thus formed.

From the preceding considerations the author drew the inference that the Loch Goil bloomery was one of the most ancient in the kingdom; remarking that in this view he was borne out by the nature of the position where the remains were discovered, it being one which, although at no great elevation, was yet freely exposed to the sudden and high winds almost constantly sweeping through the glen. In conclusion, he stated that he had as yet been unable to prove the existence of any natural deposits of iron ore in the vicity of Loch Goil, but intended to examine the locality more fully on an early occasion.

Effect of Wind on the Intensity of Sound. By Prof. G. G. STOKES.

The remarkable diminution in the intensity of sound which is produced when a strong wind blows in a direction from the observer towards the source of sound, is familiar to everybody, but has not hitherto been explained, so far as the author is aware. At first sight we might be disposed to attribute it merely to the increase in the radius of the sound-wave which reaches the observer. The whole mass of air being supposed to be carried uniformly along, the time which the sound would take to reach the observer, and consequently the radius of the sound-wave, would be increased by the wind in the ratio of the velocity of sound to the sum of the velocities of sound and of the wind, and the intensity would be diminished in the inverse duplicate ratio. But the effect is much too great to be attributable to this cause. It would be a strong wind whose velocity was a twenty-fourth part of that of sound; yet even in this case the intensity would be diminished by only about a twelfth part.

The first volume of the 'Annales de Chimie', (1816) contains a paper of M. Delaroche, giving the results of some experiments made on this subject. It appeared from the experiments, first, that at small distances the wind has hardly any perceptible effect, the sound being propagated almost equally well in a direction contrary to the wind and in the direction of the wind; secondly, that the disparity between the intensity of the sound propagated in these two directions becomes proportionally greater and greater as the distance increases; thirdly, that sound is propagated rather better in a direction perpendicular to the wind than in the direction of the wind.

The explanation offered by the author of the present communication is as follows. If we imagine the whole mass of air in the neighbourhood of the source of disturbance divided into horizontal strata, these strata do not all move with the same velocity. The lower strata are retarded by friction against the earth, and by the various obstacles they meet with; the upper by friction against the lower, and so on. Hence the velocity increases from the ground upwards, conformably with observation. This difference of velocity disturbs the spherical form of the sound-wave tending to make it somewhat of the form of an ellipsoid, th section of which (by a vertical diametral plane parallel to the direction of the wind) is an ellipse meeting the ground at an obtuse angle on the side towards which the wind is blowing, and an acute angle on the opposite side. Now sound tends to propagate itself in a direction perpendicular to the sound-wave, and if a portion of the wave is intercepted by an obstacle of large size the space behind is left in a sort of sound-shadow, and the only sound there heard is what diverges from the general wave after passing the obstacle. Hence, near the earth, in a direction contrary to the wind the sound continually tends to be propagated upwards, and consequently there is a continual tendency for an observer in that direction to be left in a sort of sound-shadow. Hence, at a sufficient distance the sound ought to be very much enfeebled, but near the source of disturbance this cause has not yet had time to operate, and therefore the wind produces no sensible effect except what arises from the augmentation in the radius of the sound-wave, and this is too small to be perceptible. In the contrary direction, that is the direction towards which the wind is blowing, the sound tends to propagate itself downwards, and to be reflected from the surface of the earth, and both the direct and reflected waves contribute to the effect perceived. The two waves assist each other so much the better as the angle between them is less, and this angle vanishes in a direction perpendicular to the wind. Hence in this latter direction the sound ought to be perceived a little better than even in the direction of the wind, which agrees with the experiments of M. Delaroche.

On the use of Prime Numbers in English Measures, Weights, and Coinage. By JAMES YATES, M.A., F.R.S.

On examining the tables of the measures, weights, and coins used throughout England, it is found that the prime numbers employed in their composition and of the most frequent occurrence, are (2), (3), and (5). Of these, (2) occurs as a factor by far the most frequently, indeed, twice or thrice as frequently as either (3) or (5).

The prime (7) makes its appearance in the following weights and measures :—

Avoirdupoise Weight	...7000 grains	=	1 lb.
	14 lb.	=	1 stone.
	28 lb.	=	1 quarter.
Wool Weight	.................7 lb.	=	1 clove, whence 14 lb. = 1 stone.
Wine Measure	............42 gallons	=	1 tierce.
	63 gallons	=	1 hogshead.

The prime (11) is used in one case only, but an important one, viz.—*Long Measure*, $\frac{11}{2}$ or $5\frac{1}{2}$ yards = 1 rod or pole, from which is deduced 4 poles or 22 yards = 1 chain. The furlong, the mile, and the acre are also multiples of this fundamental number.

The (13) also comes in once as a factor, viz., in *Wool Weight*,—$\frac{13}{2}$ or $6\frac{1}{2}$ tods = 1 wey. Wool weight is curiously compounded: no less than four primes, (2), (3), (7), (13), are used as factors, producing only six denominations, which are as follows :—

7 lb. avoirdupoise	=	1 clove.
2 cloves	=	1 stone.
2 stones	=	1 tod.
$6\frac{1}{2}$ tods or 13 stones	=	1 wey.
2 weys	=	1 sack.
12 sacks	=	1 last.

Only one other prime requires notice, and that is found in a very conspicuous position, and where perhaps it was little to be expected, viz., in a recent Act of Parliament. The law now in force and known as the "Weights and Measures Act," fixes the number of grains in the pound avoirdupoise by the use of the prime number (7); and goes on to determine the relation of the pound troy to the standard linear measure, by declaring that a cubic inch of distilled water "is equal to 252 grains and 458 thousandth parts of a grain." If this number $\frac{252458}{1000}$, be divided by 2, it will be found that a cubic inch of water weighs 126,229 five hundredth parts of a grain, the numerator of this fraction, $\frac{126229}{500}$, being a prime number.

As the result of this analysis, it appears that the primes used in the English measures, weights, and coins, are the following:—(2), (3), (5), (7), (11), (13), and (126,229). I propose to offer a few remarks respecting the aptitude of these numbers for the functions which they are appointed to perform.

The adoption of these factors does not appear to have been determined in any case, so far as we can judge, by reason or principle, but to have arisen from accidental and arbitrary causes. There is no apparent benefit in connecting our highest coins by (2) and (5), the intermediate by (2) and (3), and the lowest by (2) only. No advantage arises from measuring land by (11), and weighing wool by (7) and (13). And no reason can be assigned why (7) should be brought into avoirdupoise weight, and excluded from troy weight; or why (3) should be excluded from avoirdupoise weight, whilst it plays an important part in troy weight and apothecaries' weight. In short, all our tables present the appearance of an entire want of principle in their construction.

The introduction of an additional prime has the effect of making our weights and measures more complex and multiform: it ought therefore to be avoided, unless some necessity can be shown in its favour. Hence it would seem to be expedient to abolish from these calculations all primes except (2), (3), and (5); and here an important question arises, viz.:— should these be retained, or shall we be satisfied with (2) and (5), omitting (3)?

We are thus brought to one of the great discussions of the present day,—the expediency of decimalising our measures, weights, and coins.

The consequence of the simple fact $2 \times 5 = 10$, is that all decimal systems are also binary and quinary; the principal quantities expressed by tens, hundreds, thousands, &c., being divisible by (2) and (5) without remainder, so that their doubles and their halves can be introduced and reckoned without the least difficulty or inconvenience. But such systems do not readily admit the number (3), because in the majority of cases the quantity cannot be divided by (3) without a remainder, and in many cases division by (3) produces a repeating decimal. This is the ground on which many persons have insisted on (12) as a multiplier for measures, weights, and coins, rather than (10). But it is to be observed, that if (10) cannot be divided by (3), on the other hand (12) cannot be divided by (5), without remainder. Hence it seems to follow, that the choice must be made between decimal and duodecimal modes of computation, according as a preference is given to (3) or to (5) as a divisor. If it is more necessary or convenient to divide by (3) than by (5), duodecimal methods are entitled to the preference so far as this circumstance is concerned. I cannot, however, discover any reason for making this assumption. I think it probable that division by (5) is required as often as by (3), whilst every other consideration is decidedly in favour of the decimal scale.

The investigation which we have been pursuing is, therefore, in favour of decimal measures, weights, and coins, and supports the views of those who think that the subordinate multiples and divisions should be made by (2) and (5) only, not by (3).

In this conclusion I have the satisfaction to observe that I am countenanced by the authority of the late Mr. Drinkwater Bethune, one of the commissioners appointed by the present Lord Monteagle when Chancellor of the Exchequer, to consider the steps to be taken for restoring the standards of weight and measure. In his letter to the Chancellor of the Exchequer, dated 21st September 1841, he maintains the following positions :—

1. "That the tables of weights and measures now in use are complex and inconvenient, and that it is very desirable to get rid of inconvenient multipliers, such as the factor (7), which connects the pound avoirdupoise with the stone, and thereby with its multiples the hundredweight and ton; and the factor (11), which connects the yard with the chain, and thereby with the mile and acre.

2. "That it is desirable that no numbers which are not multiples either of (2) or of (5), should anywhere appear in the tables."

On the Proposed Suez Canal. By Dr. T. HODGKIN.

Having visited Egypt at a time when the proposal to unite the Mediterranean and Red Seas by cutting a canal through the Isthmus of Suez was exciting much attention, it was impossible for me not to take a lively interest in the question, although I had no personal interest to bias my judgment on either side. I understood that the French were for the proposed canal, and the English, for the most part, opposed to it; but I could discover no reason for the question assuming this national character, beyond the fact that, more than twenty years ago, when an English engineer had furnished the most practical and ocular demonstration that a railroad might easily and advantageously be constructed between Alexandria, Cairo, and Suez, the French interfered and declared that they would not sanction the execution of such a road, and that this expression of will on their part had been fully able to delay the commencement of the work for many years, to the detriment of Egypt and to the serious inconvenience of commerce. I could perceive no reason which should induce England to retaliate the opposition of France under a different dynasty. I listened attentively to the arguments which were adduced, and I think I saw enough both of the Mediterranean shore and the African desert to permit me, with the aid of the practical information which I received, to arrive at a tolerably decided conclusion.

I went by the railway from Alexandria to Cairo in the short space of $3\frac{3}{4}$ hours, including a half-hour spent in crossing the Nile in a steamboat. I likewise performed the journey from Cairo, about half way across the desert towards Suez, and back again, as an easy morning's ride, over that portion of the railroad which had then been completed. It was obvious, from the character of the country, that the railroad was of comparatively easy and cheap construction, and I was assured that the remainder of the line presented no more formidable obstacles. It was, therefore, very evident that this route between the two seas will furnish the greatest facilities of transport both to natives and Europeans, and on terms sufficiently moderate to admit of the agricultural peasantry not only travelling by it themselves but also of conveying their goods and beasts of burden.

To English passengers, whether going to or returning from India, the present railroad offers a most convenient and expeditious mode of transit. These facilities will be materially increased when the railroad is continued to Suez, where the energy of the viceroy is accelerating the arrangements for the accommodation of passengers and merchandise. To many who may regard mere ease and dispatch as of the chief importance, such a means of transport must be highly valuable; but when it is remembered that a large number of travellers must be solicitous to take advantage of their proximity to the many interesting and stupendous works of ancient art which Egypt presents, and who would deplore being in sight of Alexandria, Damietta, and Suez, without drinking of the Nile and visiting the Pyramids, it can scarcely be imagined that a course which must exclude these objects can have the preference. On the other hand, it is urged that a ship canal across the isthmus must economise time and labour by enabling passengers and merchandise from any European port to proceed at once to Eastern Africa, India, China, and Australia, without the delay and expense of land carriage and re-shipment. These objects are represented as being of so great importance to the all-engrossing interest of commerce, that if these pre-eminent advantages could be satisfactorily established all the comforts and interest of the Cairo route would present their attractions in vain. Hence it will be seen that the determination of the question mainly turns upon the cost at which the ship canal in this part of the world can be formed, and on the current expenses required to maintain it in a condition to be at all times available; for the canal to answer, the total outlay must be kept sufficiently low for it to serve the interests both of the merchants and of the canal proprietors. I confess that my own convictions strongly preponderate on the negative side; and until this question be decided it is a great pity to raise a political question which, so far as its influence extends, may disturb the peaceful relations which at present happily exist between the two most advanced and important nations of Europe.

Although the difficulty at one time supposed to exist in the difference of level between the Mediterranean and Red Seas is now no longer urged, there are other physical difficulties which are of at least equal importance. The canal must not only be made, but must also be maintained in a serviceable condition. Now, it is well known that on the Mediterranean side the sea is not only shallow and sandy, but that its depth is subject to constant variation from the moving character of the sand-banks. It might almost be presumed *à priori* that the same causes which prevent any of the mouths of the Nile from serving as an available ingress or egress for vessels navigating the Nile would produce and maintain an effectual obstacle to vessels passing in either direction between the Mediterranean Sea and an artificial canal. I had an opportunity of witnessing a strong confirmation of this inference in proceeding from Alexandria to Jaffa. Although we kept out at sea to the distance of some miles, the captain of the steamboat—which was a much smaller vessel than would be required for Indian or Australian commerce—thought it needful, in broad daylight, to be frequently using the sounding line as a security against stranding his vessel.

The force of this objection is so far admitted by the advocates of the canal as to induce them to allow that it will be necessary to construct piers advancing some miles into the sea, and that at their mouth, and in the channel between them, it will be necessary to keep dredging vessels constantly employed to preserve a practicable passage. The inevitable expense of such works must be fatal to the project of a transit from one sea to the other, even if the canal already existed, or could be made for a trifling expense. This, however, is so far from being the case, that the construction of the canal itself is known to be attended with immense difficulties, and its projectors are now announcing a probable outlay amounting to eight or ten times the sum for which they originally declared that the canal was to be made. It will perhaps be asked in what these difficulties consist? The general facts may be safely stated to be—first, a certain amount of elevated land to be cut through; secondly, land considerably lower than either sea, where very substantial embankments must be thrown up to prevent the neighbouring country from being submerged. Throughout this tract, and probably along the greater portion of the line, a very careful and expensive process of puddling will be absolutely necessary to enable the canal to hold water. Is there the least chance of an amount of commercial transit by this expensive route, sufficient to pay anything like a remunerative interest on so large an expenditure as these operations must require? But if such an interest cannot be relied upon with reasonable confidence, it would seem to be inexcusable folly to commence the work. To this it may be replied the Egyptian government will readily supply the deficiency, for the sake of the glory of having executed so great a work for the good of the world, as well as for its own advantage. The French advocates of the project may, doubtless, from personal knowledge be much better able to conjecture what the viceroy may be persuaded to do, but I cannot bring myself to believe that his real friends, if they have maturely studied the subject, will either encourage or sanction his taking the step, or that his own keen perception and practical knowledge will permit him to be led astray by the plausible arguments of those who, if not from interested motives, from mistaken ideas respecting the merit and glory of the undertaking, may be disposed to press it upon him. Were the necessary capital to be at once obtained, I believe that a very serious obstacle would present itself at the outset in the difficulty of bringing to the field of labour anything like an adequate number of efficient hands, as well as in the expenses, trouble, and uncertainty of supplying them with all the necessaries of life when brought there. The construction of the canal between the Nile and Alexandria incurred the sacrifice of many thousand lives, besides the outlay of enormous sums of money. But the canal was made through a populous as well as a notoriously fertile district—labourers and provisions were at hand, and supplies of both could very readily be brought down the Nile to meet the demand which the extraordinary consumption and distribution occasioned. It is true that a railroad has been easily made over a desert tract between Cairo and Suez; but in this case the labour commenced in a well provided district; and the railroad as it advanced afforded facility for the conveyance of the labourers and of their provisions, including their daily supply of water. In the formation of the proposed canal the like difficulties are far more considerable, and none of these counteracting advantages are offered.

As respects Egypt the effect of the canal, were it sufficiently completed, must be decidedly injurious. The large and constantly increasing transit which is contributing so much to the wealth and improvement of Egypt and the Egyptians, would be diverted to the new line, on which it would confer no benefits, seeing that the ships would traverse the canal without any necessary communication with either shore, except where the locks would require them to pay dues to the canal company's agents. The tract which the canal passes through would remain, as it ever has been, a dreary waste. The course of the canal is too far removed from any well inhabited or productive country to render it probable that any new port would be established upon it, which might hereafter become an attraction to lucrative commerce. Every sincere well-wisher to Egypt, and to the government under which the country is making such remarkable progress, must therefore feel an interest in the eyes of the viceroy being opened to the evils which he must inevitably bring upon Egypt, should he be induced by the vain hopes excited by the advocates of the canal to commit his councils and resources to its execution.

But perhaps it may be said that the completion of the canal will form an effectual and lasting boundary and separation between the viceroyalty of Egypt and that part of the Turkish dominions more immediately governed by Constantinople. For almost all practical purposes of government the separation is sufficiently complete at present, and I confess I am at loss to conceive any benefit which could arise either to the Porte or to the Egyptian government from such an additional separation as the canal could effect.

It would be a subject of interesting inquiry what may be the prospective effect of obstructing a highway which we know to have been in use from before the time of Abraham to the present day—which has at times served for the transit of large armies—but whose more important influence has been incessantly operating in the passage of smaller parties, from the caravan to the solitary individual. It is probably to this continued intercourse that we must attribute the great degree of similarity of the inhabitants of the contiguous portions of Asia and Africa. It is, doubtless, this intercourse which may explain the remarkable fact—than which none struck me more forcibly—that we may often find the finest formed heads with beautifully shaped and magnificent features in conjunction with a skin so dark that an American would exclude their possessors from his society; and *vice versâ*, the fairness of complexion above suspicion in conjunction with a form of head, nose, and lips which would be anything but prepossessing in the eyes of one whose judgment of human nature is founded on anti-African prejudice.

ON OUR COMMUNICATION WITH INDIA BY THE LINE OF THE EUPHRATES AND OTHER ROUTES.

By Major-General CHESNEY.*

The importance of a rapid communication with India is now an admitted fact by all the continent of Europe. In reality it should have been so considered in past times, nor can it ever be otherwise so long as India remains a dependency of Great Britain. Since I had the honour of addressing the British Association, at Belfast, in 1852, the question of our communication with India by the line of the Euphrates has taken a much higher position than it then occupied in public attention. But before going on to the few remarks which I wish to make on this subject I should like to point out to you the various existing and proposed lines of route to India, in order that you may have clearly before your mind what it is that I am so anxious to accomplish by this Euphrates route, of which you have so often heard. You all know our long sea line to India round the Cape. The map shows, first, the existing line by the Red Sea and Aden to Kurrachee and Calcutta; secondly, the route proposed by Sir R. M. Stephenson, and the one apparently preferred by Lord Palmerston, passing over the Balkan, the Taurus, and the other mountain ranges, quite regardless of engineering difficulties; and thirdly, the line which it has been proposed to carry out.

You will at once perceive that if a direct line be drawn along the globe from London to Bombay or Kurrachee, it exactly takes in the route by the valley of the Euphrates; consequently this portion of the line has necessarily formed a part of all the various projects that have been advanced with a view to facilitating and shortening our communication with India, with one exception (brought to my notice in a paper read last year at Cheltenham), which line is supposed to go from Acre, across the desert, to Bussorah. The distances by the two overland routes are as follows:—

	English miles.
From London to the entrance of the Red Sea ...	4372½
From the entrance of the Red Sea to Kurrachee, which will no doubt become the great port of India in place of Bombay	1705
Total	6077½

	English miles.
From London to the entrance of the Persian Gulf ...	4271
From the entrance of the Persian Gulf to Kurrachee	702
Total	4973

The difference in favour of the Euphrates valley being 1104½ miles. The great gain therefore is from the entrance of the Red Sea and Persian Gulf onward. From the Red Sea to Kurrachee we have 1705 English miles; whilst we have only 702 from the head of the Persian Gulf to the same port, or less than one-half. In the one case we have the monsoon right ahead towards Aden; in the other it is nearly abeam to Ormuz;—I need scarcely add, a difficult and dangerous navigation in the one case, and a perfectly safe one in the other.

The completion of the proposed arrangements would enable us to get over this distance, and carry mails and passengers from London to Kurrachee, in thirteen days and a half, or less than half the time at present occupied in the transit by the Red Sea; while by laying down an electric telegraph line by this route, we may in eighteen or twenty hours be assured of the welfare of some friend or relative in a distant part of India, whose fate is now a matter of uncertainty and anxiety. I should just point out to you also that the proposed railway will form a chain of communication with those lines up the valley of the Indus, &c. now in progress of completion in India; and will thus give us as direct a route as can be had between London and Lahore.

But the rapidity of rail and electric communications form but a small portion of the benefits which in a political, military, commercial, and social point of view will result from opening up the Euphrates valley route to India. No country possesses associations of such deep and historical interest as this. We have here the first seat of mankind,—the sites of the four primeval cities of the Bible,—the empires of Cyrus the great, Cyrus the younger, and the great follower of his steps, Alexander, whose conquests and unparalleled marches of 19,020 miles (according to a careful calculation which I have made) laid the foundation of that connection of the east with the west which is now under consideration. The Romans also were alive to the great importance of this territory, for after the empire of Seleucus had passed away we read of the attempt of Crassus to conquer the country, and of the expedition of Trajan, B.C. 51. Julian the apostate followed in the steps of Trajan, A.D. 331. He built a fleet on the banks of the Euphrates, descended the river, and, according to Gibbon, encountered a most terrific hurricane at a spot answering to the present El Kaim, above Anah; and it is remarkable that it was apparently nearly at the same spot that the expedition which I had the honour of commanding was visited by a similar and equally fearful hurricane in May 1836.

From the period of Julian, A.D. 363, we have no record of any great military expedition in connection with Western Asia until Napoleon conceived the idea in 1809 of transporting a force down the Euphrates, with a view to the invasion of India. All his calculations and arrangements were made for this end. His troops were to have been transported on rafts, constructed of timber cut down in the vicinity and on the banks of the river and sea coast. With a little of his daring we might do the same at this moment and with much greater facility. The garrisons in the Mediterranean might readily spare 7400: viz., 3000 from the 6500 at Malta, 2000 from the 4000 at Corfu, and 2400 might be detached from the 5400 men stationed at Gibraltar;—2400 might go through Egypt, and 5000 could be carried in a few days by Admiral Lyons' fleet to the mouth of the Orontes. They would then have before them a march of 110 miles, with ample means of transport to the river. Pontoons, native rafts, and boats would carry the force down to the Persian Gulf in less than fifteen days; there native vessels could be found to transport them to Kurrachee by a safe and rapid navigation at this season.

There have been various proposals at different times for opening communication with India by the Euphrates valley. That which took the most practical shape was elaborated by Lieut. Campbell, then of the Royal Engineers, in 1843. His proposal and map were in all essential points identical with those more recently proposed by the great engineer Sir R. M. Stephenson. These and many other subsequent proposals, both French and English, have all now become merged in the company of which Mr. Andrews is chairman, and Sir John MacNeill, a man well known among you, engineer in chief.

I was strongly pressed last year to join in the promotion of my favourite project of nearly a quarter of a century, and urged to proceed to Constantinople to obtain the necessary firman from the Sultan to make all preliminary arrangements. Feeling that with the prospect of a railway a more careful examination of the country to be traversed was desirable, I was accompanied by Sir John MacNeill, and two assistant engineers. We reached Constantinople by the route of the Danube, opened negociations, and made all preliminary arrangements with the Turkish government; and then proceeded to Syria in H.M.S. *Stromboli*, which was kindly placed at our disposal by Lord Lyons. We examined carefully the coast of Asia Minor, where the Taurus touches the sea, in the hope of finding a practicable valley for a future line through that country, and then proceeded to examine the coast for a good harbour. That of Alexandretta did not promise to answer on account of its mountains, impassable for a railway; and the ancient harbour of Seleucia was also condemned, as not affording a sufficient depth of water. But on the southern side of the Bay of Antioch a spot was selected by Sir John MacNeil, admirably adapted to form a safe and commodious harbour of refuge. It will be capable of receiving second-rate line-of-battle ships, and will be as good, if not superior to the harbour of Kingstown. The Turkish government has engaged to bear the whole expense of the construction of this harbour, estimated at from 250,000*l.* to 300,000*l.*, and to carry out the works by English engineers, simultaneously with those of the railway.

The spot chosen is 3 miles south of the river Orontes, and 6 miles east of the old harbour of Seleucia. The harbour is proposed to be formed by running out a breakwater on the south side of the small natural harbour, which is a perfectly secure and safe landing-place for boats, with good holding ground; so that vessels taking out materials for the construction of the railway could anchor in safety off this landing-place. Stone of the finest quality abounds close to the point where the breakwater will abut on the land, and can be quarried also to any extent in the immediate neighbourhood. It is proposed to construct about 1000 feet of the breakwater in the first instance, and to complete each portion as the work advances, so as to afford shelter and

* Paper read before the British Association, Dublin, September 1857.

landing wharfs within the first year or eighteen months, which will enable vessels drawing 20 feet of water to lie in safety during the winter months, if required to do so; and within six months from the commencement of the work a landing-place can be formed, and perfect shelter for boats, at an expense of 20,000*l*. The harbour when completed will be capable of giving shelter to thirty or thirty-five vessels. The average depth of water will be from 20 to 40 feet. I have given these details in connection with the proposed harbour because I think you will agree with me that, irrespective of the route to India, a good harbour of refuge on the coast of Syria would of itself be of the utmost value and importance to all commercial nations.

Our survey of the country and the subsequent trial sections of the engineers extended from the coast to within sight of the Euphrates, taking in the towns of Antioch and Aleppo. Beyond the latter all engineering difficulties cease, the country presenting a hard dry level surface (called in Arabic Ka Jalide, flat and hard), most naturally adapted for a railway. And even between the Mediterranean and Aleppo the difficulties are such as would be considered small in this country. There will not be a single tunnel, and only two cuttings of any consequence. Two chain bridges over the Orontes will be necessary; but neither do these present any obstacle to the engineering science of the present day.

The average expenses for the first part of the line (which will be the most expensive portion of the whole) is estimated at 13,484*l*. per mile, and another portion, which also presents some difficulties, is 12,754*l*. per mile. But as portions beyond Aleppo fall very considerably below this average, some of them being estimated at only 4693*l*. per mile, the average expense of the whole of this first section of the line from the harbour to the Euphrates has been calculated by Sir John MacNeill at 8858*l*. per mile.

On my return to Constantinople the terms of the concession were finally settled, but owing to the opposition from rival parties they were less favourable than had been previously arranged. The Turkish government gave a guarantee of 6 per cent. on the capital expended by the company, requiring from them a deposit of 28,000*l*. in exchange for the firman, with the condition that the works must be commenced within one year. The expense of the whole line is estimated at 6,000,000*l*., but assistance from our government on the first section only, or of a sum of 1,400,000*l*., since the railway after reaching Aleppo will require no assistance whatever. The assistance asked—the whole amount of which is only 100,000*l*., to supply the interest to the shareholders for the first three years, until the railway shall be in working operation—is more nominal than real; the object being to give confidence to the public, for which the Turkish 6 per cent. guarantee is not sufficient.

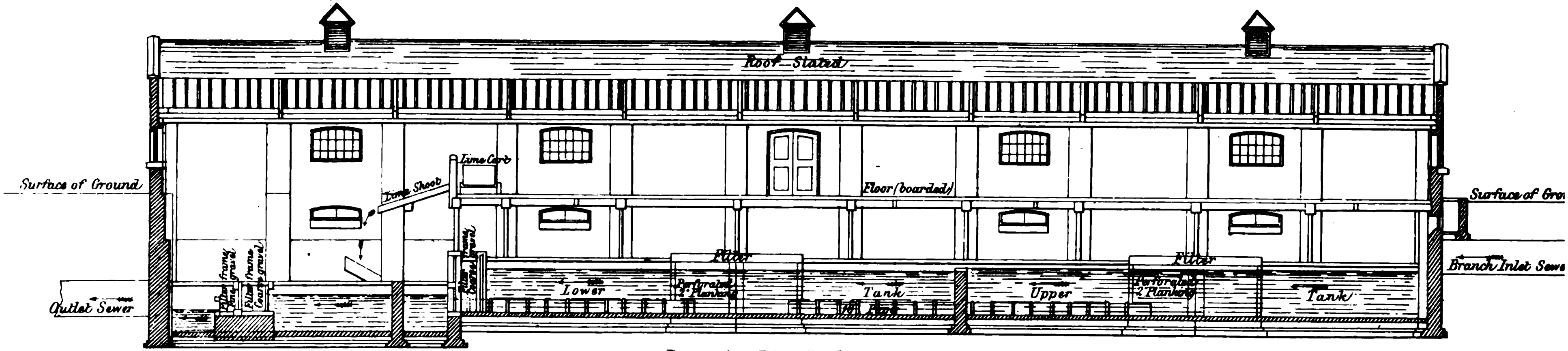
I found the Porte thoroughly alive to the great advantages likely to result to Turkey from the establishment of this line. The consolidation of the Sultan's power in distant provinces of his empire, the great extension of commerce to be expected, the centralisation of the system of government,—these and many other considerations were strongly felt by the Turks. We found indeed the existing commercial returns in Syria most satisfactory. Without taking into account any increase, Aleppo alone and her commerce would suffice to support a railway thus far, and would yield a return of 8 per cent. to the shareholders; 1800 shares were at once taken in Aleppo itself, and a petition was sent to the Sultan in favour of the railway. To the eastward of this city, however, a large additional trade may be expected; indeed a very extensive trade exists, which would all flow into this railway. We shall have Syria and Mesopotamia on one line, India and Central Asia beyond, with Kurdistan and Persia on one side, and Arabia on the other. It is impossible to estimate the amount of traffic and commerce which will arise: it must be very large, it may be beyond what even England has ever seen or imagined,—for there is no limit to the productive powers of these countries, provided capital and skill be there to turn to account the vast provision for their realisation contained in their noble rivers. The chief products at present are grain (which could be supplied to Europe to any extent), cotton of a very superior quality, which is already cultivated largely, but not well cleaned, in the neighbourhood of Mossul, and would be grown much more extensively if any means of transport existed. Mr. Rassam, British consul at Mossul, tells me that 100,000 camel loads of cotton are now lying there for want of means of transport. Wool, copper, sugar, indigo, saltpetre, dyes of various kinds, bitumen, and various other products, are the present ordinary exports of Mesopotamia. Their demands for our goods would be proportionately large. At present the natives of Syria and Mesopotamia receive many of their supplies from Russia, through Trebizond; but their markets would be supplied by Manchester, Sheffield, Birmingham, &c., if the means of transport were established. It is indeed impossible to estimate the changes in European countries, by throwing open to them these sources of commerce and openings for colonisation.

I have dwelt at some length on the commercial advantages to be expected from this line, although at this moment these must yield in importance to the all-engrossing desire for more rapid communication in India. This and telegraphic wires in operation would be worth anything to England at this moment. The means of rapid and certain transmission of mails and passengers to India ought alone to decide the public and government in favour of this line. For the transport of troops and stores it would be of inestimable importance. Few political objects could perhaps be of more consequence to England than that which will be so thoroughly accomplished by this line. I allude chiefly to the consolidation and to the commercial and political resuscitation of Turkey. We have expended lavishly money and lives ostensibly for this object, but without any benefit to ourselves, and without imparting any real strength to Turkey; by this line, however, we secure the defence of her frontier against Persia and Russia. History proves to you what a powerful influence has belonged at all times to the possession of the valley of the Euphrates. A friend who is intimately acquainted with the east writes to me—"I was in those countries during the Russian war, and frequently thought how different the position of that power would have been if their army had been moved towards the Euphrates valley, instead of invading the Principalities and European Turkey. Europe would have remained in a state of apathy, and public opinion (out of England, at any rate) would have been for them. Had they reached Mossul under these circumstances they would have been in a country whose resources surpass almost any other in the world." This, or a very similar plan, was proposed to the Emperor Nicholas by one of his generals during the war of 1828-9. We may be very thankful that it was not adopted. Dr. Sprenger says, "If properly managed, the valley of the Tigris would soon become sufficiently prosperous to form the basis of a campaign to the south-east, or the same route that was taken by the Arabs when they conquered the valley of the Indus, in the seventh century of our era. The straits of Ormuz are so narrow, that the Persian Gulf might at any time be converted into a lake belonging to the power which may be in possession of Bussorah. Europe is no longer the world, and the true key to the possession of the world is the valley of the Tigris, and not Constantinople, as it was believed in ancient times."

These are a few, and still but a few of the great results likely to arise from this line of communication. The subject is too vast to be embraced in a paper such as this; but I trust I have said enough to give you an interest in the subject: and I may add to all its practical advantages that to men of science, to the geologist, the naturalist, the ethnologist, the archæologist, and many more, new fields of interest and investigation will be opened up, with which Europe has at present but slight acquaintance.

The principal objection with which my views on the importance of the Euphrates route are generally met is, dread of the Arabs. I think myself that this difficulty will be easily overcome by judicious management and a little foresight. They are a very singular people, uniting the extremes of good and evil in their character. I have lived among them for many years, and have experienced both from them, the good and evil,—the greatest fidelity and truthfulness in most instances; treachery and dishonesty in some others. Our chief difficulties with them would arise from their ignorance, the divided and sometimes hostile state of their tribes, and their blood feuds. But I know from experience that by moderation, tact, and truthfulness on our parts these may be overcome. During the Euphrates expedition we never lost a single man by the Arabs. They carried large stores of muskets, powder, ammunition, and sums of money amounting to 6000*l*. and 7000*l*., for us, attended by only one individual of our party; and in no one instance was there any loss to us. These undertakings were usually paid in advance, and if the Arabs were prevented from fulfilling their engagements, the money paid was scrupulously returned to us. They are indeed as much alive to their own interests as other nations,

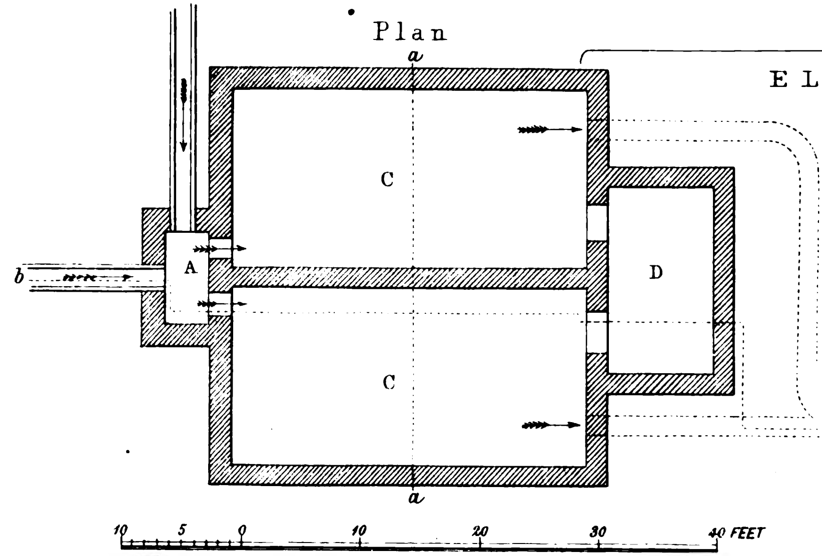
CHELTENHAM SEWAGE WORKS.



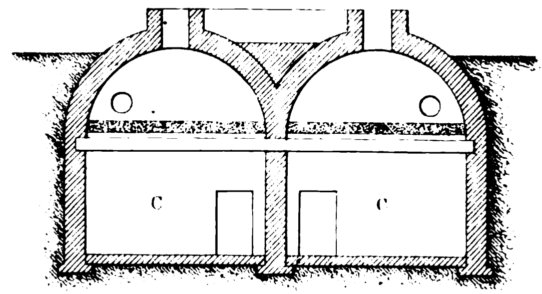
Longitudinal Section.

ELY SEWAGE WORKS

Plan



Section at a.a.



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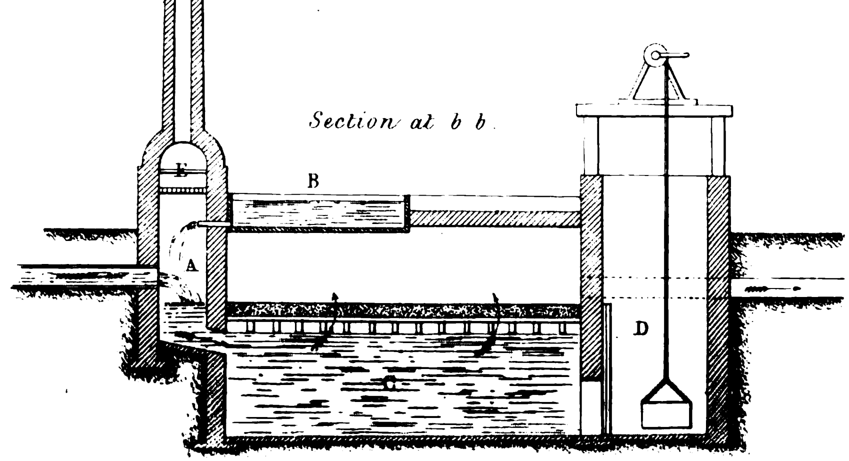
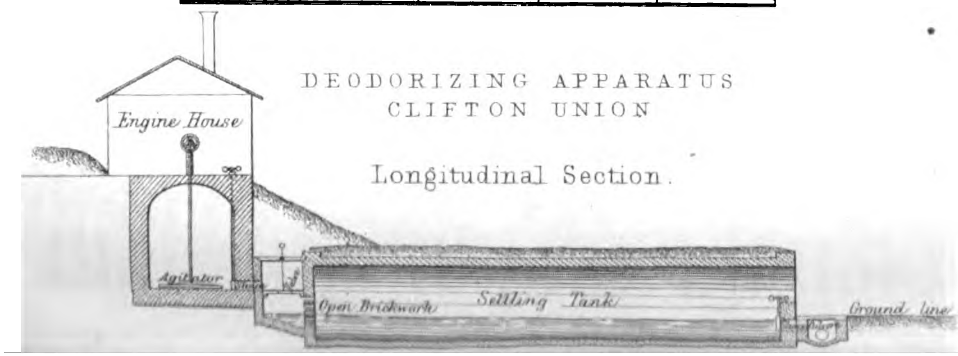


DEODORIZING APPARATUS
CLIFTON UNION

Longitudinal Section.



and will soon appreciate the advantages which they will derive from the railroad, by regular employment of themselves and their camels, and increased trade. If however they should show hostility, contrary to all expectation, such arrangements have been made with the Sultan's government as will meet even this difficulty. It must be remembered also, that a body of workmen such as we must employ, amounting to 10,000 or 12,000, are already a considerable defensive element; and we should also recollect that Ibrahim Pacha kept the Arabs under perfect control.

In addition, however, to my own opinion, I will read that of a friend, Dr. Aloys Sprenger, the first orientalist of the day, who has resided for many years among them. His description of the Arabs is too good to be omitted. He says, "Some time back I received a letter from Mr. Porter, at Damascus, expressing great uneasiness on account of the Bedouins; but nothing can be more unfounded than this cause of alarm, for they are the most manageable people in the world if judiciously treated. But even if matters were to be mismanaged, as they have been at Aden, and the Bedouins should offer every opposition in their power, it would be of litle avail. It would soon be found that, notwithstanding their personal bravery and cunning, they are very much like wild beasts. No one has ever heard of an army of tigers; and so would it be with the Bedouins, who have never been united. Like wild beasts, they would show desperate courage when irritated, but such ferocity can do nothing against discipline and calm resistance. As a proof of this, I may mention that there are some Kurdish villages below Mardin, in the midst of the desert, which, small as they are, defy all the power of the Shammaar tribe, and successfully refuse to be taxed. Whoever possesses the Euphrates has the Bedouins in his pocket; for this cuts them off, and they cannot do without its water and other resources."

Those who really entertain fear of the Arabs forget that a railway running through a fertile country is a vein of life. In less than two years we should see towns and villages springing up on both sides of the line, and thousands of these nomads settled in them. But it is on the gradual construction of a railway, and the time it must require, that I chiefly rest my expectation of ultimate and immediate and complete success with the Arabs. The impediments thrown in the way of the Euphrates expedition by the Pasha of Egypt in 1835, and the delay which was the result, really assisted our operations, by giving more employment to the Arabs, and increasing our intercourse with them. This will be the case with the railway. As far as Aleppo the Arabs cannot offer any impediment; but in any case, long before it reaches that city, they will feel the advantages of more employment, and will be prepared to further instead of impede the works.

Viewing things in this light, and looking to the gradual operation of time to establish our influence among this people, you will readily understand that I have not thought the time arrived for laying down isolated electric wires through their country with any prospect of security. I do not think it necessary to wait for the completion of the railway to accomplish this, but I do think that it would be prudent, and even necessary, to make some of the railway preparation, such as sectional levels, so as to have some kind of influence in the country before laying down telegraphic wires. I, however, thought it right so far to fall in with the views of others as to open negociations at Constantinople on this subject, and I also arranged with Mr. Barker, vice-consul at Aleppo, who has passed his life in that country, that he should, if required, go among the Arabs to make preliminary arrangements for the establishment of the telegraph, by opening in the first instance the line of Tartar posts, which would at once give us a weekly and speedy communication between England and India. This line existed for many years in Lord Wellesley's time, passing from Constantinople to Aleppo, and thence by Dyarbekir to Bussorah, from whence mails were conveyed with great regularity by a fast schooner to Bombay. Another post road is also available from Bagdad by Mossul and Dyarbekir to Constantinople. That by Aleppo would ultimately have the advantage, in consequence of the proposed railway; but for immediate use at this critical moment, we might run some little risk by using that by Dyarbekir, which, with the assistance of a qualified person living among the Arabs, would smooth the way for laying down electric wires. Sir J. MacNeill was of opinion that if a judicious commissioner were sent to reside among the Arabs —a man thoroughly acquainted with the people and their language—it would secure the interests of Great Britain; and if this were desirable in his time, it is imperative now.

With regard to our telegraphic communication with India, two companies have been formed for this purpose. The one proposes a line along the Red Sea to Kurrachee; the other along the valley of the Euphrates to the same port. Each appears to be quite practicable, and I should like to see both in operation. As in the case of the overland communication, England requires the resources of a second line in case of accidents to either; and, irrespectively of this consideration, it is clear there would be ample employment for both. I should like, therefore, to find government prepared to further and encourage both. To effect this, a submarine cable should be laid down from Kurrachee to Ras-el-Had, or some other place near the entrance of the Persian Gulf. Supposing this to be done for the companies, they might then carry their lines to England—one by way of Suez, and the other by the Persian Gulf; and as the Atlantic cable might be purchased for this purpose, both might occur to be completed very speedily.

The Red Sea line, by following Arabia, at a short distance from the coast, would encounter depths varying from 20 to 100 fathoms nearly the whole way to Suez; coral rocks are very occasionally met with, and we should have the advantage of knowing where an accident might occur, and could prepare the means in consequence of recovering and repairing the broken pieces of the cable. So that the completion of the line from Ras-el-Had to Suez does not seem to offer any practical difficulty.

For the other line there is a choice of two routes, across Asia Minor from Constantinople, as far as Aleppo by one line, and as far as Dyarbekir by the other, no difficulties whatever exist; but beyond these places the Arabs are to be taken into account, but this is only for a limited distance. The line of the railway would ultimately be the preferable one, but for immediate operation the other might be somewhat quicker. The work might, therefore, be commenced simultaneously at each extremity. A submarine cable could be laid down from Ras-el-Had to Kurnah, and from the latter place to Bagdad, along the bed of the Tigris; and again between Constantinople and Dyarbekir, beginning at several places at once in each part of these lines. The middle part only would be wanting from Dyarbekir to Bagdad, and this might be completed by a line of Tartars, pending the definite arrangements to be entered into with the Arabs by the commissioner. If the government should not be inclined to lay down the cable from Kurrachee to Ras-el-Had for the companies, these, having a promise of subsidation from government on the completion of one or both lines, may very well undertake this part of the expense jointly, and thus we should very soon be in possession of two lines of electric wires to India.

The principal points are now before you, both as regards the railway and electric telegraph. Each individual must form his own opinion as to the desirability and practicability of both undertakings. I assume the affirmative in both cases, and I am convinced that a very little of our usual energy will complete both—the electric wires at once and the railway at no distant period. The railway will be carried from the Mediterranean to the Persian Gulf, either by means of British skill and capital, or by the French, who are still more anxious than ourselves to undertake the task. Lord Palmerston appears in some measure to have adopted one part of the French plan, and seems to advocate a line through Asia Minor, more northward, so as to come in towards the head of the Euphrates. Unlimited funds might doubtless accomplish this, but my local knowledge gives me the firm belief that the Taurus can only be passed without an absolutely ruinous expense in the direction of Adana and the Orontes. Since my arrival in Dublin, a letter has reached me from Paris, saying that with the advantages of my presence and that of Sir J. MacNeill in that city, there would be little difficulty in raising thirty millions of francs to commence the work, under a joint English and French direction. I met with great difficulties at Constantinople, in consequence of the opposition of the French, who have long seen the importance of the valley of the Euphrates. They seem to know and feel, like Dr. Sprenger, that its possessor holds the key of the Eastern world. It is, in fact, far richer and more valuable than Egypt, and England therefore has now at her feet the opportunity of acquiring the means of greatly increasing her commerce, of consolidating Turkey, and of securing our Indian territory both from internal and external dangers.

THE DEODORISATION OF SEWAGE, AND ITS MANUFACTURE INTO SOLID MANURE.

By Henry Austin, C.E.,
Chief Superintending Inspector of the Board of Health.

(*With an Engraving, Plate* XXVI.)

1. *Chemical Processes for separating the Solid Matter of Sewage.*

Judging from the number of patents which have been granted for the chemical treatment of night-soil and other town refuse for the manufacture of solid manure, the subject appears to have engaged considerable attention for the last twenty years. Indeed the first patent was granted in 1802, to Lewis James Armand Estienne, for converting "human excrement into a powder divested of all smell, preserving at the same time its fertilising properties"; but no other patent for similar purposes seems to have been obtained until 1835.

From that period to the end of last year, many patents were granted for dealing in some way with town refuse: the first patent for treating sewage matter at the outfalls of drainage being that of Mr. Higgs, in 1846.

The majority of these patents seem never to have come into operation, and I do not propose therefore to enter into any general description of them; but I shall submit only a brief account of those operations which have chiefly commanded public attention, and of those which I have had an opportunity of examining.

The principal process hitherto adopted for the preparation of a solid sewage manure consists of the admixture of a certain proportion of lime, of the consistency of cream, with the sewage as it flows to the outfall, whereby the solid matters in suspension are rapidly precipitated, and some of those in solution disengaged, and the supernatant water allowed to flow off in a comparatively pure state.

The lime process is chiefly represented by the patents of Mr. Higgs and Mr. Wickstead. In 1849 works were established at the outfall of one of the main sewers in the city of London, for the purpose of carrying out Mr. Higgs' patent process. These not having proved commercially successful, were subsequently abandoned; but works have since been established on Mr. Higgs' plan at Cardiff gaol, and recently on a more extended and perfect scale at Tottenham.

The Tottenham Works.—This town, which now comprises about 10,000 inhabitants, has been completely drained under the Public Health Act. The outfall was led into the nearest stream, where of course the pollution from refuge, before retained amidst the habitations of the people, soon became a considerable though less dangerous nuisance. It was the subject of great complaint, and the next step was to seek for some means of avoiding the evil consequences of this noxious discharge.

Sewage works have been erected by a company, at great expense, for carrying out the lime process, under Mr. Higgs' superintendence. These works comprise a reservoir, capable of holding 44,000 gallons, into which the sewage is first received, and then raised consecutively into four iron tanks (each capable of holding 5000 gallons) by an engine of 10-inch cylinder, 16-inch stroke, working up to 8-horse power. The engine in ordinary work makes 110 strokes per minute, and the pumps 900 strokes per minute.

Cream of lime is poured into and mixed with the sewage as it passes into the iron tanks. The proportion of lime used is estimated to be ½ of the solid matter of the sewage, and the solid of the sewage is calculated by Mr. Higgs to be on the average 1 in 500 of the liquid. Only 1½ per cent. of this solid matter at Tottenham is stated to be grit.

When each tank is charged, from half an hour to an hour is allowed for settlement before the liquid is passed off to the outfall, and seven or eight deposits are made before the solid is removed.

The great difficulty which has been experienced in the lime process, both here and at Leicester, has been the drying of the sewage, so as to render it portable. Various expedients have been tried at both places and successively abandoned. At Tottenham a quantity of the manure had been dried by various means, but the difficulty of accomplishing this economically had not been overcome at the time of my visit. The new plan then proposed, but not in operation, was to pass the sewage in the semi-fluid state in which it is withdrawn from the tanks round a drum in a thin layer, from which it would continuously fall on a series of heated plates.

A great discharge of foul gases takes place on disturbance of the deposits in the tanks. At Tottenham these gases are not allowed to escape, but are conducted to a purifying air chamber, and there treated with hydrochloric acid and oxide of manganese. The whole establishment was perfectly free from noxious or unpleasant odour.

The price of the manure was fixed at 4*l.* per ton.

A circumstance remarked at Tottenham is so illustrative of the rapidity with which, in a properly graduated system of drainage with a smooth channel, the refuse flows from the houses to the outfall before decomposition or disintegration of the solids has taken place, that it is worth recording. A small recess or pit is formed at the mouth of the sewer, guarded by a wire screen, for the purpose of intercepting any foreign substances that might otherwise reach the pumps; and it is the duty of a boy to attend at this pit to clear away rags, paper, &c. that would otherwise choke the screen. A sufficient quantity of soap in cake or lump is daily found here to pay for this labour.

The Leicester Works.—The largest works, however, for carrying out the lime process have been established by a company at Leicester, under Mr. Wicksteed's patents. The principle is precisely the same as that adopted at the works just described. It differs only in the modes of operation, and in the adoption of various improvements which experience has from time to time pointed out.

Leicester contains about 65,000 inhabitants. The local board being compelled by their Act of Parliament to raise and deodorise the whole of the sewage of the town, in order to prevent pollution of the river, entered into an agreement with the Solid Sewage Manure Company, whereby a lease of the sewage was granted by the local board, on the condition that the company should erect works for the continuous pumping of the sewage and for its complete deodorisation at their own cost. A complete system of public sewers has been constructed in the town, and a large number of manufactories are drained into them; but a considerable portion of the houses has not yet been properly drained —cesspools still prevail in the town for the most part. The outfall, where the sewage works are established, is about a mile below the town, and here the whole liquid drainage, except in times of flood, is dealt with by the lime process.

The sewage flows into a pump well, whence duplicate engines (with 25-inch cylinders, 7 ft. 6 in. stroke, and 28-inch pumps) raise it to the level of the reservoirs. Quicklime mixed with water to the consistency of cream is raised at the same time by the same engine, and discharged in certain proportions, varying from 2 to 16 grains per gallon, into the pipe which conveys the sewage. The two are intimately mixed by a series of agitators, and afterwards pass through a perforated chamber into the first reservoir, where the greater part of the solid matter is precipitated. The bottom of this reservoir is sloped from 5 feet depth at the sides to 15 feet in the middle, to a centre channel or trench, along which an Archimedian screw of 3 feet in diameter continuously works, drawing the precipitated matter into a covered well at the upper end. From this it is lifted by a Jacob's ladder of dredging buckets alternately to one of two tanks 20 feet above on an upper floor.

At this stage of the process the material raised from the reservoir is in a state of "slush," and the chief difficulty until lately appears to have been, as stated with regard to the works at Tottenham, to get rid of the remaining fluid. At Leicester this difficulty has now been ingeniously overcome by Mr. Wicksteed, by means much more perfect, and much less costly, than those hitherto employed. A portion of the semi-fluid sewage in the tank descends through a pipe into a portable apparatus below, consisting of a pile of filtering trays secured together, from which the water is discharged by the pressure of the remaining sewage above. The solid matter comes from the trays of this press in firm slabs, and it is then cut by strings into ordinary sized bricks, and put out to dry.

The agitators, screw, and Jacob's ladder, are worked by a separate engine.

The first reservoir is about 60 feet in length and 45 feet wide, and the liquid sewage travels from it at at the rate of ½-inch per second, to a second reservoir, 130 feet long, where further settlement takes place; seven-eighths however of the precipitation takes place in the first reservoir.

An offensive odour pervaded the buildings at the time of my visit, which evidently escaped from the sewage deposit as it was raised from the bottom of the reservoir. On opening the chamber in which the Jacob's ladder works the effluvium was intolerable, but this might be very readily dealt with, and all nuisance obviated.

The water which flowed off to the river, after treatment with the lime, possessed still a perceptible smell and taste, although the sewage was in a very diluted state on that day from continuous rain; but as proof of the great improvement which these works have occasioned in the condition of the river, it must be stated that fish have recently returned to old haunts at a short distance below, where they have not been seen for many years.

It is said that upwards of 30,000*l.* have been expended upon these works. This amount however must not be taken as the necessary cost of establishing similar works elsewhere, a considerable sum having, no doubt, been sunk in the various trials and experiments necessary to bring the process to its present practical condition. Mr. Wicksteed calculates that works sufficient for a population of 500,000 could be established for the sum of 40,000*l.* From this population it is estimated that 60,000 tons of manure would be produced per annum, prepared in a plastic state, like clay ready for brickmaking, at a cost of 2*s.* 4*d.* per ton, including the discharge into carts or barges lying alongside the works.

The price of the dried manure of the Company was a few months ago fixed at 40*s.* per ton. There having been little or no demand for it, and a large and increasing accumulation at the company's works, it has been more recently offered at 25*s.* per ton.

The Manchester Experiments.—While treating of the lime process, I must not omit mention of the important trials recently carried out by Dr. Angus Smith, Mr. Crace Calvert, and Mr. McDougall, on the foul water of the river Medlock at Manchester.

In the account of these experiments published by the Manchester and Salford Sanitary Association, the effect of the admixture of lime with the river water is thus described:—When lime is thrown into the Medlock it produces what may be called 'curdling,' which results from the formation of a very flocculent precipitate. This precipitate is formed by the combination of the lime with the carbonic acid, organic matter, and other substances held in solution and suspension in the water. It separates into large and distinct portions which subside very rapidly. Careful observations repeatedly made show that the precipitate falls at the rate of about 1 foot in 8 minutes, or about 1½ inch per minute."

It was found that about 2 grains of lime per gallon added to the water of the Medlock, which had the most repulsive odour, almost totally deprived it of unpleasant smell. This proportion of lime appears to have been confirmed also as sufficient on a large scale, if time enough could be given for the operation of the lime before the precipitate was allowed to take place.

In the early experiments it was found that 17 cwt. of lime mixed with 1,000,000 gallons of water produced instant precipitation without excess or causticity. "The precipitate so made contained no caustic lime: the water also ran free from caustic lime." Further trials, however, determined that under more favourable circumstances 10 cwt. of lime would be sufficient for immediate precipitation from 800,000 to 1,000,000 gallons of water.

Considering it an important thing to devise some means of reducing still further the quantity of lime, it was tried whether the lime which had once been used had really done all the duty that it was capable of performing. It was found by using the precipitated matter over again to repeated fresh charges of the same quantity of impure water, a fourth charge was acted upon with nearly equal advantage. So that where a large subsiding area could be obtained, and the water could be kept sufficiently long in suspension, it was concluded that somewhat more than a fourth of the above quantity of lime, or about 3 cwt. per million gallons, would effect the complete precipitation.

Mr. Calvert states that "to appreciate fully the value of lime, it is necessary to draw attention to the following important fact, namely, that if we take the average amount of organic matter in suspension and solution as 12·11 grains per gallon, there remains after treatment by lime only 3·5 grains per gallon *in solution*, or, in fact, a quantity less than exists in many river waters which are used for domestic purposes."

The full effect of the application of lime, as regards the smell of the water, was not sufficiently ascertained, owing to the imperfection of the apparatus and arrangements. On this subject Dr. Smith and Mr. McDougall remark:—"We found the smell of the water of the Medlock was not entirely removed by precipitation with lime, or if removed, that it soon returned; we therefore used a disinfecting agent to the amount of 2¼ per cent. of the lime used. We used for this purpose our own powder."

As to the value of the precipitate, Dr. Smith and Mr. McDougall state that it "has a certain value as a manure, although not a great one. It may be advantageously used near the banks of the canal, but at the distance of even a few miles, it could not be used economically by farmers, as it would not bear the cost of transport......At any rate, the value of our precipitate cannot be reckoned higher than 7*s.* 6*d.* per ton." And Mr. Calvert also remarks "that no great commercial value can be attributed to this deposit."

With reference to the proportion of lime, namely, 3 cwt. per million gallons, which was found to be sufficient for deodorising the waters of the river Medlock, it must be borne in mind that these experiments will form no criterion of the quantity required for effecting this object with ordinary sewage water.

The chairman of the Leicester company estimates a consumption of lime of 100 tons per week for a population of 500,000, which, with an ordinary water supply of 200 gallons per head per week, would be equivalent to 1 ton per million gallons of sewage.

Mr. Stothert's Process.—In this patent process the sewage is treated with sulphate of alumina in addition to the lime, which causes a rapid subsidence of the solid matters, and to these, charcoal, made from solid sewage, is added. These ingredients cost 30*s.* per ton, and they are stated to make 2 tons of manure.

A small model establishment was put up by Mr. Stothert at Northumberland Wharf, Strand, where the sewage from one of the main outfalls of the metropolis was operated upon for a considerable period, with apparently complete success so far as deodorisation was concerned, but I am not aware that any other works have yet been erected under this patent.

Mr. Herapath's Process.—This consists of the admixture of sulphate of iron and burnt magnesian limestone with the sewage. The process was put in operation for a short time at St. Thomas's Exeter, by a person to whom the lease of the sewage and of certain tanks erected at the outfall was granted by the local board. The contractor, however, having no capital, soon failed in his undertaking.

The proportion of materials used is 1 of sulphate of iron to 4 of magnesian limestone. Founded on the experience obtained at St. Thomas's, Mr. Herapath estimates the cost of the materials, including labour and fuel for the manufacture of manure, at 17*s.* per ton, and 1 ton of the ingredients will produce 2 tons of dry manure.

I must add that the operation was conducted at St. Thomas's in a very slovenly manner, and at the time of my inspection was by no means calculated to improve the sanitary condition of the neighbourhood.

Mr Dover's Process.—The method proposed in Mr. Richard Dover's patent consists in "treating sewage with an acid or acids, either alone or together with a salt or salts or other chemical agents, for the purpose of depriving it of its putrescent qualities, and also obtaining certain products threfrom." Hydrochloric acid is named, with chloride of sodium and protosulphate of iron. The sewage is then to be filtered through charcoal, gypsum, or clay, and mixed with these are various other materials to form compound manures.

McDougall's Disinfecting Powder.—The agent prepared by Dr. Angus Smith and Mr. McDougall "is a compound of two acids and two bases. The acids are sulphurous acid and carbolic acid, and the bases magnesia and lime. These four exist in it as two salts, viz., sulphite of magnesia and lime, and carbolate of lime." These ingredients are said to remove entirely the noxious emanations, the sulphuretted and phosphoretted hydrogen, from fæcal and other organic matters, and at the same time to preserve the fertilising elements, the phosphoric acid and ammonia.

Of the deodorising power of this agent under various circumstances, and of its convenient form for use, there appears to be abundant testimony. The borough engineer of Liverpool has used it in cesspools with great success, and it seems admirably adapted for use in stables, and for preventing noxious emanations from cesspools and from solid manure or other decomposing substances; and it is said that it could be economically applied at the outfalls of town drainage for the deodorisation of the sewage and its preparation as manure, although this does not appear to have been actually determined yet by trial on the large scale. The price of the material is 10*l.* per ton.

Mr. Manning's Process.—Mr. Manning's material is prepared from alum shale, containing sulphate of iron and animal charcoal in equal quantities. Its use has been adopted at Edinburgh and at the new gaol near Liverpool, with considerable success as a deodorising agent.

The ingredients are stated to cost 7*s.* 6*d.* per ton, and including carriage, the cost of deodorising 1000 gallons of sewage will be a penny, or say 1*s.* per head per annum, and according to the analyses of Dr. Penny, a valuable manure is the result.

The actual working expenses at the new gaol near Liverpool were 50*l.* per annum for the deodorisation of 12,000 gallons per day, including the digging out of the solid and carting away.

Croydon Sewage Works.—The process originally conducted at the outfall of the new drainage works of Croydon was that of mechanical separation of the solid matter from the liquid by passing the sewage through perforated plates or strainers. The liquid was then allowed to flow off, and the solid was mixed with peat charcoal. Various causes led to the failure and abandonment of these operations, and an action having been brought against the local board for pollution of the river Wandle, various endeavours have, I believe, since been made by them to arrive at more satisfactory results.

I visited the outfall again last year, when it was still by no means free from nuisance; but the works were then in a transition state. They had recently been let for the carrying out of a new process.

It was proposed to treat the sewage with lime in alternate reservoirs within the building at the outfall, in which the chief precipitation would take place, the effluent water being made to travel afterwards through a long course of open brick channel, constructed in parallel lines, the water flowing along it backwards and forwards before discharge into the river. The solid matter was to be mixed with various other materials, to form manure of different qualities and description.

Clifton Union Sewage Works.—An action in the Court of Queen's Bench having been a few months ago decided against the Guardians of the Clifton Union, near Bristol, for an alleged nuisance arising from the drainage of their workhouse, Mr. Blackwell, the engineer, was called in to advise on the means to be taken for deodorising the sewage, and the following process was adopted.

The inmates of the workhouse number 608 on the average, and the actual liquid sewage from the establishment appears to be only about 3 gallons per head.

Mr. Blackwell's examinations led him to consider that lime and sulphate of iron would be the best deodorising ingredients, but that a larger quantity of water would be required to obtain the desired effect.

At the outfall of the sewage from the house a well was sunk, and a small steam-engine about 2-horse power erected, for raising the additional supply of water of about four times the previous quantity into the cisterns in which the sewage is received. When these cisterns are full the lime is first thrown in and agitated with the sewage by a kind of churn apparatus worked by the engine, then the sulphate of iron is added and treated in the same way. The contents are afterwards run off alternately into one of two adjoining tanks, whence after some hours' settlement the water is allowed to flow off to an open stream which runs into the river Frome.

The operation of mixing takes place twice each day, each of the two tanks (together containing about 10,000 gallons) being filled and discharged every twenty-four hours. The cost of the works was about 600*l.*

Six bushels of lime are used per week, and 2¼ cwt. of sulphate of iron. One man's time is occupied in the operation. The total working expenses, including coals and all materials and labour, may be calculated at 94*l.* per annum, and if the interest and wear and tear be assumed to be 45*l.*, the total cost of the operation would be about 3*s.* per head per annum; but with a more copious supply of water, for which arrangements are now being made, it is expected that the cost will be less. The solid deposit is removed from the reservoirs about once per month, but it has scarcely yet been applied as a manure. I apprehend that it would be of little service for that purpose.

A longitudinal section (Plate XXVI.) is given as an instance of the compactness with which deodorising arrangements may be established for small populations.

I found a perceptible smell from the sewage in the reservoirs after the operation was performed, arising probably from the disengagement of the ammonia by the lime, but the works may be said to have accomplished their object, as no complaint whatever has been heard since their establishment from the parties residing near the open stream below, who indicted the guardians for the previous nuisance.

The sulphate of iron, I presume, would not be a beneficial addition to the manure; and other substances equally efficacious as deodorisers, to which that objection does not apply, being at command, its use is not to be recommended.

For this reason also I do not propose to enter upon any account of other chemical agents long used for deodorising, such as chloride of zinc and nitrate of lead; for however valuable their properties for dealing with specific cases of decomposition, they would render the sewage unfit for use as a manure, and would involve therefore perpetual waste and additional expense.

2. *Mechanical Processes for separating the Solid Matter of Sewage.*

Among the works which have been established for the mechanical separation of the solid matter of the sewage from the liquid by straining or filtration, and applying it as manure, those of Cheltenham appear to be the most extensive, and at the same time most successful.

The Cheltenham Works.—There are two outfalls of the sewage at Cheltenham, and works have been established at each of them. For the more ready comprehension of the following description a section is given showing the construction at the principal outfall. (See Engraving.)

The building is divided longitudinally, forming below ground two sets of reservoirs or tanks, which are employed alternately. The sewage passes through vertical filters in the upper and lower tanks, whereby the great bulk of the matters in suspension is separated and retained. These filters are 5 feet deep and 2 feet thick, and consist of coarse gravel inclosed within 2-inch perforated boards, these being protected with basketwork to prevent clogging.

The heavier matters of the sewage deposit themselves at the bottom of the tanks, but a large proportion of the solid forms itself into a floating body, and accumulates to about 18 inches thick on the surface. The liquid is conveyed from the angular filters in the upper tanks by a line of pipes in each division. A weir or rather division in the third or liming tank, causes the water, then partially clear, to flow through a channel at each end, during its passage through which a certain proportion of cream of lime, mixed on the floor above, falls into it, and occasions a further precipitation to take place. The effluent water then passes through another filter of gravel finer than before, and then through a third, finer still, to the outfall.

When either reservoir contains a certain amount of solid matter, the flow of sewage is cut off and turned into the other. This takes place about every eight weeks, and the filtering medium of gravel is removed at the same time and washed. The contents of the tanks, which are in a state of "slush," are then hoisted in buckets through the trap-lids on to the floor above, and wheeled out and mixed with the scavenger's refuse of the town, the ashes, street sweepings, &c. These are brought to the yard, and a kind of embanked reservoir is formed of them immediately outside the building, and as the semi-solid sewage is wheeled into the midst the dry refuse outside is turned on to it. The liquid is at once absorbed, and after being turned over and thoroughly intermixed, the solid mass is fit for immediate removal and use.

The ashes and dry refuse of the town are said to be just about sufficient for the purpose. They absorb about two-thirds of their bulk of sewage; that is to say, that one cubic yard of the ashes, &c. and two-thirds of a cubic yard of the semi-fluid sewage, make only one cubic yard of solid manure.

This operation was commenced in the spring of 1855. The drainage of Cheltenham is not yet by any means complete, but already the manure is manufactured at the rate of about 2000 cubic yards per annum.

None of the lime deposit had been removed at the time of my visit. This addition to the process had only recently been adopted. The cost of it is about 14*s.* or 15*s.* per week.

The outlay upon this building was about 1250*l.* The houses draining to it number about 3200, discharging about 300,000 gallons in 12 hours of daytime. The cost of the operation at the outfall is found to be 2*s*. 2*d*. per cubic yard of manure, and the ashes are worth 8*d*. per yard. The local board wisely put a low value on the manure in the first instance. Up to the time of my visit it had been sold at 2*s*. 6*d*. per yard, but as the demand exceeded by two or three times the supply, it was intended immediately to raise the price: 3*s*. 6*d*. per yard would pay the working expenses and interest on the outlay.

As the first attempt of the kind I must observe that Mr. Dangerfield, the local surveyor, has carried out this work very satisfactorily; but further consideration dictates some improvements in a sanitary point of view, and in economy of construction and labour, which may be useful for future guidance, more especially to small towns.

The operation did not appear to give rise to any nuisance, and the effluent water and solid sewage were nearly free from unpleasant odour; but the process may, in my opinion, be conducted in so complete a manner as to obviate the slightest offensiveness, even in the hottest weather.

Similar works to those at Cheltenham have just been adopted by the local board of health at Coventry.

The Uxbridge Works.—The local board of health of Uxbridge being much pressed by an injunction prohibiting the discharge of the sewage of that town into the river Colne, without its being deodorised, constructed works for this purpose.

The sewage is received into a large tank arched over. As much of the solid matter as can be collected is dragged by a rake out at a door at the end of the tank. This refuse is here spread on the ground and covered with a thin layer of charcoal or earth, and is then conveyed away in carts by the farmers. The liquid refuse flows from the tank through boxes filled with peat charcoal in lumps of 3 or 4 inches. It simply passes through these boxes and runs direct to the river.

I refer to this case more as an example not to be followed than as one possessing any merit. Although considerable expense has been incurred in constructive arrangements, which are sufficient for complete deodorisation, care has not been taken to collect information as to processes which have been found effective, and it is not surprising therefore that the local board should still be in legal difficulties on the subject. Endeavours are now being made, however, to rectify the errors into which they have been led.

There are about 1500 houses in the town of Uxbridge. An examination of these works took place when about 500 only of the houses were connected with the drainage, and it was then found that the liquid refuse running into the river Colne was much discoloured, and the appearance of the ground showed evident symptoms of a deposit of an unpleasant character.

The local board are restrained by the injunction from turning lime water into the river, on the plea that it would destroy the fish; but the experience at Leicester shows that this is not a necessary consequence of treating the sewage with lime. There, however, the lime water does not enter the river; sufficient reservoir space is allowed for its precipitation before the effluent water is discharged.

The Ely Works—Mr. Burns, the local surveyor of Ely, having, as early as 1834, made some successful experiments in treating gas water with clay, was induced recently to apply it, in conjunction with lime, for deodorising the sewage, on completion of the drainage works of Ely. Sewage works have been erected at the outfall, in which the experiment has been in operation for some time, and it is stated with complete success. At the time of my visit the place was certainly quite free from offensive smell; but the collecting tank has not been opened to try the effect of the manure.

It is found that one ton of clay is sufficient to deodorize 600 tons of sewage as at present discharged at Ely; but, as only a portion of the houses have waterclosets as yet, the liquid is comparatively weak. It is expected that every house will in the course of the present year be connected with the sewers, when it is supposed that about double the weight of clay will be required for the same quantity of sewage.

As the sewage discharges into the mixing tank A (Plate XXVI.) a stream of clay water falls from a cistern B above, and passes with the sewage alternately into one of two reservoirs C below, whence the water filters upward through a layer of charcoal and sand, and discharges by the outfall drain to the river.

It is proposed to pass the solid matter daily into the emptying chamber D, and to mix it with dry clay powder and peat charcoal, or with fine dry ashes, when it will be fit for removal and use as manure.

The furnace E shown in the section is intended for consuming the foul gases from the sewers, and for heating an oven for drying clay and peat for mixing with the wet manure. When the drainage works will be complete it is proposed to add a series of open tanks, with other filters of charcoal and sand, through which the effluent water will pass before discharge.

The Hitchin Works.—An attempt has been made for some time at Hitchin to intercept the solid matter of the sewage in a series of reservoirs and open pits at the outfall of the new drainage works, without any means of deodorising, or arrangements for precipitating, straining, or filtering. As might be expected, the process has not been successful. An action has been decided against the local board for pollution of the river, which will necessitate the adoption of more complete arrangements.

The Dartmoor Works.—The gas for lighting the Dartmoor Prison has been manufactured for the last five years from the peat with which that neighbourhood abounds, and some very interesting results are being elicited in the process by Mr. Watts, the resident engineer, by whom the system was introduced.

The peat charcoal and the ammoniacal liquor, two of the products of the manufacture, are mixed with the solid nightsoil of the establishment, and with bone dust, to form a solid manure which is used on the neighbouring lands. The liquid refuse of the premises is pumped up and applied for irrigation.

It may be useful to mention, with reference to the manufacture of peat charcoal, that one cubic yard of the dug peat makes about 4½ cwt. of the dried material, and that 5 cwt. of charcoal are produced from one ton of the dried peat.

Peat Charcoal and Boghead Coke.—As so much disagreement prevails with respect to the deodorising power of peat charcoal, Mr. Blyth was instructed to make some experiments on the subject, and to determine the comparative value of peat charcoal and the ground Boghead coke for this purpose. The results obtained are of considerable interest.

It appears that neither of these substances has much deodorising power when mixed with liquid. When heated after saturation they both gave off offensive effluvia in abundance, but, when spread over the surface of offensive matter, the escape of all odour was prevented. The experiments show that they have no power to separate matters from solution, and thus confirm the previous statements of Professor Way and Dr. Henderson that the power of charcoal to absorb ammonia from the atmosphere does not extend to the separation of that gas, or of anything worthy of notice, from solution.

In condensing gases, or as a deodoriser of atmosphere, the peat charcoal appears to have about four times the power of the Boghead coke; but, on the other hand, it must be borne in mind that, whereas the peat charcoal has latterly cost in London between 4*l*. and 5*l*. per ton, the ground Boghead coke is to be had for 12*s*.

In the course of these experiments a valuable property of the Boghead coke was discovered. It is only with great difficulty that this material can be made to mix with water; it remains a floating mass on the surface, and it was found that in that position it has considerable power of promoting evaporation of the liquid below, while effectually condensing the odorous gases that would otherwise escape. It thus becomes of value in promoting the drying up of offensive deposits. The sample of the Boghead coke was obtained from the Chartered Gas Company's works, Horseferry-road, a certain portion of this coal or bituminous shale being now very generally used in the manufacture of the London gas.

3. *Deposition of the Solid Matter of Cesspools; and the Separate System of Drainage.*

The simple deposition of the excremental refuse of towns, and the draining off of the liquid from the solid mass, as the means of manufacture of a portable manure, is carried out on the largest scale in Paris. A full and able report upon these works was prepared by Mr. Rammell, C.E., and is comprised in the Appendices of the Water Report (1851) of the first General Board of Health. It would be needless, therefore, under any circumstances, to enter into detailed description of that operation here;

but it is, in truth, so utterly inapplicable to the mode of drainage which I assumed to be indispensable for the health of town populations, and constitutes so great a nuisance in itself, that I should scarcely have considered it necessary to allude at all to this method of dealing with the matter, had it not still been doubted by many whether that system of drainage can itself be right which leads to considerable difficulties in realising the full value of the refuse of town populations.

I fear that all such objectors who would revert to the cesspool system view the subject with agricultural or commercial sympathies, rather than with an anxious regard for the public health as the primary consideration. At least they must be ignorant of the overwhelming evidence which a long course of inquiry has brought to light of the evils sustained by the retention of town refuse about habitations.

Some will admit these evils, but maintain that they arise from carelessness and defective arrangements both for the retention and removal. So far as this country is concerned, these defects, whether of construction or transport, must be admitted; but the Paris arrangements are the very perfection of the system. No care or expense has there been spared, and yet it is proverbial that the great source of the noxious atmosphere in Parisian houses is the cesspool.

Admitting this danger, even with the best arrangements, some will ask, Is not chemistry equal to the control of these substances,—either to prevent their passing into a dangerous state or to convert them into innocuous and valuable fertilisers?

Granting this power to chemistry, we must bear in mind that any arrangement made with this view, must receive daily proper attention in every separate household; and supposing this to be given, cost of the necessary arrangements and collection would exceed the difference of value between the refuse in this more solid form and that in which it is presented at the outfall, diffused in a large body of water.

The middensteads of Liverpool and Manchester are an example of this kind of treatment. These places receive daily the ashes and the privy refuse; they have of late years been drained, and have received constant attention in other respects, with the view to make the best of them. The ashes themselves form an excellent deodoriser when properly used, and yet the rate of mortality in both of these towns seems to me to support the conclusion of those who contend that a high standard of health is not to be expected until the water-closet has been generally substituted for the middenstead.

Sharing in this conviction, I shall not consider the cesspool system further. The deposition of the refuse and draining off of the liquid practised in the neighbourhood of Paris, whereby the portable manure "poudrette" is obtained, is practicable only as part of that system, and is itself, at best, a most offensive operation.

With the method of town drainage now established in this country, arrangements for deposition of the solid matter of the sewage at the outfall would be insufficient as a sanitary operation, as the attempt at Hitchin has shown; nor, if this could be admitted, would the solid possess anything like the value of the Paris deposit, the chief value of the matter in our case being in solution in the water. Here, indeed, we may invoke the aid of chemistry, to render that value again available in all towns and places in which the liquid itself cannot be applied to the lands; and we may reasonably hope that the great attention which the importance of the subject has for some time secured to it from scientific men, will, ere long, be crowned with greater success than has hitherto been attained.

The Separate System of Drainage.—From the foregoing observations,—first, as to the constituents of the sewage of towns, and second, as to the state of dilution in which alone it is available either for solid manufacture or for direct application to the land in the liquid form,—we may judge of the difficulties which present themselves in realising the value of this manure, however well determined that value may be,

Having alluded to the opinions of those whose remedy for the difficulty would consist in reverting to the cesspool system,—modified and improved of course, but in any case a system, in my opinion, incompatible with a due regard to the public health, even if preferable in the interests of agriculture,—I come to a further difficulty in the question, namely, the additional dilution of the sewage by rain. For the remedy of this, what is called "the separate system of drainage" has long been strenuously advocated.

The difficulty of this increased dilution is at first sight so great in practice, and the remedy so obvious and simple in theory, that I purpose to offer a few observations on the subject, feeling satisfied that the proposition of two separate systems of drainage, one for surface waters and another for house refuse is founded on a mistaken view of the question.

First, as to the extent of dilution by rain water, which has to be considered.

Because a certain amount of rain falls in the course of the year at a given spot, it is not to be assumed that this represents the daily addition of water to be applied to the land, or from which the sewage constituents have to be disengaged.

An annual rainfall of 24 inches, equally distributed, would amount to about the same quantity per head as the usual water supply of the population of a town, namely, 25 gallons per day. Whatever the amount of rainfall, however, considerable deduction must be made from it for evaporation. On examination of the registers of rainfall, it will be found, moreover, that a very large proportion of the whole quantity of rain usually falls in a small number of days of the year, which of course may be discarded from calculation altogether; for on those occasions of flood or storm there would be no attempt, after the first flushing of the sewers, to make use of their contents. Conveyed in such an enormous bulk of water on those few days. the sewage would be innocuous and of no service for manure, and therefore might safely be allowed to pass off direct to the outfall.

Taking some years' registers of rainfall in the metropolis at hazard, I find that about *one-half* of the total rain fell in from twenty to thirty days of the year, and such days will naturally be eliminated from calculation, with reference to the distribution of the sewage. On half the remaining number of days in which rain fell, the quantity would not have exceeded the usual daily water supply, and the maximum fall upon other days was only such as should, with proper arrangements, be usually under command for distribution.

Mr. Walker, at Rugby, has scarcely been deterred at all by rain from pumping all the sewage that he could on to his land, for, except during one period of frost, he has worked on regularly for 300 days of the year; stopping, therefore (Sundays of course being excluded), for only thirteen days on all accounts. So far as the quantity of water thus distributed over the land is concerned, even if the whole of the usual rainfall on the site of Rugby, in addition to the town water supply, were applied to Mr. Walker's land, it would not be above one-sixth of the bulk of water which is regularly applied to the Craigentinny Meadows in ordinary working.

It is obviously desirable, on agricultural grounds, to avoid as much as possible any dilution by rain of the already greatly diluted sewage; and all land water, drainage of suburban roads —in short, all waters free from pollution—should, *as far as practicable*, be excluded from town sewage. Allow me, however, briefly to consider what advantage would really be obtained by the separate system of drainage applied to a town.

To what area is the separation to extend? What will it amount to? If it is to be a separation of the drainage of all public streets, and other public areas of all kinds, from that of private properties, I have been at some pains to discover what proportion these bear to each other, and I find, from the admeasurement of these areas in 11 separate towns of various population, that the average extent of the public surface is not one-fifth of the area of the private property, or rather of that portion of private property to which the drains would extend. By separation to this extent, therefore, four-fifths of the rainfall would flow to the original sewers with the house drainage, and one-fifth to the new or rain-water sewers.

But if the system is to extend, in addition, to private properties, where is the separation to take place? A complete double system of house drainage would be necessary. Will the interior of the house be drained to the refuse sewers, and the exterior to the rain-water sewers? the stable-yard with its dung-pit to the one, the stable itself to the other? Or will the waste from the wash-house sink, and that from the accumulations in house-yards of the lowest class, where the scavenger rarely enters, drain their several ways?

It is manifest that the separate system, if by it we mean the division of a clear water drainage and a foul water drainage, is simply impossible; but were it not so, it would simply be, in the agricultural view, a question whether it would be cheaper to construct this costly system of complicated works than to apply the useless rain water to the land, or to waste the sewage on wet days. But it will be observed that the distribution of the additional quantity is not all profitless expenditure. Large quantities of manure are at all times brought down from town surfaces by rain, although the street washings will not often be found anything like so rich in fertilizing elements as were those of the metropolis examined by Professor Way.*

There is no sufficient evidence of the precise value of these elements; but there seems reason to suppose that at all ordinary times a very large addition of manure is thus washed down with the house sewage. This fact is the more obvious to those who have given much attention to the subject, from the evidence which is constantly presented to them of the rapidity with which stagnant water from street surfaces becomes extremely offensive, although kept perfectly distinct from other drainage. During repeated examinations some of the foulest emanations I have experienced were from places with which no house drainage whatever was connected; the noxious smell came from the surface refuse only, washed by the rain into gullies and catch pits.

And this consideration leads me to the main objection to this proposed separate drainage, namely, that we should have two foul systems of sewers and house drains instead of one; at the best, two sources of foul atmosphere ramified over every town, and each the more dangerous for that very separation. So that even if the interests of agriculture loudly demanded this treatment of the case, and the enormous cost were not an object, REGARD FOR THE PUBLIC HEALTH WOULD FORBID IT.

In short the public would be called upon to incur double expense for a source of great and decided danger to their health, and a very questionable advantage to agriculture.

* The objections to the separate system are far stronger in the metropolis than in provincial towns, both on agricultural and sanitary grounds. In the first place, the rainfall does not bear so large a proportion to the water supply; and in the next, it becomes much richer in manurial elements, or in other words, much more foul and noxious than in less crowded places.

POLLUTION OF THE ATMOSPHERE ON THE BANKS OF THE THAMES.

THE correspondence between the First Commissioner of Works and Mr. Goldsworthy Gurney, and the Commissioners of Sewers and the Board of Works, on the state of the river Thames, and the pollution of the atmosphere on the banks of the Thames and the Houses of Parliament, has been published; from which it appears that for some years previous to 1854 the atmosphere of both Houses of Parliament was often impregnated with the most offensive odours; the courts of law were at one period so much affected, that the judges were compelled to rise and leave the courts. Various causes were assigned for the annoyance; amongst the rest, exhalations from St. Margaret's churchyard, imperfect drains under the buildings, &c. The nuisance was at length complained of, and the subject brought before the House of Commons: in consequence, Mr. Gurney was requested by the late Sir William Molesworth to investigate it.

On close inquiry it was ascertained that the source of the evil arose from untrapped gully-holes in St. Margaret's-street, New Palace-yard, and from the open mouth of Bridge-street sewer, which discharged itself at the Middlesex end of Westminster Bridge.

Mr. Gurney recommended that the gully-holes should be immediately trapped, as well as the mouth of the sewer, and that the effluvia, pent back, should be withdrawn and destroyed by special means. These suggestions having met with approval were carried out, and on completion the arrangements were found successful in removing the nuisance; the annoyance complained of suddenly ceased, and from that period to the present no complaints whatever have been made either in the courts of law or in the Houses of Parliament.

Although the greater nuisance was removed, a minor annoyance was suffered to remain. Mr. Gurney recommended the open mouths of some sewers on the Middlesex side of the river, and others on the opposite side, to be trapped; had this been done, it is believed the impurity of the air now complained of would not exist. The principal reason why it was not done at the time was on account of a fear expressed by the Commissioners of Sewers, that if the open mouths of the sewers on the Thames were trapped, the effluvia would be pent back, and escape into the streets. Experience has now demonstrated that this fear need not have been entertained, for it is in evidence that the great Bridge-street sewer has been trapped ever since 1854, and no such evil has arisen; indeed, as a further proof of success, it may be stated that the outfall has now been carried out under low water-mark by the Commissioners of Sewers, and is permanently sealed. The mouth of the great Victoria sewer, from Pimlico, going up Parliament-street and Whitehall, is also trapped; the mouth or outfall is carried out under low-water mark at Hungerford Bridge. If any evil had arisen from trapping these sewers (and they are large ones), it would have been discovered and complained of long before this. It is manifest that trapping the mouths of any sewers about the Houses of Parliament may be effected with impunity.

At the pier contiguous to Lambeth Palace there are two sewers untrapped; two at Millbank; one at the Penitentiary; two at Vauxhall Bridge, one on either side of the river. Of these the most offensive to the Houses of Parliament are the sewers at Lambeth and Millbank. The others affect the atmosphere only in south-westerly winds, and on the fall of the barometer. They do not require such immediate attention; but it is suggested that the Lambeth and Millbank sewers should be trapped as soon as possible.

There are nuisances affecting the atmosphere of the Houses of Parliament from offensive manufactories; the worst are the bone manufactories; the effluvia from which constantly finds its way across the river, and is very offensive. The exhalations from the river itself are also a source of impurity to the atmosphere about the Houses of Parliament.

Respecting the sewers on the river, Mr. Gurney states that he has made all necessary inquiries and observations.

First, in regard to the periods at which the flushing drains are opened.—In dry weather the mouths require to be opened to the river for filling the flushing beds almost every tide, but in wet weather there is generally sufficient rain water for the purpose.

With regard to the period of tide at which they are opened.—They may be opened at any time from half flow to high water. At neap tides they are opened at or near high water.

With respect to the effect produced from opening the mouths of the sewers.—Nothing can be more offensive; a sudden outbreak of stinking gaseous sewage takes place; as the water runs in the effluvia runs out, displacing volume for volume. It also escapes rapidly, from the fact of being lighter than the atmosphere. On a gradual fall of the barometer, generally before rain, the escape of effluvia is increased. On a sudden fall of the barometer, as before a storm, the whole surface of the river has been known to become pestilential in less than twenty minutes.

With respect to the distance at which the discharge from the open mouths of the sewers is felt, much depends on the state of the weather and direction of the wind. In a calm it hangs about the river to within a short distance of its escapage; but in windy weather it is driven by the wind, and felt to a considerable distance.

The run of the tide in calm weather produces a local current of air along the surface of the river, moving at the same rate and in the same direction as the water. The stench in such cases falls into this aërial current, and is carried by it up and down the river as the tide sets. Sometimes volumes of accumulated stench, escaping into this current from the different mouths of the sewers down the river, is brought up by this tidal current of air, and renders the atmosphere about the House pestilential for hours together.

When the wind is blowing across the river, the main escapage will be driven in that direction; but along shore, on the leeward side, there is generally a retrograde or brattice current of air which retains and carries a portion of the stench with it. In hot weather when evaporation from the river is considerable, the effluvia will rapidly combine with the water held in solution in the air, and remain for a longer time than otherwise on its surface.

Mr. Gurney is of opinion that trapping would have a counteracting effect. If the mouths of the sewers on both sides of the river, from Rotherhithe to Vauxhall, were properly trapped, there would be a very different state of atmosphere at the Houses of Parliament, and also on every part of the river. Trapping the open mouths of the sewers in the neighbourhood of the Houses will reduce considerably the present nuisance; but to do away with it effectually the mouths of all the sewers should be trapped up and down the river. This would be a great comfort to the public, and protection to health. The traps must be properly made, air-tight, sound in principle, and perfect in construction. It is said that the mouth of the intake flushing sewer at Lambeth Stairs cannot be trapped; but this is a mistake.

With respect to the question of danger or inconvenience likely to arise from trapping back the effluvia of the sewers, Mr. Gurney observes that no inconvenience need arise from it, for this question has long since been set at rest by arrangements made at the House by the Commissioners of the Board of Works.

Mr. Gurney observes that the mouth of the Bridge-street sewer has lately also been untrapped, the stench from the mouth of which, about three years since, was a great annoyance, and was then trapped at his representation, when the annoyance ceased. Further, that at times there is a greater escape of offensive effluvia from the gasworks at Vauxhall Bridge than there need be; but that the most offensive source of impurity is from a bone-boiler's factory in Princes-street, Lambeth, belonging to Mr. J. T. Hunt.

Mr. Gurney further remarks that the great Victoria sewer, going up Parliament-street, has lately broken in somewhere about Whitehall-yard, and that all the sewage which used to go through this large sewer is forced down the Bridge-street sewer; and that lately, in order to empty Grosvenor Basin, they passed the whole of the water and mud down this small sewer; the result being the "blowing up," as it is called, of the trapping at the mouth of the sewer; this fact has considerably augmented the pestilential state of the atmosphere of the river, and the whole of the neighbourhood.

The Board of Works, in reply to Mr. Gurney, state that the inlet which he calls the "Lambeth-pier sewer," but which is known to the board as the "Archbishop's inlet," is not a sewer discharging into the river, but is merely a closed communication between a sewer and the river, which can be opened at will to admit the river water into the sewer for the purpose of cleansing it; it is most completely trapped, and when properly worked no nuisance can arise therefrom. With regard to Mr. Gurney's suggestion that the mouths of the sewers on both sides of the river from Vauxhall to Rotherhithe should be trapped, they state that these subjects are connected with and depend upon the main intercepting scheme which has been submitted to the First Commissioner of Works, and still awaits his approval.

Mr. Gurney, in answer, says he is well aware that the mouth of the Lambeth-pier sewer is used for the admission of water for flushing, and had pointed out how the stench was driven out. The mouth of this sewer is closed by a penstock, on lifting which a quantity of effluvia escapes. He has had it examined recently, and finds that the mouth of the inlet is still untrapped.

The Metropolitan Board of Works have, since the date of the above Report, ordered the extension of the outlets of the Wood-street, the Horseferry-road, and the Grosvenor-ditch main sewers to low water in the river.

IMPROVED CONSTRUCTION OF SHIPS.

(*With an Engraving, Plate* XXVII.)

The primary object of the improvements in shipbuilding, illustrated in the accompanying Plate, is the securing increased strength in, and making of smaller dimensions than usual, the framework of ships, by attaching to one or both sides of the several timbers iron plates or bars, the employment of which also renders it unnecessary to use timbers so large as those ordinarily adopted, thereby allowing more stowage room for cargo. The spaces between the several ribs or frames of the vessel, in certain places, are filled in solid and watertight, so as to prevent the flowing from one part into another of any water that may accumulate between the outer and inner planking of the sides or walls and bottom of the vessel.

Fig. 1 represents the deck plan, showing the several timbers F, with the iron plates or bars G, attached to one side of each of them; fig. 2, midship section, showing the ribs or frames A, and deck beams F, with iron plates or bars B attached to sides of ribs and iron stancheon Q; fig. 3, sheer plan, showing keelson M, and knees M', with iron plate N attached to side of same, and the spaces O filled up between the ribs from keel to keelson; fig. 4, details to a larger scale, showing wood ribs A, with iron plates B, attached by bolts C to one side of each outside planking D, inside planking E, deck beams F, with iron plates G attached to one side of same; fig. 5, plan of spirketting H, filled in between the ribs A; fig. 6, section of deck beam F, and elevation of rib A, with iron plates B and G in each, secured together with iron bolts C'; fig. 7, section through part of the side or wall and deck of the vessel, showing rib A, with iron plate B on side of same, deck beams F, deck planking I, outside planking D, inside planking E, bolts C, and iron knee K; fig. 8, elevation of keel L, keelson M, iron plate N, on sides of keelson spaces O, filled up between ribs or frames A; fig. 9, section of keel L, keelson M, iron plates N, N', on sides of keelson and filling in pieces O, also side elevation of rib A, and iron plate on same B; fig. 10, section of one of the joints B' of the iron plates, with iron strap P, and bolts C'', to connect them together; fig. 11, plan or top of ditto.

The plates or bars are secured to the several timbers by the bolts C, and where the deck beams have the plates on one side the ribs or frames have them on the opposite side, as seen in figs. 4, 6, and 7, in which case they are secured together at the ends by the bolts C'. Iron knees K are attached or fixed by bolts R, to hold up and secure the deck beams F to the ribs A.

Where joints are required to the several iron plates or bars, as at P, fig. 2, the plates or bars are connected together with straps bolted over them, as shown in figs. 10 and 11. One plate or bar only is usually attached to each deck beam, rib, or frame; but to main timbers, or where extra strength is required, as in the keelson, a plate or bar is fixed on each side, and they are bolted together, as shown in figs. 2, 3, 8, and 9.

The patentees claim, first, the application of iron plates or bars, as described, to one or both sides of the beams, keelsons, ribs or frames of ships, for the purposes of strengthening and reducing the size of the frame-work; and, secondly, the filling in and making solid and watertight the spaces between the several ribs and frames, and the outer and inner planking, particularly between the keel and keelson of the vessel in certain places, so as to prevent any water that may accumulate between the outer and inner planking in one part of the vessel from flowing or passing into another part of it.

The patentees are Messrs. Thos. and R. A. Ayles, jun., shipbuilders, Weymouth.

INSTITUTION OF MECHANICAL ENGINEERS.

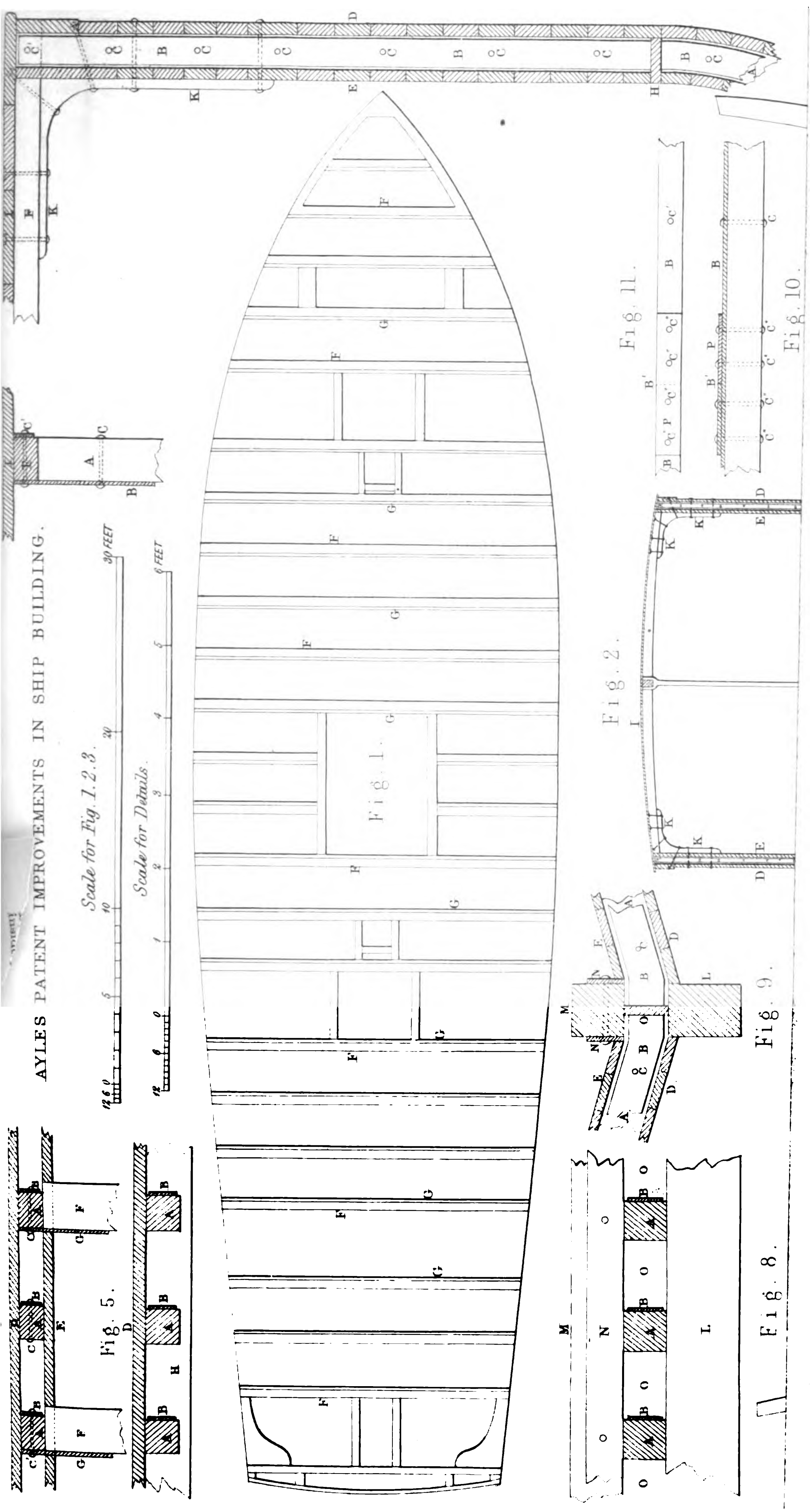
At a recent meeting of the Institution, at Birmingham, Mr. William Fairbairn, V.P., in the Chair, the following communications were made:—

The first paper read was a description of an "Improved Pressure Gauge," by John Inshaw.

The second paper was on an "Improved Construction of Safety-Valves for Steam-Boilers," by J. C. Kay. Three varieties of valves were described. The third form is generally used. This is intended and serves as a protection both against excess of steam pressure and against low water in the boiler. It consists of a large-sized conical valve, on the upper side of which is a disc of rather larger diameter, the effect of which is that when the valve is slightly raised by an increase of pressure beyond the limit to which it is loaded, the steam then acts on the larger area of the disc, and the valve is lifted considerably higher, giving a large opening for the free escape of the steam. To render the valve a protection also against low water, the valve spindle or stalk is carried down into the boiler, and from the bottom of it is suspended by a pivot a horizontal lever, carrying a float at one end and a balance-weight at the other, the two forming the load of the valve. This lever is furnished with a second pivot, situated between the float and the valve-spindle at a short distance from the latter; in the event of the water falling too low in the boiler, this second pivot comes to a bearing in a fixed stirrup suspended from the roof of the boiler, and the load is thus taken off the valve-spindle, so that the valve immediately rises and the steam blows off.

The third paper was a description of a new "Curved Plate Laminated Spring," by J. Wilson. The plates, instead of being plain flat plates, are rolled with a transverse curvature or convexity in an inverted-trough form, by which an increased stiffness is imparted to them; and in place of the ordinary fixing bolt or rivet passing through the centre of the plates and clip, a small fixing-pin is driven down at one side of the spring, having a little less than half its thickness in a notch in the edge of each plate. By this plan the strength of the plates is preserved uninjured.

Another paper showed a series of experiments, with a view to



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ascertaining the "Heating Power of Coal," made by the aid of an instrument invented by Mr. Jonathan Wilkinson, of Grimesthorpe, near Sheffield. The results obtained from the several descriptions of fuel experimented upon are subjoined; the figures showing the number of lbs. of water evaporated by 1 lb. of fuel:

Charcoal for foundry blacking	12·20
Charcoal, oak	12·25
Charcoal prepared for electric light, very pure ...	12·50
Anthracite coal	13·00
Anthracite coal, average of two samples	13·10
Hard Yorkshire coal, Woodhouse	13·75
Wallsend coal, Yorkshire	14·85
South Yorkshire coal, average of seven samples ...	15·00
Welsh coal	15·12
Silkstone coal, Yorkshire	15·20
Gas coal, near Chesterfield, first sample	15·50
Ditto ditto, second sample	16·00

From these results it appears that the evaporating power of coal does not depend so much upon its containing a large proportion of carbon, as in the case of charcoal and Welsh coal, as upon the gaseous quality of the coal. In one case, with two qualities of Yorkshire coal, a 30 grain experiment made with this apparatus was fully borne out by a 5 ton experiment with a steam-boiler; but in another instance the results did not agree, as a different sort of coal requires a different description of furnace; coals composed almost entirely of carbon requiring less air for combustion than the gaseous coals, and consequently requiring a smaller furnace and smaller flues. The result obtained from coke, which is composed almost entirely of carbon, is low with the apparatus; whereas, with a strong draught and proper furnace it would be high.

THE ROYAL ALBERT BRIDGE, SALTASH.

One of the most important engineering works in the country is the bridge which has been for some time in course of construction across the river Tamar, and which is being erected from the plans and under the superintendence of Mr. Brunel, in connection with the Cornwall Railway.

The bridge is to be altogether 2200 feet in length, the span of each main opening being from the centre of one pier to the centre of the other, 445 feet; height of centre pier from foundation in the bed of the river, 240 feet; height of roadway above high-water mark, 100 feet; of ditto above low-water mark, 118 feet. The main openings are each spanned by an oval tube whose diameters are 17 feet and 12 feet, and each of which are connected by chains which together form a parabolic curve, and from those chains are suspended the roadway. To prevent the sacking down of the tube, at intervals of 40 feet occur vertical struts above the points of suspension, diagonal braces connecting the struts for the purpose of distributing the load, the weight of the section over each opening being 1100 tons. These sections when fixed in their permanent positions will stand with their shore ends on brick pillars, surmounting granite and limestone piers, and their other ends on standards supported by four octagonal cast-iron columns, 10 feet diameter, and resting on a solid granite circular pillar, 35 feet diameter, built in the centre of the river, and standing 12 feet above high-water mark, two of the iron columns supporting each section. From the bottom of the roadway to the top of the tube at the centre is about 75 feet, and the whole is constructed of malleable iron plates. The section of the bridge has been constucted on a temporary quay by the water's edge, and docks cut under a stage erected for the admission of two pontoons at each end. These pontoons draw about 8 ft. 6 in. of water, one foot of immersion beyond their natural draught being equal to 250 tons or thereabouts. By means of valves, the pontoons admit water into their interiors, and were thus passed beneath the ends of the tubes, and which, on closing those valves, rose with the tide, and raised their immense weight the height required. At the ends of the tubes bed plates and rollers allow of their free extension and contraction under varying temperatures.

The important and interesting part of the work that was carried out on the 1st ult., was the raising and floating off of the first or western section from the yard where it was built, and landing it on the piers. Five vessels, borrowed from the government authorities, were moored in a semicircle above the bridge, on board of which were powerful crabs for the purpose of warping the tube round to its position. A large portion of the gear employed and appliances used were borrowed from the dockyard. Captain Claxton, R.N., was present to superintend everything afloat, Mr. Brunel taking entire control of the pontoons, and directing the operations by means of signals and flags.

At 1·5 p.m., the whole of the preparations having been completed, the pontoons glided into the river. There were about 500 men aboard the vessels and ashore employed in the operation and kept busily at work, especially those on board No. 4 station vessel, whose assistance was required for a longer period than the others. The arrangements were so admirably conducted by Mr. Brunel, that not the least irregularity occurred, or the least noise or confusion prevailed. About 3·30 the western end of the tube was placed in its position. The tube and roadway chains, struts, &c., present a most unique appearance; at once a memorial of engineering ingenuity, and the triumph of mechanical science, as applied to practical purposes of great difficulty. It is believed that several months will be occupied in raising this section vertically to its permanent place on a line with the railway. From its present position it will be gradually raised as circumstances will allow by means of hydraulic presses.

NOTES OF THE MONTH.

The Board of Works for the Holborn District have elected Mr. John O. Hall, solicitor, of Brunswick-row, Queen-square, to be the representative of the district at the Metropolitan Board of Works, in the stead of Mr. R. B. Seeley, resigned.

It is now understood to be determined not to renew the attempt to lay the Atlantic cable this year. The cable is to be forthwith unshipped from the holds of the *Agamemnon* and *Niagara*, and stowed away for the winter in the government dockyard at Keyham. There it is to be well tarred and attended to, to prevent it from rusting. In the meantime about 1000 miles more of cable are to be manufactured, which, with the quantity in hand, will make 3000 miles for the experiment next year. The *Agamemnon* and *Niagara* will go into winter quarters. The cost of the unsuccessful experiment is estimated at about 30,000*l.* The company are said to be inundated with hundreds of designs for laying the cable, and for improving the machinery for that purpose; and since the commencement of the month numerous applications have been made for patents in connection with machinery for submerging submarine cables.

One of Boydell's traction engines, which has been purchased by government for use in the Royal Arsenal, made the journey from Thetford, in Norfolk, to Woolwich, drawing a load of timber on four trucks, the foremost of which contained 11 tons 10 cwt.; the second, 10 tons, 10 cwt.; the third, 9 tons, 10 cwt.; the fourth, 7 tons, 10 cwt, together with a van laden with coals, water, &c., the whole load, including the engine, which weighs about 15 tons, being 57 tons. The "patterns," or endless railway, enabled the engine to travel over the uneven and long line of country roads, some of which were scarcely passable on account of the late heavy rains, at the average rate of about four miles an hour, and on entering Woolwich the speed was far greater. On arriving at the dockyard gate the control of the engine was remarkable, being, with its complete load, conveyed with much facility into the interior of the dockyard, where the timber is stored for shipbuilding. This is the second engine which has been purchased by government, and is on a much larger scale than the former one. It is fitted with a couple of 7-in. cylinders, and is said to do the work which would require a team of 60 or 70 horses. Colonel Sir Probyn Huntley, of the East India Company's service, joined the train at Epping, and accompanied it about eight miles on the road to Woolwich, in order to verify its efficiency on behalf of the Indian government, who have entered into an engagement for the purchase of a large number of the endless railways, for the conveyance of troops, as well as to work in the cotton and sugar plantations in the West.

Advices from the Engineer corps report rapid progress with the location of the Honduras Inter-Oceanic Railway. The Atlantic division had completed the sectification of the line, 43 miles, to Portrillos, and had advanced to join Mr. Trautwine between Yojos and Ojos de Agua. Mr. Gliddon, deputy agent, had reached the capital. Lieut.-Col. Staunton, R.E., lately member of the commission for settling the European boundary of Turkey, and Serjeant Finch, R.E., have gone to Honduras, to review the work now in progress, and report to the government on the route generally. These officers sailed on the 17th from Southampton. The following are extracts from a letter of Mr. W. Whitehead, one of the assistant-engineers on the Honduras Inter-Oceanic Railroad, dated San Pedro Sula, July 14:—"I shall soon move with my party fifteen miles from here, to Plau, and from there we shall take another long stride, perhaps to Yojoa. Some one about Omoa has started a project to have a monthly or semi-monthly steamer to run thence, *via* Belize to Havana. In that case we will have a regular mail route on both sides, and can send letters with certainty either way. As to our survey, as far as we have gone, we have got a beautiful first-class cheap road, with easy grades and very slight curves. We are 40 miles from Puerta Caballos, and have risen 125 feet only." Colonel Kinney, in a private letter to a gentleman of New York says:—"I shall leave to-day for Belize, and return to San Juan, *via* my possessions on the Mosquito shore, with a view of coming back to establish myself here, to lend a helping hand to the great railroad, which I regard as the leading enterprise of the age. When in New York, and until recently, I had my doubts as to the practicability of joining the oceans through Honduras, but since I have come on the ground I am satisfied that the work is not only feasible, but, in one word, *the* route between the seas."

The Russian government is determined to profit by the last war. It has engaged for 10 years the services of a party of French and English engineers, and the first work they intend to complete is the railway to the Crimea; so that if fresh differences should arise with the western powers she will not give them another opportunity to attack her in that quarter.

A lieutenant in the French navy, M. Vergne, has invented a new steam screw propeller, which he calls the fluted screw. The improvement is founded on a very nice observation of the directions taken by the particles of the water displaced and repelled by the screw. A commission was appointed to compare the working and results of the old and new screws. The persons composing it embarked, at Toulon, on board the *Vigilant*, an iron steam despatch boat of 60-horse power, fitted with the ordinary screw. Four trips were made along a measured distance; then the screw was replaced by that of M. Vergne's invention, and four other trips were made along the same line. The result showed a gain of 17 per cent. in speed with the new screw, and the almost complete suppression of that disagreeable vibration usual in screw steamers, and which in small vessels renders it necessary to make the hinder part of the ship heavier and more costly than it otherwise need be. The question has been raised whether the same advantages would be obtained in large vessels. Some scientific persons believe that they would even in a greater degree, and give reasons for their belief. This question will soon be set at rest, for the Emperor has ordered the experiment to be renewed, this time on a ship of the line.

One of the heaviest and most costly works ever undertaken by the Clyde Trust is now approaching completion—the new addition to the south quay wall of Glasgow Harbour. The length of the new wall is nearly one-third of a mile, and when completed there will be a stretch of quay wall, westward from Glasgow bridge, of 2028 yards, or fully 1¼ mile of quayage for vessels on the south side of the harbour. The section of the wall is curvilinear in front and vertical at back, is in thickness 7 feet at top and 16 feet at bottom, and contains about 650,000 cubic feet of masonry and concrete, or about 47,000 tons weight. Some of the stones employed in the wall weigh fully three tons, and the only dressing they receive is from the "pick." It is intended to get a depth of 20 feet at low water, so that the largest vessels, when laden, may lie afloat at all times of the tide. Its cost is about 50,000*l.*

M. Felix Abate, of Naples, recently communicated to the French Academy of Sciences a new system of moulding, which gives to plaster the hardness and durability of marble. He proposes to employ this substance for all ornamental purposes where marble or stone has been previously used; and from calculations which he has made is of opinion that it will cost only one-fifth of the best cut stone.

A bridge is now being constructed over the "River Jordan," on the line of the Catasagua and Foglesville Railroad, in Pennsylvania, which is said to be the largest of the kind in the United States. It is 1100 feet long, and is built entirely of iron—the spans being supported by heavy iron towers 100 feet high.

An American collection of modern British art, comprising 168 oil pictures, and 178 in water colours, has been made, and will be exhibited in New York during the months of October and November, and afterwards in Philadelphia and other cities. It contains some excellent specimens of the modern art of Great Britain. The projectors conceive that the time is arrived when the kindred intellect of the two countries should be interchanged in other forms besides those of literature. The names of Longfellow, Bryant, and Prescott are as familiar in the Old country as those of Tennyson, the Brownings, and Macaulay, in the New; and they hope that if they succeed in rendering well known to Americans the best names in living British art, they shall be no less paving the way to the knowledge of American art in England. It is understood that, in the event of a money-success, the profits will be applied to the promotion of a knowledge of British art in America.

M. de Sauley, a member of the French Institute, who has passed some time in Egypt, and is very conversant with the archæology of that country, states that an important discovery has lately been made in one of the tombs of Memphis, of a whole library of hieratic papyrus. An Arab, an agent in the pay of the British Museum, was fortunately apprised of the matter, and bought up the whole lot.

The drainage of Lake Fucino is going on well, though the works cost much more than was anticipated. The oak centres, for turning the arches in the times of the Romans, have been found hard and black, and some have been turned into a variety of articles, as tables and sticks. No objects of antiquity have been found besides a few coins.

Calcutta was lighted with gas for the first time on the 6th July last, and the public lamps have been lighted steadily every night since. Some private houses are also lighted with gas. Mains are being laid, and additional lights extensively erected.

Mr. Serrell, the American engineer, who constructed the Niagara Suspension Bridge, and who has offered, for a certain sum, to complete that across the Avon at Clifton, has recently been occupied in making measurements, examining the state of the piers, &c., with a view of definitely stating to the committee the sum for which he would finish the work. In answer to a question as to the time necessary to complete it, he said that he commenced the Niagara-bridge the day after he signed the contract, and that it was ready for traffic within 11 months from that day. If arrangements are made with the engineer, a short unopposed bill will be obtained early next session.

The great new landing-stage at Prince's-pier, Liverpool, for seagoing steamer, luggage-boats, and tugs, is in one respect a failure. Owing to the shortness of the bridges by which it communicates with the pier, they are practically useless—except a little before and after high water—for the conveyance of carts, carriages, or loaded vehicles of any description. The angle of inclination is so acute, that no available amount of horse power can draw the loads up, or "steady" them in going down, with safety; and there is no rope and capstan to meet the difficulty, as was the case at the old Seacombe slip. Sir William Cubitt has been made aware of the inconvenience, and according to the statement made by Mr. Hornby at the council meeting last week, he has merely advised that the stage should be tried for some time in its present condition before any alterations are attempted, in order to ascertain the best way of effecting them.

The *Great Britain* is now in the Sandon Graving Dock, being coated with Peacock and Buchan's composition, which has established itself the favorite composition for preserving and keeping clean the bottoms of iron ships. Besides preserving the iron plates, it is found to add speed to the ships using it, by becoming shortly after immersion, slimy, like the back of a fish.

The North-bridge, Edinburgh, as the greatest thoroughfare in the city, has just been made the subject of an experiment in causewaying. The traffic in coaches, carts, and other heavy carriages, is considerable along this street, and hitherto the ordinary mode of causewaying with blocks of whinstone in regular courses has been found insufficient, the paviors being scarcely ever off the road. The experiment now put in action consists in making a bedding for the paving-stones of macadamised metal converted into a solid mass by heavy liquid asphalte poured over it. The paving-stones are then arranged in wide-courses, and the interstices are filled up with the same mineral substance, viz., melted asphalte.

COMPETITIONS.

The Vestry of St. Mary's, Islington, wish to receive designs for the erection of a new Vestry Hall in that parish. Premiums 50*l.* and 20*l.* The building to be completed for a sum not exceeding 5500*l.* Building not to be in the Gothic style. Plan of the ground and particulars may be obtained at the vestry offices, 21, Milner-square, Islington. Designs to be sent in by the 3rd instant.

The Burial Board of Belper, Derbyshire, are desirous of receiving Plans and Estimates for the erection of two Chapels and an Entrance Lodge, and for enclosing the Burial-ground. Plans must be sent in by the 23rd instant, to Mr. George Pynn, Clerk to the Board, Bridge-street, Belper, of whom any further information may be obtained. Those plans which combine the two chapels under one roof will be preferred.

The municipal authorities of Bourdeaux have invited artists of all countries to submit designs for a Fountain of monumental character to be erected in that city. The choice of material is left open, and may be of several kinds; the cost is not to exceed 8000*l.* A premium of 240*l.* will be awarded, if a design of sufficient merit to justify it be presented. In addition, the sum of 160*l.* will be placed at the disposal of the jury, and be appropriated as they may decide. In the event of the execution of the selected design being confided to the author of it, he is to receive, independently of the selected design, an honorarium equal to the twentieth of the whole outlay. The designs are to be sent in by the 20th of November next.

Drawings or models of designs are invited for the erection of a Memorial of the Great Exhibition of 1851. Premium 100 guineas. The time for sending in designs is extended to February 2, 1858. A scale of 2 inches to the foot is suggested, but not insisted on.

The Corporation of Halifax invite designs for Public Baths to be erected there. Premium 50 guineas. Particulars may be had upon application to Mr. G. W. Stevenson, the borough engineer.

Plans and specifications are invited for the erection of St. Paul's Schools, Nottingham. Particulars will be furnished on application to Mr. Thomas Mellers, Shakspere-villas, Nottingham.

Designs are required for the erection of two Prisons in Turin and one in Genoa. The cost of one of the prisons in Turin (580 cells) is fixed at 62,400*l.*, and that of the other at 50,400*l.* The cost of the prison at Genoa is not to exceed 64,000*l.* One prize is offered for the two prisons in Turin of 320*l.*, with further premiums of 100*l.* and 60*l.* for the second and third best. For the design for the prison in Genoa the premiums offered are 240*l.* 80*l.* and 48*l.*

COMPETITION AWARDED.

The Committee have selected the design of Mr. Thomas for the Attwood Testimonial. The design consists of a statue 8 feet high, to be executed in Sicilian marble, and placed on a pedestal of grey granite, and rising from a series of broad steps of Yorkshire stone; the whole being 22 feet high.

NEW PATENTS.

PROVISIONAL PROTECTIONS GRANTED UNDER THE PATENT LAWS AMENDMENT ACT.

Dated May 22.

1444. E. Whitaker, Rochdale, A. Law, Littleborough, and J. Fletcher, Little Clegg, Lancashire—Improvements in steam-engines

Dated July 17.

1980. C. Barlow, Chancery-lane—Improved brick-making machine. (Communication)

Dated July 20.

1995. A. Whyte, Glasgow—Improved mechanical arrangement for weaving

Dated July 23.

2024. C. F. Vasserot, Essex-street, Strand—An apparatus for moulding candles. (Communication)

Dated July 27.

2042. A. Mortera, Paris—Improvements in coupling carriages on railways

Dated July 28.

2060. P. A. F. Bobœuf, Paris—Improvements in preserving and otherwise treating animal and vegetable substances, and in the purification of oils employed therein, and which may be used for other purposes

Dated July 31.

2084. I. Moll, Cologne, Prussia—Economical fire regulator

Dated August 5.

2116. S. Botturi, Paris—An apparatus and oven for the carbonisation and distillation of all animal and vegetable matters

Dated August 6.

2121. S. Botturi, Paris—A system of weaving for the manufacture of all kinds of textile goods, viz.: shawls, silk stuffs, carpets, knotted or unknotted, single or double faced, Gobelins' tapestry, drapery, velvets, damasked linen, and various other articles, by means of a frame which replaces the Jacquard loom

Dated August 8.

2136. G. Collier, W. Noble, and W. Holroyd, Halifax—Improvements in cutting, shaping, and planing wood, and in the tools and apparatus employed therein

Dated August 13.

2158. W. S. Wheatcroft and J. N. Smith, Manchester—Improvements in valves and the chambers connected therewith, applicable to hydrants and taps for the supply of water and other fluids

Dated August 15.

2170. S. Clift, Manchester—Improvements in the purification of certain gases, and in the application of their products to the manufacture of alum

2172. J. J. Cardia, Orange-street, Red Lion-square—Improvements in breaks for omnibuses

2173. A. J. Aucher, Paris—Improvements in elastic tissues for ladies' petticoats and other similar articles

Dated August 17.

2180. J. Abraham, Birmingham—A new or improved gauge for gauging wire and sheet metal, and for other like purposes

2182. P. Carmichael, Dens Works, Dundee—Improvements in calendering and mangling cloth

2184. F. X. Poznanski, Craven-street, Westminster—Improvement in instruments for ascertaining and indicating the state of the pulse, which improvement is also applicable to other instruments in which fluids are required to circulate or work in tubes of small bore

2186. J. Grist, Islington—Improvements in mash tuns, and in apparatus to be employed therewith, which apparatus is also applicable to the heating and keeping up of a continuous circulation of liquids in any vessel to which it may be connected

Dated August 18.

2188. J. Coupe, Preston—Improvements in power looms

2189. H. P. Hughes, Coetmore, near Llanllechid, Carnarvonshire—Improvements in the construction or arrangement of a rock-boring machine

2190. W. H. Miller and H. E. Skinner, Shadwell—Improvements in rotary engines and pumps

2192. B. Lupton, R. Jackson, D. Dean, and J. Holden, Burnley—Improvements in power looms for weaving

2194. T. Keddy, Handsworth, Staffordshire—New or improved machinery for the cultivation of land

Dated August 19.

2195. S. Rosenthal, Red Lion-square, Holborn—Printing on both sides of a sheet of paper by a single impression on an ordinary lithographic or other press

2196. S. Bottomley, J. Bottomley, and T. Bottomley, Buttershaw, Yorkshire—Improvements in machinery acting upon, and in connection with, rotary shuttle boxes, for weaving checks, plaids, figured and fancy goods

2197. A. Wall, East India-road, Poplar—Improvements in amalgamating metals

2198. A. Wall, East India-road, Poplar—Improvements in coating metallic surfaces

2199. A. J. Dessales, Southampton-buildings, Chancery-lane—Improvement in lamps for railway carriages, ships' cabins, and other oil lamps

2200. P. A. Balestrini, Brescia, Italy—A new method of, and apparatus for, sounding at sea and in other waters

2202. C. F. Vasserot, Essex-street, Strand—A smoke-consuming grate. (Communication from D. de Luzy and H. G. de Chateauneuf, Paris)

2203. E. Lund, Manchester—Improvements in cocks, valves, pumps, and water plugs

2204. F. Potts, Birmingham—Improvements in the mode of cutting out, forming, and finishing certain descriptions of metallic tubes, part of which is also applicable for other such like purposes

2205. W. Hartley, Bury, Lancashire—Improvements in steam-engines and steam-boiler apparatus

2206. R. C. Gist, Cannon-street—Improvements in the manufacture of manure. (Communication)

2207. F. Ruff, Gray's-inn-road, and M. Gutkind, Noble-street—Machinery or apparatus for folding and measuring fabrics and registering the same

2208. J. M. Napier, Vine-street, York-road—Improvements in apparatus for paying out submarine telegraph cables

Dated August 20.

2209. R. L. Brooke, Kepple-street, Russell-square—Improved method of discharging, paying out, and submerging electric telegraph cables, wires or ropes, or such like articles, from ships or vessels of any description

2210. T. Gough and J. Margerison, Bristol—Improvements in breaking apparatus for vehicles used on railways or on other roads or ways, parts of which are applicable for communication between guards and drivers of trains

2211. J. Gedge, Wellington-street South, Strand—Improved means of heating buildings, and of facilitating the escape of smoke and gases therefrom. (Communication from X. Lorents, Nancy, France)

2212. R. A. Brooman, Fleet-street—A new method of defecating sugar and other saccharine matters, and of refining or rectifying alcohol. (Communication)

2215. R. Taylerson, Tryons-terrace, Hackney—An improvement in metal ships and vessels

2216. D. Messmore, New York, United States—An improved method of dressing millstones for hulling rice and other grain having hulls or husks. (Communication)

2217. T. Ingram, Bradford, Yorkshire—Improvements in railway breaks

Dated August 21.

2218. W. K. Hall, Cannon-street—Improvements in apparatus for measuring and registering the speed and leeway of ships, and indicating the distance accomplished. (Communication from the Marine Velocimetre Company, New York)

2219. J. Glover and J. Bold, Liverpool—Improved material for transfer printing

2220. J. McMaster, Caldons, Stoneykirk, and W. Wilson, Whithorn, Wigtownshire—Manufacturing liquid farm manure, and rendering it as efficient as any artificial manure, at a small expense to the farmer

2221. V. H. Laurent, Plancher-les-Mines, France—Improved machine for forging nails and other similar articles

2222. P. Ashcroft, Richmond-house, Dalston—Alarm signals for the prevention of accidents on railways

2223. H. Cartwright, Dean, Broseley, Shropshire—Improvements in the construction of steam-engines

2224. J. Dauglish, Great Malvern, Worcestershire—Improvements in the preparation of dough

2225. J. Dufau, Paris—Improvements in regulating or controlling railway and lighthouse signalling

2226. H. Clarke, Chancery-lane—Improvements in the lines of steam-vessels, and in the method of propelling the same

Dated August 22.

2228. H. Dircks, Moorgate-street—Improved fire-escape. (Communication)

2229. G. Steele and W. Steele, Kew-road, Richmond, Surrey—The better construction of a double-backed double boiler for heating with hot water, churches, horticultural buildings, mansions, theatres, &c. &c.

2230. F. A. Gatty, Accrington, Lancashire—Improvements in the manufacture of chlorine and sulphuric acid

2231. T. Settle, Bolton-le-Moors—Improvements in looms for weaving

2232. J. Pinchbeck, Katesgrove Ironworks, Reading—Improvement in screens for dressing or separating corn and other grain

2233. L. Levison, Birmingham—Improvements in mechanical purchases, to be employed for hoisting purposes and for extracting roots and stumps of trees. (Communication)

2234. P. G. Gardiner, New York, United States—A new and useful process in the treatment of cast-steel while passing from the molten state into that of being hardened or tempered, and which, with certain variations, is applicable to the making of tools, instruments, axles, wheels, or ingots

Dated August 24.

2235. F. J. Blanc, South-street, Finsbury—Improved tyre for the wheels of railway carriages, engines, and tenders

2236. G. D. Davis, St. Leonard's-road, East India-road—Improvements in the construction and in the method of working windlasses

2237. A. V. Newton, Chancery-lane—Improvements in temples for looms. (Communication from F. C. Keim, Thann, France)

2238. T. Rickett, Castle Foundry, Buckinghamshire—Improvements in machinery for sowing seeds and manure

2239. A. Hamilton, Oxford-square—Improvements in the construction of and in mooring buoys, beacons, floating lights, and other floating vessels and bodies.

2240. S. Fox and J. W. Slater, Sheffield—Improved metallic compound, applicable to the manufacture of various useful articles

Dated August 25.

2241. T. Macauley, Shoreditch—Improvements in apparatus for condensing the noxious vapours arising from varnish-making and other like manufactures

2242. F. Preston, Manchester—Improvements in apparatus to be applied to the spindles of machines for preparing, spinning, and doubling cotton and other fibrous materials

2244. E. Riley, Droylsden, near Manchester—Improvements in looms

2245. G. W. Hemming, Belsize-road, St. John's-wood—Improvements in apparatus employed in delivering submarine telegraph cables from ships
2246. C. C. James, Norwood-green—Improvements in propelling vessels
2247. W. Nicholls, Chippenham, Wiltshire—Improved apparatus for warming milk
2248. H. Parry, Croydon—Improvements in the construction of rails for railways or tramways
2249. J. Ronald, Liverpool—Improvements in laying or depositing submarine telegraph cables
2250. J. Penn, Greenwich—Improvement in apparatus for taking the thrust of screw and submerged propellers
2251. J. J. Tucker, and G. Blaxland, Sheerness—Improvements in steam boiler and other furnaces
2252. W. Staufen, Baker-street—Improved method of treating agava Americana or Mexican grass, and the manufacture of a new fabric therefrom
2253. A. V. Newton, Chancery-lane—Improvements in machinery for preparing, roving, spinning, and twisting fibrous substances. (Communication from E. Hubner, Mulhouse, France)
2254. A. V. Newton, Chancery-lane—A mode of varying the length and reversing the direction of the throw of excentrics, applicable to the reversing gear of locomotives and expansion gear of other steam-engines, and to other purposes. (Communication)
2255. P. Hill, Manchester, and J. Moore, Salford—Improvements in machinery or apparatus for cutting velvets or other similar piled articles

Dated August 26.

2256. J. Gedge, Wellington-street South, Strand—Improvements in the manufacture of soap. (Communication)
2257. T. Forsyth, Manchester—Improvements in machinery for raising, lowering, traversing, and compressing
2258. W. Hargreaves, Bradford—Improvements in screw gills for preparing wool and other fibrous substances
2259. T. Smith, Manchester—Improvements in machinery or apparatus for embossing woven fabrics, paper, leather, and other materials
2260 A. V. Newton, Chancery-lane—Improved machinery for kneading dough. (Communication)
2261. H. Elvin, Castle Acre, Norfolk—Improvements in governors for steam and other engines
2262. A. V. Newton, Chancery-lane—Improved means of operating slide valves for the induction and eduction of steam in reciprocating steam-engines. (Communication)
2263. J. Goodwin and A. Boyd, Milton, Campsie, Stirlingshire—Improvements in cleansing printed cotton and silk fabrics from colouring matters
2264. J. Webb, Bristol—Improved hopper
2265. T. Brown, Fenchurch-street—Improvements in machinery for raising and lowering weights

Dated August 27.

2266. J. McIsaac, Manchester—A machine or apparatus for washing or churning
2267. W. Harling, J. M. Todd, and T. Harling, Calder Foundry, Burnley—Improvements in looms
2268. C. Thompson and J. Thompson, Padiham, Lancashire—Improvements in apparatus for discharging condensed water, air, or other fluids, from steam pipes, drying cylinders, and other apparatus where steam is used
2269. A. V. Newton, Chancery-lane—Improvements in bakers' ovens. (Communication)
2271. R. Aytoun, Edinburgh—Improvements in safety cages or apparatus for mines
2272. F. X. Gentil and E. Gentil, Paris—Improvements in preparing and treating asphodel in order to obtain alcohol

Dated August 28.

2273. A. Shanks, Robert-street, Adelphi—Improvements in machines for shaping and cutting metals and other substances
2274. J. D. Brady, Calais—Improvements in saddles
2275. W. Smith, Liverpool—Improvement in the manufacture of size made from gelatine

Dated August 29.

2277. R. Whittam, Accrington, Lancashire—Improvements in machinery or apparatus for ruling upon metallic rollers cylinders for printing upon calico and other materials
2278. G. Cumming, Edinburgh—Improvements in apparatus for thermometric, hygrometric, and barometric purposes
2279. J. Fisher, Carrington, Nottinghamshire—Improvement in the manufacture of bobbin net or twist lace
2280. J. A. Chartier, South-street, Finsbury—Improvements in steam-engines

Dated August 31.

2281. J. Gilbert, Evesham, Worcestershire—Improvement in combined thrashing machines
2282. P. Spence, Pendleton, Lancashire—Improvements in the manufacture of sulphuric acid, and in obtaining salts of ammonia thereby
2283. P. Roehrig, Paris—Improved fabric to be used for manufacturing petticoats and other parts of women's dress
2284. W. Clark, Chancery-lane—Improvements in the application of portable rails or ways to vehicles. (Communication from A. J. Florn, Orleans)
2285. H. Brinsmead, Ipswich—Improvement in the beaters of thrashing machines
2286. G. H. Cottam and H. R. Cottam, Old St. Pancras-road—Improvements in the manufacture of children's cots and metallic bedsteads
2287. L. Gisborne and C. H. Forbe, Duke-street, Adelphi—Improvements in apparatus for paying out electric telegraph cables

Dated September 1.

2289. H. Coates, Crawshaw Booth, Lancashire—Improvements in heating liquids used in bleaching, dyeing, soaping, clearing, and sizing
2290. T. Bradford, Salford—Improved apparatus for washing clothes or articles of wearing apparel, which apparatus is also applicable to churning
2291. G. Bell, South Inch-Michael, Perthshire—Improvements in reaping and mowing machines
2292. H. Rawson, Leicester—Improvement in machinery for combing wool and other fibres
2293. G. W. Lenox, Billiter-square—Improvements in apparatus for sounding alarums at sea
2294. T. Gray, Richmond-street, St. George's-road, Southwark, and G. J. Gladstone, Blackwall—Improvements in apparatus for lowering and letting go ships' boats
2295. R. Elliott, South Shields—Improvements in photography, by which the lensular defects of the present process of taking photographic prints are avoided, and impressions are obtained of any size
2296. E. Taylor, Blackburn, Lancashire—Improvements in looms
2297. E. Grenet, jun., and A. Vavin, Paris—Improved electro-magnetic machine
2298. R. Sack, Loeben, near Luetzen, Prussia—Improvements in the construction of ploughs

Dated September 2.

2299. E. Leigh, Manchester—Improvements in constructing certain parts of machinery or apparatus used in preparing and spinning cotton and other fibrous substances
2301. T. W. Roys, Southampton, Long Island, United States—Improved apparatus applicable to the capture of whales and other purposes.
2302. A. V. Newton, Chancery-lane—Improvements in meters for gas and other liquids. (Communication)
2303. J. Petrie, Rochdale—Improvements in apparatus for regulating the admission of air to furnaces

Dated September 3.

2304. G. F. Parnell, Hoxton—Improvements in the construction of books and eyes
2305. T. Holland and J. Rubery, Birmingham—Improvements in the mode of manufacturing the runners and top notches of umbrellas and parasols
2306. T. Jackson, Orchard-street, Portman-square—Improvements in the action of pianofortes
2307. J. R. Atha, Heckmondwike, W. Pearson, Birstal, and W. Spurr, Birstall, Yorkshire—Improvements in railway signals
2308. P. G. Gardiner, New York, United States—Improvements in the conical coiled steel railroad cut spring, and also of new and useful machinery for preparing, coiling, and converting steel plates or bars into such springs, and for testing and measuring the length of such spring
2309. H. Inskip, Hertford—Improvements in fire-arms

Dated September 4.

2310. J. Y. Borland, Manchester—Improvements in machinery for preparing, spinning, winding, and doubling fibrous materials
2311. L. Moreau, Paris—Improvements in apparatus for carbonising peat wood and other combustible matters
2312. P. B. Godet, Paris—Improvements in stereoscopes
2313. T. Petitjean, Hatton-garden—Improved method of obtaining aluminium and magnesium
2314. C. W. Ramié, Camberwell—Improvements in constructing the permanent ways of railways
2315. J. A. Ferrier, Paris—Improvements in transparent photographic pictures and their application to stereoscopes
2316. J. Robertson, Kentish-town—Improvements in furnaces, and in the consumption or prevention of smoke
2317. W. E. Newton, Chancery-lane—Improvement applicable to rolls for rolling iron or other metals. (Communication)
2319. J. Nuttall, Silver-street, and L. Stean, Goswell-street—Improvements in fur gloves

Dated September 5.

2320. U. Scott, Camden-town—Improvements in machines for cleaning knives
2321. T. B. Wilkins, Birmingham, T. Milward, Harborne, Staffordshire—Improvements in the combination of dies for stamping belt fastenings, and which said improvements are also applicable to the stamping of other such like articles or ornaments
2322. R. Johnson, Blackburn—Improvements in purifying and filtering water
2323 J. King, Cannon-street—Improvements in the manufacture of boots and shoes, and in machinery for that purpose. (Communication)
2324. W. E. Newton, Chancery-lane—Improvements in clocks or timekeepers. (Communication)
2325. W. E. Newton, Chancery-lane—Improvements in the manufacture of a composition to be employed in the preparation of pigments. (Communication from the inventor)
2326. H. Archer, Gloucester-street, Pimlico—Improvements in envelopes
2327. P. A. le Comte de Fontainemoreau, London—Improved timekeeper dial, shewing the exact time in different countries. (Communication)

Dated September 7.

2328. S. Butler, Birmingham—A new or improved hearse
2329. P. A. le Comte de Fontainemoreau, South-street, Finsbury—Improvements in doors. (Communication)
2330. A. Walker, and T. Walker, Shotts, Lanarkshire—Improvements in the treatment or preparation of moulds for casting metals
2331. T. Goodchild, Guildford—Improvements in stoves and fireplaces
2332. W. Lewis and W. H. Lewis, New York, United States—Improvements in plateholders or frames for photographic cameras
2333. W. Sellers, Philadelphia, United States—Improvements in boring or turning mills for operating in metals or stone
2335. C. J. Duméry, Paris—Improvements in smoke-preventing apparatus
2337. L. A. Imbert, Trevilly, near Avallon, France—An iron straight-edge holder, designed for strengthening walls, edges, or mouldings

Dated September 8.

2339. G. J. Parson, Adelphi-terrace, and T. Pilgrim, Bow—Improvements in the mode of generating steam in the boilers of steam-engines, and in raising the temperature of steam for other uses
2341. B. Sharpe, Hanwell-park—Improvements in electric telegraph cables, and in the apparatus used for paying out such cables
2343. J. M. Miller, Washington, United States—Surface condenser, applicable to steam engines and other purposes
2345. W. Howard, Great Queen-street, Lincoln's-inn-fields—Improved apparatus for supplying air, medicated or pure, to persons in confined apartments and other places requiring ventilation

Dated September 9.

2347. L. Letournel, Paris—An appparatus for weighing ships' anchors
2349. L. L. H. Bertou, Paris—Improvements in the manufacture or production of ornamental wrappers or packings for fabrics or other goods
2351. J. Eastwood, Derby, and S. Lloyd, Wednesbury, Staffordshire—Improvements in machinery for shearing iron and other metals

Dated September 10.

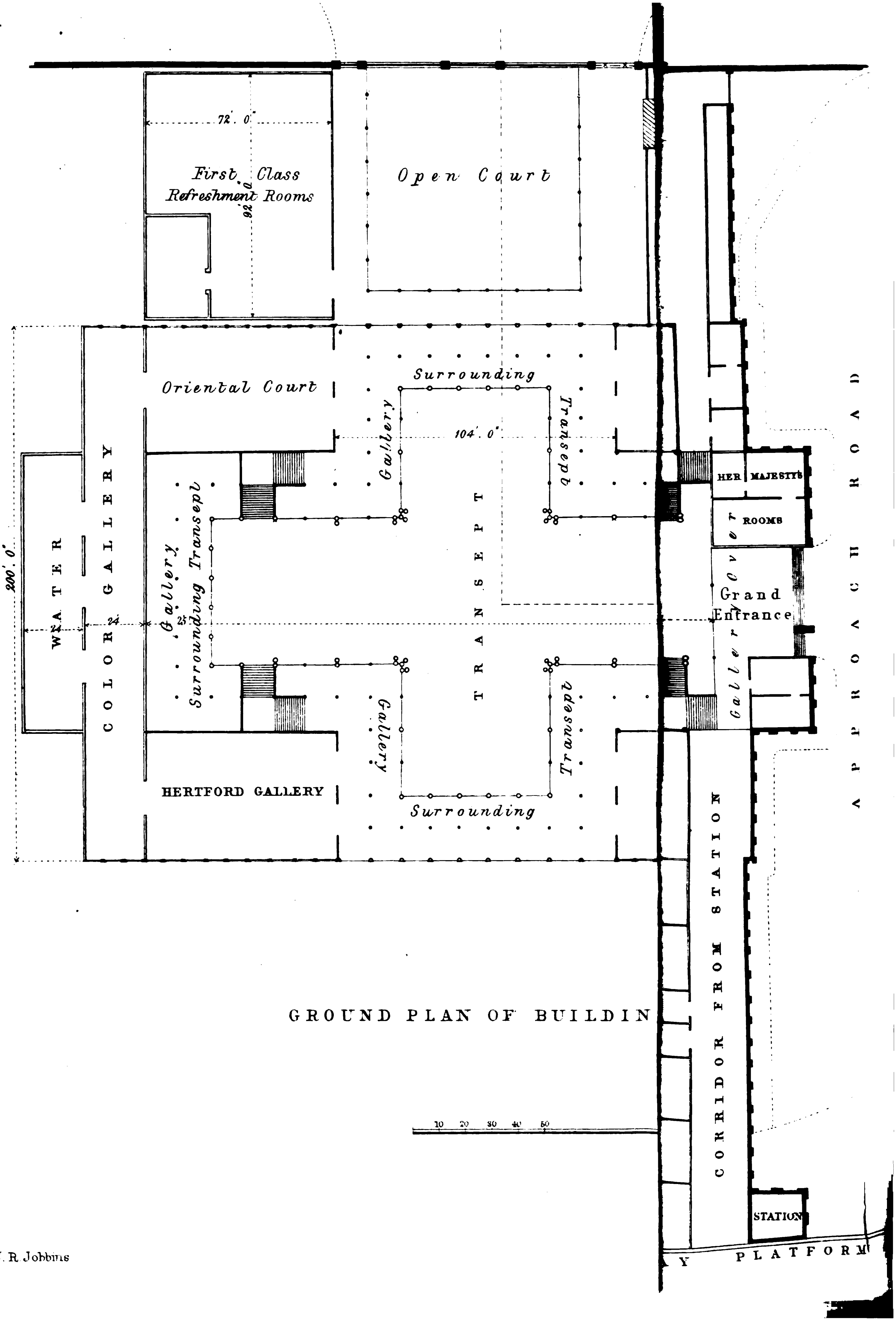
2355. J. Honeyman, jun., Glasgow—Improvements in generating steam
2357. W. Jamieson, Ashton-under-Lyne—Improvements in looms for weaving figured fabrics
2359. R. Houchin, Bridport-place—Improved press for punching, stamping, and embossing, or otherwise for cutting out paper, leather, or other materials, and for fixing and closing eyelets
2361. J. D. Dunnicliff, Nottingham—Improvements in dividing and measuring breadths of lace and other fabrics
2363. W. Crofts, Nottingham—Improvements in the manufacture of various weavings in bobbin net or twist lace machinery

Dated September 11.

2365. M. A. F. Mennons, Paris—Improved smoke-condensing apparatus. (Communication)
2367. J. Mills, Manchester—Improvements in the manufacture of keys, tapered pins, split pins, and other similar articles employed in the construction of machinery
2369. A. M. Servan, Paris—Improvements in the cementation of iron combined with the manufacture of coke
2371. C. Lungley, Deptford-green Dockyard—Improved apparatus for directing, signalling, and indicating on board ships or vessels, or other places

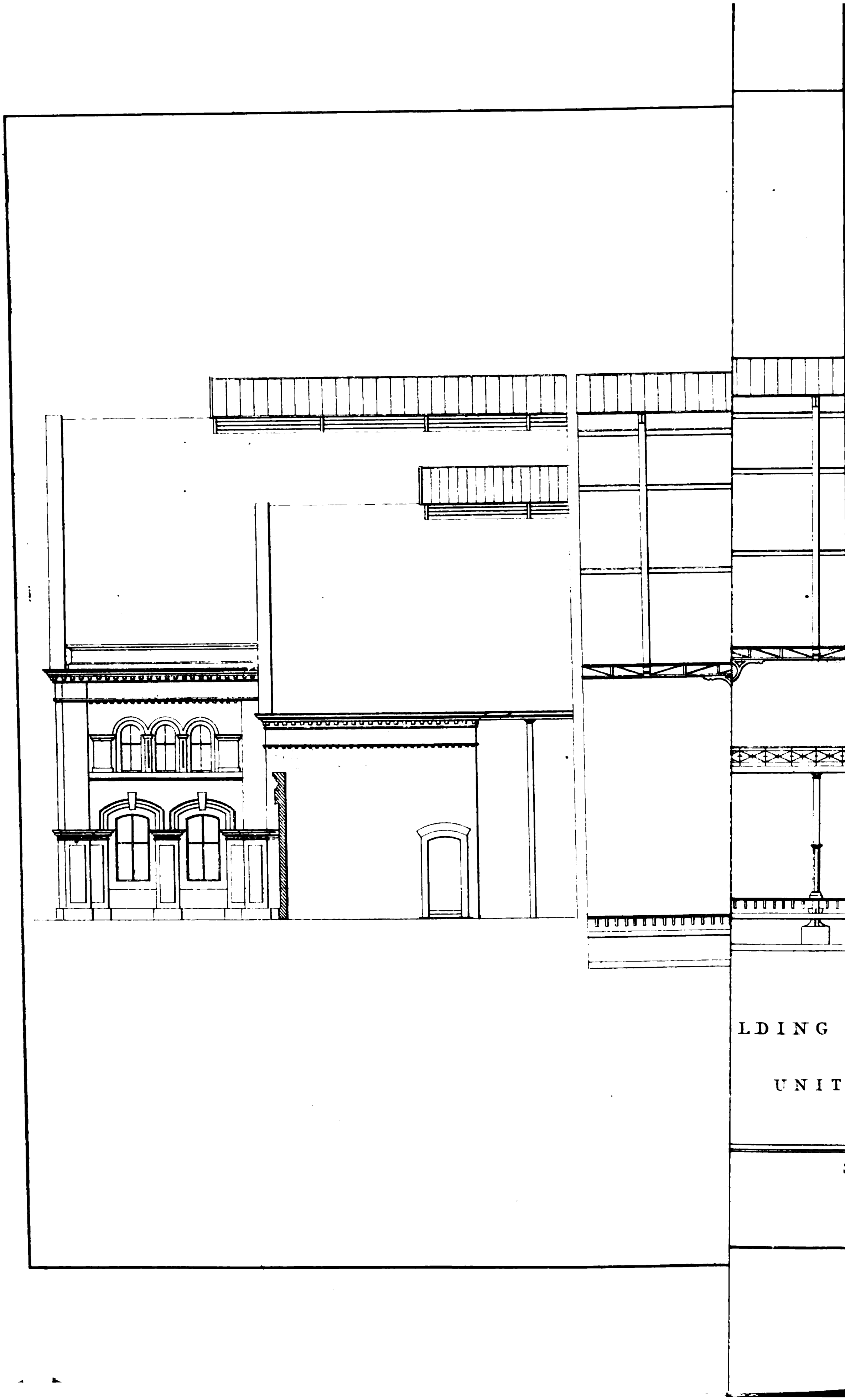
Dated September 12.

2373. N. G. I. de Laphalèque, Paris—Improvements in violins and other stringed musical instruments of a similar nature
2375. J. Butler and J. Pitts, Stanningley, Yorkshire—Improvement in fastening tyres on wheels for railway carriages
2377. I. C. Clöet, Ghent, Belgium—Machinery or apparatus for treating and dressing rice



First Class Refreshment Rooms
72. 0
92. 0
Open Court
Oriental Court
Surrounding
Gallery
104. 0
Transept
HER MAJESTY'S ROOMS
Gallery over
Grand Entrance
WATER
COLOR GALLERY
200. 0
24
24
25
Gallery
Surrounding Transept
TRANSEPT
HERTFORD GALLERY
APPROACH ROAD
CORRIDOR FROM STATION
GROUND PLAN OF BUILDIN
10 20 30 40 50
STATION
Y PLATFORM

J. R. Jobbins


LDING
UNIT

MANCHESTER EXHIBITION OF ART-TREASURES OF THE UNITED KINGDOM.

(*With Engravings, Plates* XXVIII., XXIX., *and* XXX.)*

SPECIFICATION.

Site.—The building to be erected on the Old Trafford Cricket-ground, adjoining the Old Trafford station, to the south of the Botanic Gardens, and between them and the South Junction and Altringham Railway, in the position indicated on the ground-plan.

Plan.—The building to be rectangular in plan, 200′ broad and 654′ long, exclusive of a 24′ projection 104′ wide on both the east and west fronts, so that the total length is 704′. These dimensions apply only to the main building, and are exclusive of wings, outbuildings, railway station, platform, &c.

The building is divided longitudinally into central hall 104′ broad, and two side halls each 48′ for the exhibition of pictures. The offices, reception and refreshment rooms are arranged as shown in plan.

Drainage.—Main drains to commence at east end 3′ below surface; to have a gradient fall of 1 in 100 or thereabouts; to commence 9″ diam. and gradually increase to 20″×15″. The drains used to be glazed ware pipe-drains well and truly laid, and junctions connecting drainage of main building to be formed. On the north side the soil excavated to be mixed with ashes, so that the north drain may form an intercepting drain for the upland water. The drains thus formed to be connected with main sewer at point shown at east end of railway station.

Foundation.—The east and west front to be of brick, and the foundations excavated to solid blue clay, which averages 2′ to 2′ 6″ over entire surface. For the side walls of the building, pits of a sufficient depth to be dug ranging in a course down the line of walls on both sides of the building, and spaced 8′ apart; and in the space within the building similar pits to be excavated down the lines shown in plan for the partitions between galleries and main hall. Trenches for foundation sleeper-walls, &c., to be made 12′ apart across the entire width of the building.

Brickwork.—Walls and piers to be built in every respect similar and agreeable with the drawings, and of the thickness shown thereon; the foundation of each wall to have four courses of footings, each course to project one-quarter of a brick on each side. The side face of front wall to be built with best seconds stocks and purpose-made white bricks in fine mortar set in flemish bond; all to be neatly dressed off with putty joints composed of burnt marble. The remainder of the walls, foundations, and backing up to front walls to be executed in best hard-burnt common bricks; those required for external face of back wall to be picked, set in mortar composed of best buxton lime and sharp sand in the proportion of 1 to 2. The whole of the doors and window arches to be executed of the best picked seconds stocks, rubbed, gauged, and dressed off; and to have inside arches two-and-a-half brick rims of the best common bricks.

The cornice in front elevation to be executed out of red and white moulded bricks dressed off as before specified; the imposts and neck moulds to be executed in red or white moulded bricks properly dressed off.

Piers of brick 21½″×21½″ to be built up in each of the pits excavated in the line of the outside walls and within the area of the building, and each pier to be carried up to receive base-plates of cast-iron to a level below floor line; each pier to be level in itself and with respect to each other.

Sleeper walls half-brick with piers 2″×4½″ every 18″ to be built 12″ apart across the building in the trenches excavated for that purpose and to the height shown.

Masons' Work.—The whole of the window sills in front elevation to be out of Yorkshire flag 12″ wide and 3″ thick, rubbed, gauged, and throated; also 3″ York flag to be fixed under brick cornice to extend 18″ into wall and project 9″ from face, to be neatly tooled and properly pointed.

The entrance steps and landings to be out of 3″ Yorkshire flag neatly tooled and laid on brick foundations; risers to be out of similar flag jointed and bedded in cement.

IRONWORK.

Base Plates.—These to be of cast-iron flanged out at bottom 6″×1′ 6″ and at top 1′×1′; to be set in fine mortar on each pier along the line of the outside walls and within the area inclosed by the walls. To be connected longitudinally by flanged pipes of cast-iron; the outside line and that beneath partition of main hall and picture gallery to be 5″ diam., those below columns of great hall 7″ diam.

Wall Standards.—Cast-iron standards of section shown to be fitted on the top of table of base-plate; the standards to be 23′ 9″ long and flanged out at top to receive eaves-gutter, and to support foot of principals for picture gallery. The standards to be connected longitudinally at the top by runner plates of cast-iron which are to be bolted thereto. The roof principal of the picture gallery being spaced 12′ apart and wall standards only 8′, it follows that each alternate principal must be intermediate between two standards; to support this cast-iron girders to be provided and connected with adjacent standards.

Eaves Gutters.—Moulded eaves gutters of cast-iron to be provided and attached to runner plate. The frame of whole north and south wall, with exception of transept ends, to be thus constructed.

Standards in Transept Ends.—Cast-iron standards or columns 7″ diam., with ribs or fillets on the outside to receive frames of windows and doors. The columns to be 29′ 9″ high, to be connected together at the height of 15′ above floor with a cast-iron girder as shown, and at the top the columns to be connected by an open ornamental girder; an inner screen consisting of similar columns and girders to be constructed 12′ from each end of transept, and to be connected therewith by transoms of cast-iron.

Partition dividing Great Hall from Picture Gallery.—Standards of cast-iron 12′ apart and 29′ 9″ long to be fixed on base-plate in line which divides picture galleries from main hall, and also in line of partition dividing Oriental and Hertford galleries from main hall. These standards to be flanged and corbelled out on side next picture gallery at the height of 22′ 2″ from the floor level, to support principals of picture-gallery roof. Valley gutters and runner plates to be provided and fixed.

Columns in Main Hall.—Double columns each 7″ diam. and 29′ 9″ long to be set upon base-plates in main hall; at the angles between the columns and girders presently specified, ornamental cast-iron brackets to be provided and fixed; such of the columns as support the galleries to have pockets cast on them to receive bearing beams of gallery.

At the angles where transept intersects nave, six similar columns to be grouped and fixed as shown on plan.

Valley gutters to be fixed on columns as shown, with short pipes to convey water down columns to drain-pipes below floor-level.

Gallery Columns.—Columns of cast-iron 5″ diam. and 15′ long, to support galleries intermediately with main columns just specified; these columns will support main timbers of galleries.

Lattice Girders.—Lattice girders of wrought-iron each 23′ 7″ long and constructed as shown, to be bolted to columns of great hall, connecting them longitudinally.

Cast corbels or brackets to be bolted on to the centre of each to support roof girders or principals, placed alternately with columns.

Roof Girders.—Semicircular roof girders or principals of wrought-iron 28″ radius to be constructed and fixed to top of coupled columns and upon brackets secured to lattice girders. The roof girders are fixed 12′ apart down the entire length of the building and transept, and where transept crosses main hall these roof girders to be groined and to be made to the curve projected by the intersection of the two semicircles; the groined girders to be secured at the base to the group of six columns at each angle. A cast-iron key to form intersection of groined ribs against which the ribs abut and to which they are secured.

Smaller girders for the purpose of stiffening the principal girders at the groin, and shortening the length of the bearings for the purlins for the roof, the same as to the rest of the building.

Side Aisle Roofs.—Angular roofs to be made of wrought-iron and fixed to coupled columns, and girders to line with main-roof principals of great hall.

Picture Gallery Roof.—The picture gallery roof principals to be composed of trusses constructed as shown in section. The feet of roof principals to rest on one side on corbels of partition standards, and on the other alternately on standards of outside wall and girders connecting the standards, and in all cases to be bolted thereto.

Corrugated Sheets.—The space between the standards in outside walls to be filled in with corrugated sheets, No. 18 B. W. G., the corrugations to lay horizontally, and the roof to be covered to

* Plate XXX., the Transverse Section, having reached us too late, will be given in December *Journal*.

within about 12' of apex with corrugated sheets, No. 20 B. W. G., and both walls and roof to be lined with ⅝" spruce boarding as presently specified.

The east end of picture gallery to be made good and filled in with corrugated sheets.

The Oriental Court and Hertford Galleries, both of which are 72'×48' and 24' high.—The outside walls and partitions are constructed as before specified for walls and partitions of picture galleries. Columns of cast iron placed 24' apart in a line down the middle of the court, to be connected by lattice girders of wrought iron; to the girders are bolted brackets of cast iron which support roof principals constructed same as roof of side aisles.

The Water Colour Gallery, which is 200' long 24' broad, the walls of which are of brick and the roof of wrought iron. The principals are semicircular with 12' radius and spaced 12' apart; this roof is also covered to within 4' of apex with corrugated sheets and lined with ⅝" spruce boarding.

The roofs over the rooms beyond picture gallery, which is shown in section and in plan, are constructed same as side-aisle roofs before specified.

Timber.—Spruce batten joists to be built into sleeper walls and spaced 1' 6" apart from centre to centre, the joists to be laid level in themselves and with respect to each other, to extend over all the space occupied by ground floor; upon the joists 1¼" flooring boards of spruce to be spiked with ½" spaces between them.

The outside walls and partitions to be framed with morticed framing 3"×4", and covered with ⅝" boarding, the walls to be lined only, but the partitions to be boarded on both sides.

Purlins 7"×2½" of spruce to rest and be bolted to cast-iron shoes fixed on back of principals and spaced about 6' 3" apart.

Lighting.—The building is lighted entirely from the roof, for this purpose pine standards 2' long are framed to upper purlins, with a cast ridge standard at apex of every principal to support a framework of rails and sashbeams as shown in section.

The bearing beams of gallery to be of Memel, 12"×6" running longitudinally; they are supported every 12'. The surface of beams to be dressed and edges chamfered.

The main bearing beams to run parallel with partition, 12' apart all round the space marked in plan as galleries, both round transept and east front. The joists to be of same scantling as floor joists, and to be close boarded with 1¼" spruce.

Façade.—It was at first intended that the whole of the façade should be of brick, but the lateness of the season rendered it imperative that the arches above the springing should be constructed of material more rapidly put together, and not requiring time for consolidation, &c. Iron and timber were therefore used for the three arches, and the following is the specification:

Central Arch.—The wall in exit passage to be built up 21" thick to correspond with opposite wall in same passage, and to be carried up to same level, the top nine courses to be set in Portland cement.

A sole-plate of cast iron 12' long 18" wide and 1¼" thick, feathered, to be let into a sleeper block of timber built into brickwork and bolted thereto. A cast-iron girder 7' 6" long to be built firmly into brickwork, secured to bearing stones of York landing.

From the front sole-plate in the position shown, two semicircular wrought-iron girders, one 28' outside radius, the other 18' 2" outside radius, and both of scantling and construction as the arched roof girders of central hall; they are fixed concentric and securely bolted.

Girders similar in every respect rest on and are bolted to the cast-iron girders 7' 6" from the front of wall; diagonal trusses of T iron 4"×4" connect the front and back arches together, and are placed about 10' apart measured on outside rim of large arch.

Face of arch and soffit to be boarded with 1½" pine boarding, and fixed to frame of battens securely attached to main iron ribs.

The central part of arch below soffit to be filled in with open light with cast-iron frame glazed with 21 oz. glass.

Side Arches.—For the side arches sole-plates of cast iron bedded on timber sleeper blocks to be laid on cornice of brickwork and built into same. Semicircular arched girders same as for central arch to be bolted to sole-plates, the radius of outside ribs same as radius of roof of picture gallery, the inner ribs to be same as inner ribs of central arch, the face of arch to be boarded with 1½" pine boarding in panels, and central fan-light with cast-iron frame same as fan-light of central arch.

Twelve feet back from face of wall standards of cast iron to be fixed on brick foundations in cement, and carried up to level of top of cornice, cast-iron girders to connect columns together and also columns with sole-plate on brickwork, and on top of these columns similar arched girders to correspond with girders in front, and to be connected with 4" T iron diagonals with face girders, the whole to be well and securely fixed with sexagonal screw bolts, and the inside surface lined with ⅝" spruce boarding.

Glazing.—The roof lights and ends of transept to be glazed with 21 oz. sheet glass back and front puttied; the glass in roof to lap ½", and to be back and front puttied.

Painting.—The whole of the interior and exterior ironwork to be three times well painted with white lead or stone colour, besides priming coat.

First Class Refreshment Room and Court.—On the north side of transept an open cloistered court is shown in plan, three sides of which to be surrounded by a verandah 12' broad, the roof supported by columns and open cast-iron arched girders, the columns to be placed at the distance marked in plan, and the girders of the pattern shown in elevation; the roof to be made good to walls of main building and flushed with lead, and rain to drop into gutters at eaves and discharge down angle columns to be conveyed into drain; the space beneath verandah to be laid with joists and open boarded same as floor of main building, and with timber of same scantling.

The first class refreshment room leads from east side of verandah, the walls composed of I shaped standards 16' long, the spaces between which being filled in with corrugated sheets, and lined with boards ⅝" thick same as the walls of the main building, the floor is also of same scantling, and two rows of columns go up centre to support roof, which is of same construction as roof of side aisle.

The Second Class Refreshment Rooms lead from the corridor to railway station, and to be of same construction as first class rooms.

Urinal closets, &c. &c. to be provided of approved construction, and to be constructed of best materials to satisfaction of committee.

The end of corridor to be connected with a railway platform 800' long, 400' of which is to be covered with a light open iron roof similar in construction and dimensions to roof of side aisles, and resting on cast columns with open cast-iron girders.

The whole of the work to be done in an efficient and satisfactory manner with the best materials of the several kinds, to the satisfaction of the Executive Committee or any one they may appoint.

ON WAVES.

By Joshua Wilson, of Sunderland.

A wave, strictly speaking, is an oscillatory or vibratory movement of the particles of water. If we admit this definition as a correct one, "a wave of translation" must be regarded as an inaccurate term, since any progressive movement of the water must be the effect of some circumstance attending the undulation. For example, when the wave breaks, the crest in rolling down its side produces a current, and it is to this current accompanying the wave that any progressive movement of the particles of water is due. The attraction of gravity also produces a current on each slope of the great oceanic tidal wave, but it is only when the tide enters a narrow strait or river that it is propagated by a current whose velocity is dependent on the slope of its surface. But in the case of a river, if the narrow entrance is succeeded by an expanse of considerable breadth, this current will by its impulsive action produce an undulatory movement in the pool, which wave will be propagated at a higher velocity than would be due to the slope of the surface, or where an actual transfer of the particles of water takes place, as would be the case with a mere current.

This combination, from its partaking of the properties of both wave and current, may not improperly be denominated a wave-current. The tidal bore is a combination of this description; it retains so much of the undulatory character as to break on the shallows like an ordinary wave. A wave has been defined as "a motion of the particles of water in a circular or elliptical orbit;" but such a definition is clearly inapplicable to the great oceanic tidal wave, which is several thousand miles in breadth. Yet the tidal wave has a similar origin, and is governed by the same laws as those of an ordinary description; all being produced by the exercise of lateral pressure on a body of water, which in the first instance raises its surface,—and if the water possessed the same consistency and tenacity as bakers' dough, the part so raised would remain, and no undulation would be produced; but from its being a fluid this upward movement is held in check by the attraction of gravitation, which, in its efforts to restore the equilibrium, produces a second undulation; and so it continues, until at length the cause having ceased to operate, the equilibrium is again restored.

The arrangement of the particles of water forming the wave may be described as in the form of a series of vertical planes, with their breadths contracting beneath the wave, and again expanding under the hollows between.

The tidal wave is produced through the attraction of the sun or moon causing the water in that part of the ocean which is more immediately under its influence to be specifically lighter than that which is out of the sphere of such attraction; this heavier portion, by means of its lateral pressure, forces the other up into the form of a wave. If the influence of the sun or moon were suddenly withdrawn, we might reasonably presume that, in obedience to the laws which govern other waves, the great tidal undulation would be followed by others gradually diminishing in size, until the ocean was restored to a state of equilibrium. Thus we have a primary tidal wave raised by the attraction of the sun or moon, and a second oscillation succeeding it; but the attractive influence is again brought to bear on the third undulation, thus forming it into a second primary wave. Under these circumstances, the secondary tide cannot be expected to rise so high as the primary one; and a careful observation will show this to be the case, that during one portion of the year the morning, and in the other the evening, tide, is usually the highest, —the time of the day of the higher tide varying with the place of the sun in the zodiac, and consequent position of the moon when full.

A breeze of wind passing over the surface of an expanse of water produces an undulatory movement, which is accompanied by a surface drift or current, and this drift is always accompanied by an under-current in the opposite direction, by which the equilibrium is maintained. A stone thrown in,—the launch of a vessel,—the paddles of a steamboat,—or, in short, any movement which exerts a lateral pressure on a body of water, will produce an undulatory motion on its surface. A wave does not break when its sides retain a slope sufficient to support its top. But when from whatever cause the slope on either side approaches too near to the perpendicular, a crest forms on the top which rolls down its side, causing the wave to break. This change may be the result of a variety of causes. The wave may arrive at a shoal where there is not sufficient water to form the necessary slope in front. The wave may have to encounter a strong tidal or river current running in an opposite direction, which, by retarding the oscillatory movement at the base of the undulation in front, causes it to approach so nearly to a perpendicular that it can no longer support its top, which consequently falls over, and the wave breaks. A gale of wind will also cause a wave to break in deep water, by blowing the top too far to the leeward; this often occurs in off-shore gales, when the wind meets the waves that ordinarily roll towards the shore, and blows over their summits in an opposite direction to that in which they are moving.

It is not improbable but that the frequent changes of wind that usually occur in hurricanes or typhoons may be one reason why the waves almost universally break during their continuance. Waves breaking in deep water exert a powerful influence on the bottom, even at a considerable depth. Capt. Sir Edward Belcher, of the *Samarang*, mentions that while employed in surveying the islands of the Eastern Archipelago, he found that in typhoons and violent tempests the submarine agitations have been known to reach a depth of 200 feet, and that they were so violent in their effects as to break the rocks in pieces. The effects of the mere oscillating movement of the wave also extends to a considerable depth. A commander in the royal navy, while lying at the port of Santander, observed ripple marks running parallel to the waves at the bottom of the water where they lay at anchor, the depth being 40 feet; whereas the height of the waves from crest to hollow was at the outside only 5 feet.

These facts have an important bearing on the controverted question, as to whether a perpendicular wall or a sloping breakwater is the best adapted to resist the action of the sea. The perpendicular wall would only have the oscillatory movement of the unbroken wave to resist; but in the sloping breakwater, the wave exerts the excavating power of a cascade while in the act of breaking, in addition to the abrasive action of the wave current in advancing and retiring.

It is usually considered that the velocity of a wave is dependent on the depth of the water, whereas careful observation will show that it is the breadth of the expanse that determines the velocity. The great tidal wave, which moves at a rate of some 500 miles per hour, is reduced to a tenth of that velocity in the narrow seas around this island, and becomes a mere tidal current, whose rate is determined by the slope of the surface in the deep narrow channels of the Orkneys. It may also be noticed, that the friction of the coasts causes a considerable retardation of the tidal wave inshore. The same law holds good in a tidal river or estuary, as the tidal wave moves with a much greater velocity along the broad shallow expanses than through the deep narrow channels. If we notice the waves rolling into a bay on the coast, we perceive that they are impeded by the friction at the sides of the bay, so that the wave itself becomes elongated, conforming in fact to the shape of the inlet, so that it breaks on the sides as well as the end; and in addition to this, if it break over a shoal in passing, there is scarcely a perceptible diminution of the velocity of that portion of the wave, but it keeps pace with the other part which has moved along in deeper water.

ON THE WINDS AND RAIN OF CENTRAL AMERICA.

By Thomas Hopkins, M.B.M.S.

There are certain regions which have extraordinary meteorological characters, some of which have been adverted to in previous papers: such as the Himalayah mountains, towards which winds rush across the Indian ocean in summer,—the great East Indian archipelago, to which winds blow in different seasons from all parts around, as to a central area,—and Cape Horn, Terra del Fuego, and the mountains of western Patagonia, which have winds incessantly blowing on them. Accounts of these parts, and of the causes which are presumed to be in operation to produce their peculiarities, have been given in former papers. But they are not the only parts that may be specially pointed out as having such characters, although the causes which have produced them may possibly be rather more palpable in their cases than in some others. Central America and the countries adjacent, including the contiguous parts of the ocean, on both the Atlantic and Pacific sides, present evidence of characters which may be called extraordinary. Winds pass from the Atlantic ocean over the Caribbean sea to one side of those countries, whilst other winds blow towards them on the opposite side from the Pacific ocean; presenting a case where contrary winds blow towards an intermediate area, as is seen in the instance of the East Indian archipelago.

It has been proved that in the summer of the northern hemisphere a north-west wind blows from California into the Bay of Panama; and Mr. A. G. Findley, in an account read before the Royal Geographical Society, has shown that, at the same time, another wind from the west passes across the equatorial part of the Pacific to the same bay; whilst a third wind is blowing to it from the south in lower Peru. And it is well known that in the same season an eastern wind from the tropical Atlantic blows over the Caribbean sea, reaching the eastern side of Central America at Terra Firma and the Mosquito shore. These statements are fully sustained by the accounts of many travellers and writers.

Basil Hall says, that "on the Pacific side of the Isthmus of Panama winds blow from the Gulf of California to the Bay of Panama. The return passages from the west are always much easier; a distance of 35 to 50 leagues from the coast insures a fair wind all the way. In the winter it is better to keep off 100 leagues, to avoid the calms, incessant rains, squalls, and lightning;" and that "on the south-west coast of Mexico, from June to November inclusive, every part of it is liable to hard gales, tornadoes, or heavy squalls,—to calms, to constant deluges of rain, and the most dangerous lightning." Lieut. Maury states that "between California and 130° west, and from 30° to 40° north, the prevailing direction of the wind in summer and fall is from north to west inclusive." The Panama *Star*, of Nov. 20, 1852, when giving an account of the weather in that quarter of the world, says, "Our rainy season does not fairly commence before the 1st June,—the dry season sets in, say after the 1st December." These accounts relate to the Pacific side of Central America.

Respecting the Atlantic side, Norman, in his 'Rambles in Yucatan,' asserts that "in Campeachy the rainy season commences about the last of May, and ends in September." Old Dampier says, "the wet weather in the Bay of Campeachy sets in from May with fierce tornadoes, and continues thus till June, from which period rain falls almost incessantly until the end of August. By this time the rivers have risen, and the savannahs and all the low grounds have overflowed; and in this state they remain, the savannahs appearing like inland lakes, till December." During this time wind blows to these countries from the Caribbean sea and across the Gulf of Mexico. The same kind of weather prevails along the whole of the eastern coast of Central America to the Gulf of Darien in the latitude of 8° north.

To account for this kind of weather in the part in summer, we may remember that by the end of May the sun has great power over the northern tropic, within which water is energetically vapourised from both the Atlantic and Pacific oceans,—this of course fills the atmosphere with vapour over these oceans. The winds which blow from them to Central America must therefore take this vapour with them,—hence the weather that has been described in the extracts given.

But what causes these opposite winds to blow at this season? It has been generally said that such winds are produced by broad sun-heated lands. In Central America, however, the land is not broad, but narrow, and most of it lofty. In Guatemala, in from 14° to 17° of north latitude, there are very high mountains, and there are others almost as high in Nicaragua. Southward of the Isthmus of Panama the elevated land of New Granada commences, rising to the heights of Chimboraza, and extending beyond the equator. And it is at the time of the rainy season among these mountains, when they are thickly enveloped in clouds, that the winds blow towards them. There is, consequently, no ground for the assumption that winds here blow towards sun-heated land.

With reference to the statement which has been made, that within the tropics the earth, in its diurnal revolution, left the air behind, and thus produced an apparent movement of air from east to west, as a wind; I have already shown that the air by its pressure on the surface of the earth soon acquires the rotatory velocity of that surface, and moves with the same speed as the solid or liquid parts, from west to east;—the air, therefore, cannot be left behind over the Atlantic ocean and Caribbean sea, to constitute an apparent east wind on the eastern side of this part of America. But whatever may be imagined by those who are wedded to the theory of air being left behind by the rotating earth, it is impossible that such a cause should produce the winds which blow from opposite sides to this locality, and more particularly that which comes from the Pacific. If there were any truth in this notion of the air being palpably left behind by the land and water, it would be shown over the part of the Pacific ocean which is adjacent to the American coast, extending westward within the northern tropic. But over this portion of the Pacific winds blow to Central America, which is in a direction the opposite of that in which the air would appear to move if it were palpably left behind by the rotating surface of the globe. These western winds in the Pacific, therefore, furnish strong evidence of the fallacious nature of the suppositions that have been indulged in by theorists.

Yet strong winds blowing from opposite directions towards this locality indicate that there is some powerful influence operating in the part, which makes the air pass towards it from various other parts. We are not however, in order to find some cause for this, obliged to suppose that it is either sun-heated land, or air left behind in rotation, that produces these winds; as a cause can be clearly traced which has been shown to have great power, and that has displayed it in many parts of the world very differently situated geographically. This cause is the vapour, which, raised by the sun from the Atlantic and Pacific oceans, and being in part condensed against the lofty lands of Central America and adjacent countries, heats the air about the mountains, and produces ascending atmospheric currents, creating horizontal movements of the air, or winds that blow from all the low regions around, and furnishing the heavy rains that fall in the parts. On the Atlantic side this powerful cause creates the eastern trade wind of the Atlantic, which blows up the river Orinoco to the Andes, and over the Caribbean sea to Central America, the winds passing from the ocean to various parts of the cordillera of the Andes.

On the Pacific side, in like manner, copious condensation of vapour causes winds to blow towards portions of the same general area: first from lower Peru, where it is a constant south wind; then from the open ocean, near the equator, where it is a west wind; and from off the coast of California, where it is a north-west wind;—all, however, terminating in some part of the elongated area of condensation in the mountain chain of the Andes, that has been pointed out. Now the two last-named of these winds, blowing as they do in directions opposite to that in which air would appear to move if left behind by the earth, prove, not only that the atmosphere is not so left behind, but also the great power of condensing vapour to act upon the air, and to cause it to rush over the ocean towards the area of condensation as a wind, and to move faster than the rotating surface of the globe. There is consequently little reason to doubt what is the cause of the various winds of this part of the world. It cannot be direct sun-heated land, because the land is screened by clouds; nor can it be air left behind by the rotating globe, seeing that the winds blow from the two oceans in opposite directions to an intermediate part, whilst some of them rotate faster than the surface of the globe. And condensation of vapour being the only other influence that can be discovered, it may safely be admitted to be the real cause, as its operations can be explained so as to account for all the effects that are produced.

It is also stated, on authority equally good with those already given, that in the winter winds blow on the eastern side of Central America, from the north, to the same general area, showing that in that season some cause is in action to create winds. Humboldt says, "The north winds (los Nortes) prevail in the Mexican gulf from the autumnal to the vernal equinox; they are very violent in March. On the east coast of Central America impetuous cold winds blow from October to March, that have cooled the air at Havannah to 32°." And Turnbull, in his account of Cuba, states that, "The Nortes are rarely heard of at Havannah before the end of October, but they continue at irregular intervals until the month of March." From these statements we see that air, which by theorists had been supposed to be left behind, to constitute an east wind in these parts, cannot be so left in the winter, as during that portion of the year it comes from the north. And as the earth revolves at the same speed in both seasons, winds coming from different quarters in different seasons cannot be effects of the rotation of the globe.

From these accounts it may be seen, that whilst heavy rains fall and winds blow from the ocean on each side towards Central America during the summer, in the winter the wind comes from the north into the Gulf of Mexico, and passes over Cuba to the Caribbean sea; and it may be thought necessary that we should ascertain why the wind should come from a different quarter in the winter to what it does in the summer; and particularly whether the same kind of cause is in operation in the two seasons. I am not aware that any meteorologist has attempted to account for the north wind of this part, and it may therefore be presumed that the cause is somewhat obscure. Indeed, without some knowledge of what is going on in certain other parts of the world, to assist as a guide, it would probably not be easy to discover it. But, aided by such knowledge, we may search for localities in those parts towards which the north winds blow, in order to discover whether condensation of vapour is taking place in any of them sufficient to create the wind.

It is from November to March that these winds blow, and it has been shown that on the eastern side of the Andes to 15° of south latitude very heavy rains then fall. These are evidently brought by the south-east trade wind of the Atlantic, which at that period is fully charged with vapour raised by the sun from southern seas. Now this vapour being largely condensed against the part of the Andes named, creates there vacua in the atmosphere, into which additional air rushes, not only from the Atlantic ocean, but from both the north and the south sides of the vacua. Air passes from the south, over eastern Patagonia and the pampas of Buenos Ayres, to this area of condensation; but the vacuum which is created more to the north leaves room for northern winds also to blow towards it. It is accordingly found that at this season the plains of the Orinoco are dry; rendered so, no doubt, by air passing over them from the northern hemisphere to the area of condensation in the south.

Humboldt says of this dry part of South America, that "in an inland district to the east of the cordilleras of Merida and New Granada, in the Llanos of Venezuela, and the Rio Meta, from the fourth to the tenth degree of north latitude, nothing can equal the purity of the atmosphere from December to February. The sky is then constantly without clouds. The breeze from the east and north-east blows with violence." And Lieut. Maury asserts that at the vernal equinox the valley of the lower Orinoco is very dry and extremely dusty, yet whirlwinds, gales, and tornadoes of terrible force, sweep over it. And he considers that large quantities of dust are borne from this part, by ascending winds, into the higher regions of the atmosphere. This is the dry season of the West Indies; and we have seen that in Cuba the temperature sinks so low as 32° as a consequence of cold air passing over it from the north, going doubtless towards the great area of condensation that then exists in the south.

It is then in South America, against the east side of the lofty Andes, that we find the cause of the winds that blow in the winter from the north over Cuba, the Caribbean sea, and the valley of the Orinoco. It is to the extensive vacua, and consequent ascending atmospheric currents created by condensation of vapour which produces the immense body of water that flows down the mighty Amazon at this period of the year, that we have to attribute these winds and the kind of weather that accompanies them. And the same cause, extending its influence northward, may evidently produce the north-west wind which then blows down the valley of the Mississippi and across the Gulf of Mexico.

But when the sun evaporates water freely from the surface of the ocean in the southern hemisphere, it is not alone on the eastern side of the Andes that vacua are created, into which winds blow, as similar phenomena are traceable in certain parts on the western side of those mountains in Ecuador and New Granada. It is well known that in Guayaquil, a little south of the equator, to the Isthmus of Panama in say 10° of north latitude, whilst the dry perennial wind is blowing towards it from Peru, very heavy rains, brought from the Pacific, fall during the southern summer. And where these rains fall vacua may be presumed to be created sufficiently powerful to draw air from the southern Pacific extending over the wide space between Guayaquil and the Society Islands, and giving birth to a Pacific monsoon.

Admiral Fitzroy informs us that, "It is not generally known except by readers of voyages, that from November to March there is much west wind, rain, and occasional tempests, between the vicinity of the equator and about 15° south. This westerly monsoon, for such in fact it is, sometimes is steadily regular, and at other times interrupted by calms, storms, or heavy rains. The easterly limit to which it usually reaches is about 110° west longitude, but there is reason to suppose that it extends at times, irregularly, to the Galapagos Islands, if not to the adjacent continent when Guayaquil is suffering from heavy torrents of rain." Judging from what is found to take place in other localities, it may be presumed, even from this imperfect account, that the rains of Guayaquil, by the vacua that they created perhaps at some considerable elevation, produced this west wind. But whatever may be thought of this Pacific monsoon, there is no doubt that winds blow from the tropical part of the Pacific into the Bay of Panama and against the adjacent mountains, in our winter as well as in our summer. It is considered by some writers that they blow with sufficient strength and constancy to keep the level of the water on the Pacific side as high as that on the side next to the Atlantic. We thus find, in the southern summer, and of course in our winter, an area of condensation of vapour towards which winds blow from all adjoining parts, excepting where lofty mountains intervene, one of them coming from the Gulf of Mexico as a north wind.

Towards certain parts of this extended area, on the eastern side of the Andes, when the sun is south of the equator, winds blow from the southern Atlantic as well as from the northern, including those from the United States and the West Indian islands; whilst other winds are blowing to parts of the western side of the same chain of mountains, from lower Peru, the central portion of the Pacific, and the Californian seas. This takes place during our winter. But in our summer the vapour from both the Atlantic and the Pacific oceans comes in greater abundance from the northern parts of these oceans, and is more largely condensed over lands that lie north of the equator; the northern summer winds therefore extend into the southern hemisphere less than the winter winds. Condensation of the vapour takes place in different latitudes over the same ridge of mountains in both seasons, producing winds in each; but in our winter they are less stormy and more continuous within the northern tropic, and pass further into the southern hemisphere than they do in the summer. The amount of vapour in the air being greatest in each hemisphere when the sun is in it, the largest quantity of the vapour is at that time condensed there. And winds blow in each part, strong in proportion to the condensation of the vapour, but they are generally more continuous when the air is drawn from a great distance, as it is in the winter from the northern tropic to the southern Andes; and more fitful, irregular, and stormy, accompanied by thunder, when the vapour is condensed either over the ocean itself or over widely-distributed elevated lands not far from the seas that furnish the vapour, as it is in the summer in Central America and the West Indian islands.

It is not however contended that the winds which have been pointed out are the only ones ever found blowing over the large spaces that have been just treated of. The numerous mountains that exist in the great chain of the Andes and in the West India islands, so various in elevation and form, and so different in their aspect, must be presumed to affect the atmosphere variously at different times and seasons, producing local winds in all conceivable directions, sometimes blowing with greater force towards one particular area of condensation and sometimes towards another. But the general directions and characters of the winds that have been pointed out, have by travellers and others been spoken of with great confidence as being well known; and they have been shown to blow towards parts remarkable for having heavy rains at the times that the winds blew. In the present state of our knowledge of the weather in this part of the world, we can speak with confidence only of that which is prevalent or usual. Exceptional cases may hereafter be inquired into by persons who reside in the parts, or who have good opportunities for making inquiries, when it may possibly be ascertained that the same causes were in operation to produce such local and temporary cases as those which have been proved to create the general winds.

A remarkable instance of the predominance of cold north wind in that part of the United States of America which is near the Gulf of Mexico, occurred in the beginning of the year 1856, particular accounts of which appeared in the American newspapers at the time, and will probably have been observed by the meteorologists of that country. It appears that at that period the whole of the portion of the United States which extends from the eastern coast of Florida to the Mexican mountains was swept by a very cold north wind that lasted above a month, and the severe cold seems to have been felt as far north as the great Canadian lakes. The *New York Herald* of the 12th February says: "On the 23rd January the river Brazos, in Texas, froze strong enough to bear a horse. The mercury at sunrise on the 25th was only 1° Fah.; on the 26th, 0°; on the 27th, 1° below zero; on the 28th, 0°; and on the 29th, 1°; and during this time a fierce wind blew from the north and north-east."—At New Orleans: "For thirty days we have been visited by almost uninterrupted frost. The ice remains in the streets; the portion melted by the sun during the day is again solidified at night."—The *San Antonio Texan* of the 24th January says: "The cold weather has lasted thirty-two days; the thermometer has been 14° below the freezing point."—At Nashville: "The thermometer on the mornings of the 23rd and 24th January was down to zero or below." Many other places are named as experiencing similar weather in the southern part of the States.

Though this cold weather is described at great length in the newspapers, which assert that it did much damage in the country, no attempt is made to account for the great departure from the ordinary cold of their winters, or to suggest any course of inquiry into the particular cause of it. But afterwards we have the following statement given as ordinary mercantile news in the *New York Herald* of February 20:—"The *Quaker City* left Mobile February 5th. Crossing the gulf she had a continuous gale of wind from the southward and eastward, with heavy rains. Remained twenty-four hours in Havana. From Havana we learn that the constant rainy weather is fast destroying all hopes of a large sugar crop from Cuba,—the pressed cane will not dry." It appears, therefore, that during the month of January, when north winds were blowing over the United States, and bringing a temperature below zero to the southern parts, there must have been continuous heavy rains falling in the island of Cuba, which is situated south of Florida, and therefore in the quarter towards which the wind blew. The island is large, and the mountains in it are rather lofty; there might consequently be enough of condensation of vapour (brought from the tropical Atlantic) taking place in it to create a vacuum sufficient to allow air to pass freely towards it from the north. If we had registrations of the movements of the barometer in the parts where the rain fell, they might throw some light on the subject. Yet the long-continued winds coming from a great breadth of country to the north are indications that large amounts of vapour had been condensing at the time in more southern places than Cuba. This is rendered something more than probable by the following account which appeared in the same newspaper of the 12th of April:—"Belize, March 5: From the 1st January we have had heavy rains, and much thunder and lightning, gales from the north succeeded by gales from the south;—there has not been such a time of it in the recollection of our oldest inhabitant."

From these various statements, and in the absence of more information, we may infer from some combination of circumstances which we are unable to trace, that about the beginning of the year 1856 a large amount of vapour passed from the tropical Atlantic over the Caribbean sea, but instead of going forward to a more southern latitude on the eastern side of the Andes, as it usually does, was condensed against the mountains of Cuba and Central America, creating in those parts such vacua in the atmosphere as enabled cold air from the United States to rush southward during the month of January, as described in the newspapers. Winds, in the winter, generally blow from the United States to southern parts, determined, it is to be presumed, by ordinary condensation of vapour in the usual places at the season; but in January 1856 this condensation appears to have taken place to an unusual extent in localities well situated to allow north winds to rush to them from the States.

If the view here taken is admitted to be substantially correct, it obviously becomes desirable that, whenever very cold north winds blow in the winter from the United States of America to the Gulf of Mexico, inquiry should be made by meteorologists respecting the weather that prevails at the time in countries to the southward towards which the wind blew; when it might be discovered that the northern wind was produced by condensation of vapour in the south; and that the vapour which generally exists in great abundance in the locality, by its condensation determines winds to blow towards the part on extraordinary occasions, as well as from nearly all sides during both winter and summer.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.[1]

Twenty-seventh Annual Meeting, held in Dublin, 1857.

[Concluded from page 337.]

SECTION G.—MECHANICAL SCIENCE.

On Fused Wrought Iron. By E. RILEY, Dowlais Ironworks.

The fusibility of wrought-iron and its properties is a subject upon which little has been written: some even doubting its fusibility. The following experiments were made to determine its properties.

First,—Black plate from tin works, was cut in pieces about ⅜ths of an inch square, covered with the cinder from an old iron assay, placed in a wind furnace with a strong draught for two hours. The iron was perfectly fused, and formed a smooth even button (weighing 1638 grains) under the cinder, which was of a dark green colour. On attempting to cut it with a cold chisel it broke with a very crystalline fracture, in the direction of the planes of cleavage of the crystals. The pot was taken out hot, and allowed to cool on an iron plate. Half of the button was worked out by a smith into a bar ¼-inch square. The iron was very soft, and had a fine face and sharp even edges like steel; two pieces were welded together,—whilst at a welding heat the iron worked very well; on cooling to a red heat it became very cracky, and broke; the fracture of the iron not exposed to a welding heat was very silky, and it was readily bent back double without cracking—the smith stating it was some of the toughest iron he ever worked. This experiment was repeated, and another with 7 ounces of black plate, part of which ran out of the pot; the properties and character of the iron were precisely similar to those above detailed. In the second experiment shale and lime were used to form a cinder.

An experiment with the best $\frac{7}{8}$-inch cable bolt (very fibrous). This bolt was cut in small pieces whilst hot, varying from ¼-inch to ½-inch long; and 8 oz. of bolt, 5 gr. red ore, 300 gr. lime, and 260 gr. mine shale, were placed in a pot. In two to three hours the fire burnt down, the pot was taken out hot, and cooled on an iron plate; the iron was perfectly fused and covered with a dark green cinder, the button being very smooth, and free from cavities; on trying to break it with a blunt tool, the button being laid hollow, it broke in several directions, all being planes of cleavage of the crystals, which extended through the button, and had the appearance of galena. The properties of this iron were precisely similar to the fused black plate, viz., very tough and fibrous when worked cold, in this respect working very similar to copper. The smith, after having welded two pieces together, could not work it after it had cooled to a red heat, as it invariably cracked and broke to pieces.

Six ounces of the same cable bolt were fused *per se.* The iron ran down into a flattish button, with some olive cinder at the sides; the button broke with a crystalline fracture, the crystals not however so large as in the last experiment. It worked precisely similar to the previous button, and was useless after it had been exposed to a welding heat.

Half a pound of the same bolt was fused *per se* into a flattish button, the fusion being quite perfect; it broke with a very crystalline fracture, and proved in every respect similar to the last button.

Experiments were also made with ¾-lb. and 1 lb. of the same bolt,—the iron running through the pots on the bars. On testing the burnt iron taken from the bars the properties were found to be the same as in the previous experiments. Did not succeed in obtaining a button more than ½-lb. weight, owing, probably, to the pressure of the melted iron against the soft sides of the pot. The pots used in these experiments were of Cornish clay, about 3 inches high, clay lids being luted on.

Fused Wrought Iron made direct from the Ore.—Experiment No. 1, with calcined Welsh mine; the following proportions were used:

Mine	2500
Lime	450
Anthracite	360
	3310

Weight of button, 1241 grains. The cinder was dark green, and the button quite solid; it worked exceedingly tough and soft like lead; on putting heat on the iron it cracked and broke like copper, and would not, in fact, take a higher temperature. This button was found on examination to contain no silicium, and ·29 per cent. of phosphorus. The following is an analysis of the calcined mine used:

Silica	8·38
Alumina	5·79
Peroxide of iron	76·61
Oxide of manganese	1·21
Lime	3·13
Magnesia	3·96
Phosphoric acid	0·57
Potash	0·87
Sulphur	0·06
	100·58

Experiment No. 2, on

Mine	2500
Lime	460
Anthracite	375
	3335

Weight of button, 1311 grains. The cinder was a little lighter in colour than the last; the button had a small cavity in the centre; a piece drawn out would not stand a welding heat, but crumbled to pieces like copper.

Experiment No. 3, on

Mine	2500
Lime	460
Anthracite	390
	3350

Weight of button 1333·5 grains. Cinder olive green, not very dark, with a few black wavy lines. The button broke like cast steel; one half of it was found to stand no heat, the other portion worked into a small chisel, hardened on chilling, and broke with a tolerably close fracture.

Experiment No. 4, with red ore from Lynmouth Cornham Ford lode.

Silica	1·01
Peroxide of iron	98·41
Alumina	(traces)
Peroxide of manganese	0·29
Magnesia	0·16
Phosphoric acid	0·12
Moisture	0·13
Oxide of copper	0·04
	100·16

Mixture used—

Mine	2500
Shale	160
Lime	260
Anthracite	430
	3350

Cinder dark green; iron very tough and soft, but stood no heat, and was in every respect similar to iron made in Experiments 1 and 2. The anthracite used was from Glyn Neath, and of the very best quality, being nearly free from sulphur; and to show that it had no influence on the quality of the iron, it may be mentioned that large quantities of very good welding cast steel was made from the Cornham Ford ore, this anthracite being used as the reducing agent. In some experiments on steel made from Cornham Ford ore, too small a quantity of wood charcoal was used; the result was a very dark cinder with a metallic face, and a button of very soft iron, which would not stand a welding heat, but crumbled to pieces.

An experiment was made with a small amount of binoxide of manganese, added to ½-lb. of cable bolt, with a little shale and lime to form cinder, a small portion of carbon insufficient for the complete reduction of the oxide being added. The iron was similar to that obtained in other experiments, except that it stood the welding heat a little better.

Experiments were made with iron turnings from best cable bolt mixed with fine sand from pounded conglomerate; the object being to ascertain whether the iron took silicium from the pot. Three ounces of fine iron turnings and two ounces of sand were mixed together intimately, and heated for two or three hours at a temperature sufficient to melt wrought iron. The turnings were fused into small buttons varying in size; the sand fritted together quite hard, especially at the bottom. On dissolving these buttons in hydrochloric acid, no silicium was detected; they could be readily flattened by hammering into thin plate.

Another experiment was tried by mixing iron turnings with sand and carbon: it was then found that the silica was reduced and combined with the iron, which fused into hard brittle buttons, containing from 1 to 2 per cent. of silicium (silica obtained in analysis was found to contain some iron).

The property of becoming useless after exposure to a welding heat appears from the above experiments to be a special character of fused wrought iron. The experiments have not been carried far enough to lead to any explanation of this: it may probably be due to the absence of a small portion of carbon usually present in wrought iron. In Bessemer's iron, Mr. Riley believes, there is no carbon, yet it certainly welds, but not very well. Wrought iron made directly from the ore appears to be rather worse than the fused bar or plate iron, as it crumbles to pieces when subjected to a great heat.

Mr. Riley intends continuing these experiments during the winter, and trusts eventually to be enabled to give some reason for the peculiar properties of fused wrought iron above described.

On Machinery for Lowering Submarine Telegraph Cables.

In the course of the discussion which arose on the several papers on this subject submitted to the section, Prof. Rankine said he objected to the friction-break as a means of controlling the speed of the machinery, on the ground of the impossibility of accurately adjusting or gradually varying its resistance, which is of uncertain amount, and subject to abrupt changes. He also described the machinery patented in 1855 by himself and Mr. J. Thomson, C.E., an engineer of great practical experience in laying submarine cables. Two of the chief peculiarities of that invention were, the substitution of grooved pulleys for cylindrical drums (an improvement which has been used by the Atlantic Telegraph Company), and the employment, instead of the friction break, of the hydraulic break, in which the resistance, being that of a fluid forced through a valve, can be accurately adjusted, and cannot vary abruptly. He believed that the use of the hydraulic break would prevent such accidents as that which had recently occurred to the Atlantic cable.

Mr. James Thomson, in alluding to the paper on the "Specific Gravity of Telegraph Cables," by Capt. Blakely (*ante* p. 328), said he did not concur in the view taken by the author, as he conceived that in the method proposed the cable would be apt to sink in festoons: a bend, when once formed, by its superior weight dragging down more rapidly than the parts on each side, yet horizontal, and thus the cable would have large folds, or even coils, when it reached the bottom.

During the conversation a new light seemed to break upon the Members, as it seemed to be universally admitted that it was mathematically impossible, unless the speed of the vessel from which the cable was payed out were almost infinitely increased, to lay out a cable in deep waters (say two miles or more) in such a way as not to require a length much greater than that of the actual distance, as from the inclined direction of the yet sinking part of the cable, the successive portions payed out must, when they reach the bottom, arrange themselves in wavy folds; since the actual length is greater than the entire horizontal distance. The fact, therefore, which, when noticed, led to the increasing of the strain on the Atlantic cable until it broke ought to have been anticipated, and must be provided for in the future progress of that great national undertaking.

On the Principle of the Transformation of Structures.
By Prof. Macquorn Rankine, LL.D., F.R.S.

This paper consisted of an explanation of some of the practical applications of a principle first communicated by the author to the Royal Society in 1856, viz.:—"*If a structure of a given figure be stable under forces represented by a given system of lines, any structure whose figure is a parallel projection of the given figure will be stable under forces represented by the corresponding parallel projection of the given system of lines.*"

By a "*parallel projection*" of a figure is to be understood any figure derived from the original figure by alteration of its dimensions or by distortion; subject only to the condition, that all straight lines in the original figure which are parallel and equal, shall be represented by parallel and equal straight lines in the new figure.

This principle applies to *stability* alone, and not to *strength*. It enables the properties of structures of complex and distorted figures to be deduced from those of other structures of simpler and more symmetrical figures. Thus, from the conditions of stability of a circular arch with a horizontal extrados, can be deduced those of an elliptic arch with a sloping extrados; and from the figure of an equilibrated arch for sustaining the pressure of water, which is equal horizontally and vertically, can be deduced the figure of an equilibrated arch for sustaining the pressure of earth, which is less horizontally than vertically in a given ratio.

Flow of Water through Pipes and Water Channels generally.
By John Neville, C.E., M.R.I.A., Dundalk.

He said: "A cylindrical pipe, flowing full, discharges less than the same pipe when only filled through a segment whose arc is 281°·30′ by 2·5 per cent., while the velocity is less by 9·5 per cent., the hydraulic inclination being the same. The full section discharges less, and also with less velocity, in other forms of pipes as well as in cylindrical ones. The scouring power of circular pipes, flowing full, is therefore less by nearly 10 per cent. than that of the same pipes filled through an arc of 281°·30′,—a new element to be considered in the arguments for and against circular pipe sewers."

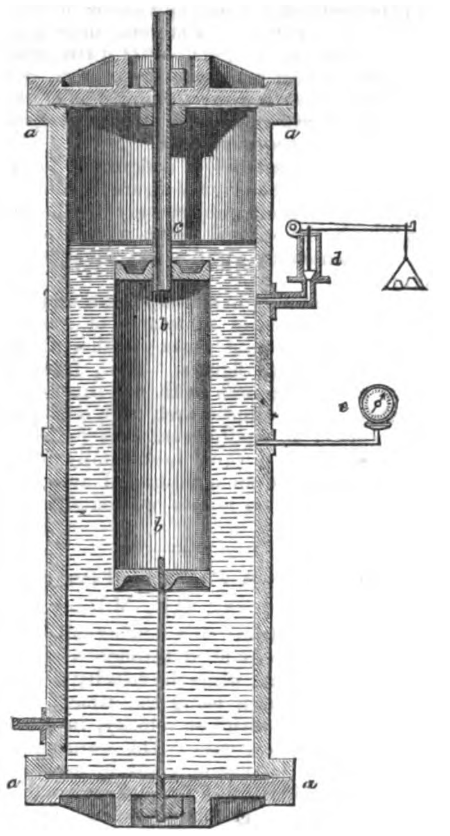
Mr. Neville also submitted a new general hydraulic formula for finding the velocity in pipes and rivers, which he had previously given in a paper read at the Royal Irish Academy, and is published in the *Journal*, Vol. XIX. (1856), p. 353.

On the Resistance of Tubes to Collapse. By WM. FAIRBAIRN.

The following experiments were undertaken at the joint request of the Royal Society and the British Association for the Advancement of Science. It is well known that the immense extension of steam power, and the consequent inducement to save fuel, has caused an increase of the working pressure, varying from 10 lb. to 50 lb., and in some cases to 150 lb. on the square inch; and this change has sometimes been accompanied with the most disastrous results. Unfortunately, our knowledge of the principles of construction has not kept pace with our desire to economise; and hence have followed the numerous and fatal catastrophes caused by boiler explosions. These lamentable and too frequent occurrences have been shown by investigation to have sometimes arisen from the weakness and collapse of the internal flues; and hence it was considered essential to institute a series of experiments calculated to establish data on which could be founded more correct and more reliable principles of construction.

In order to save space, and increase the generative power of boilers, internal flues and tubes have been generally adopted, and that without sufficient attention to the proportioning of diameter, length, and thickness, and to those laws calculated to ensure safety, on the one hand, and economy of material and judicious distribution on the other. Hitherto it has been considered as an undisputed axiom, that a cylindrical tube, such as the flue of a boiler, when subjected to a uniform external pressure, was equally strong in every part; and that the length did not affect the strength of a tube so placed. But though this rule may be true when applied to tubes of indefinitely large length, or to tubes unsupported by rigid rings at the extremities,—it is very far from true where the lengths are limited within certain multiples of the diameter, and the ends are securely fastened in frames to prevent them yielding to an external force.

In some experimental tests to prove the sufficiency of some large boilers, the author had some misgivings as to the strength of the internal flues to resist a force tending to collapse them.



In these experiments it was found that flues 30 feet long were distorted with considerably less force than others of a similar construction 24 feet long. This anomalous result led to further inquiry, which being far from satisfactory, the series of experiments recorded in the paper were instituted, with very conclusive results.

To render the experiment satisfactory, a large cast-iron cylinder *a, a, a, a*, was prepared, 8 feet in length, 28 inches in diameter, and 2 inches thick of metal. In this cylinder were placed the tubes to be experimented upon, one of them being seen in section at *b, b*, attached to the massive covers of the cylinder. A small pipe *c, c*, was screwed into the cast-iron end of the tube *b, b*, and afforded egress to the air in its interior when collapse took place. The pressure was obtained by means of a powerful force-pump, by which water was injected into the cylinder till the resisting powers of the tube were overcome. The amount of pressure was indicated by the steam-gauge *e*, and the accurately-fitted safety-valve *d*.

As the whole of the experiments are likely to be published, it will not be necessary in this brief abstract to give more than an outline of the results obtained.

Of the laws which have been deduced that which relates to the length of the tubes is perhaps the most remarkable. With tubes of similar proportions to those experimented upon, it is found that the strength varies in the *inverse* of the length; that is, other things being the same, a tube 6 feet long will support only half as great a pressure as one 3 feet long, or one-third as much as one 2 feet long, the length being measured between the discs supporting the ends. Thus in the following experiments:

Experiment.	Diameter. inches.	Length. inches.	Collapsing pressure. lb. per square inch.	
(1)	12·2	58½	11·0	11·75
(2)	12·0	60	12·5	
(3)	12·0	30	22·0	

Assuming the mean of experiments (1) and (2) to be correct we may find by the above law the collapsing pressure of a similar tube half the length; for, as 30 : 59·25 : : 11·75 : 23·2 lb. Experiment (3) gave 22 lb., a difference of about 1/18. Similarly, taking the results given in Table I., in which the tubes are of the same thickness, and 4 inches in diameter:

Experiment.	Diameter. inches.	Length. inches.	Collapsing pressure. lb. per square inch.	
(1)	4	19	170	153·5
(2)	4	19	137	
(3)	4	40	65	
(4)	4	38	65	
(5)	4	60	43	

Assuming the correctness of experiments (3) and (4), we find by the above law that the resistance of a 19-in. tube would be 133 lb., and of a 60-inch tube, 42 lb. By experiment the results were 153·5 and 43 respectively. In conducting experiments of this kind it is next to impossible to form tubes, where the joints have to be soldered and riveted, theoretically correct; and allowances must therefore be made for discrepancies which must of necessity occur in their powers of resistance to strain. It is nevertheless obvious, that after making these allowances for inaccuracies of construction, the results of the experiments approximate so nearly to the truth as to afford unmistakeable evidence that the tubes follow the same law in their resistance to collapse as a beam subjected to a transverse strain; the strength in each case varying inversely as the length.

Comparing the above experiments with the following, we shall find evidence of a second law, relating to the diameters:

Experiment.	Diameter. inches.	Length. inches.	Collapsing pressure. lb. per square inch.	
(1)	6	30	48	47·5
(2)	6	29	47	
(3)	8	30	39	

Comparing this table with the first, we find the strengths to vary in the inverse ratio of the diameters. Thus, experiment (3) above, as 6 : 12 : : 22 : 44 lb. By experiments (1) and (2), the collapsing pressure was 47·5 lb. Similarly, 8 : 12 : : 22 : 33 lb.; by experiment (3) it was 39 lb. So, taking the mean of several experiments on 6-inch tubes as a standard, we may construct the following table:

Diameter. inches.	Length. inches.	Collapsing pressure. lb. per square inch. By experiment.	By calculation.
6	30	50	50·0
8	30	39	37·5
10	30	33	30·0
12	30	22	25·0

The law which relates to the thickness of the plates is less evident, and has not yet been determined with sufficient accuracy. However, tubes similar in other respects vary *directly* according to a certain power of the thickness rather greater than the square. The index of this power is about 2·163.

The above abstract will be sufficient to show the nature and object of the experiments, and the apparatus by which they were conducted. They are still in progress, but as soon as they are completed they will be given to the public, so fully, as to enable those conversant with the subject to judge of their accuracy and value. Meanwhile, the results already arrived at point to important modifications of existing constructions, to which further attention will be directed at some future period.

The Boyne Viaduct. By J. Barton, C.E.

The chief feature of interest connected with the viaduct is, that the principles of mechanical science had been thoroughly applied in detail in its construction; that is to say, having ascertained by scientific investigation that such and such portions would be subject to a certain amount of strain, each portion of the bridge had been constructed accordingly, so that all the parts of the Boyne Viaduct are more nearly proportionate than is by many deemed necessary in works of a similar nature. Mr. Barton entered very minutely into the calculations which had been requisite to ascertain the precise amount of tensile or compressive strain that the several lines and portions of the bridge would be called upon to sustain; and went on to state that the iron employed in the construction of the bridge amounted to 740 tons, and cost about 24*l.* 10*s.* per ton complete as it stands. All this iron had been obtained from Staffordshire; those portions subject to a tensile strain were of "best best" iron, those in compression were of that termed "best" iron. The maximum amount of strain upon those parts in compression when under the testing loads was 4 tons per inch, and the tensile strain never exceeded 5 tons per inch.

Mr. Barton explained the modes in which the calculations were modified by the movement (under varying loads) of the points of contrary flexure, and explained how the absolute correctness of the calculations had been tested in a remarkable way, by actually severing the top of the main beams in the centre span at the points where theory decided there was no strain. The effect proved the perfect equilibrium of the structure. A number of experiments as to the strength of the various parts of the structure were also explained, and the paper closed by describing how theory had again been proved remarkably correct. Calculation had shown that when the centre span alone was loaded with the testing load of 540 tons, the extreme ends of the side spans should be lifted off the pier when the test was on. The fact proved so; the side spans rose one inch off the piers, and an engine traversing the side span from the centre did not bring that portion down until it had approached within 4 feet of the pier. The dimensions of the work are: height above high-water mark, 90 feet; opening of the centre span, 204 feet; and of the two side spans, 140 feet each.

A brief discussion ensued on the subject, in which Prof. Barlow and Mr. Stoney took part; and the latter observed that certain very abstruse and difficult mathematical analyses, which were necessary for the construction of the viaduct, had been made by Mr. Blood, Professor of Civil Engineering in the Queen's College, Belfast, and he hoped he would soon be induced to allow him to give a statement of his analyses to the public. Mr. Stoney contended that the difficulties and trouble of the diagonal system had been greatly magnified and exaggerated.

Mr. M'Connell said, No doubt every kind of bridge had its advantage; but where foundations could be got, his opinion was that short spans and the latticed principle answered very well; but where such was not the case, the bridge itself and the calculations of Mr. Barton showed the very successful manner in which great engineering difficulties might be overcome.

Improvements in the mode of Working Steam Engines. By Thomas Moy, London.

These improvements consist in employing a boiler formed of a continuous tube or series of tubes which communicate with and cause circulation of the heated water through the boiler jacket and valve-box, thus keeping the cylinder at the same heat as the boiler. No steam is allowed to be formed in the boiler. The necessary amount of water to form steam is measured off by a peculiar form of valve, and this water turns into steam as it enters the cylinder, working the engine expansively. No explosion or priming can occur.

On a mode of rendering Peat economically available as a Fuel, and as a source of Illuminating Gas. By J. J. Hayes.

Mr. Hayes stated that knowing nearly all the failures which had occurred in the operations upon peat had been from trusting too much to what had resulted from model experiments, he first began with a model, and then, finding the principle good, he determined upon erecting his furnaces for charcoal upon a full scale, to thoroughly prove the fact of being able to make such an article at a cheap rate. After various trials, and making the economy of labour his study, he had succeeded in producing charcoal fit for metallurgical operations, and the cheapness of which was approached by making one product obtained during the carbonisation pay the cost of the other—that is, the tar obtained from the peat will nearly pay the cost of the charcoal. The cost of the manufacture is as follows:—Two and a-half tons of peat are required to make one ton of charcoal.

	s.	d.
Peat, $2\frac{1}{2}$ tons at 2*s.* 6*d.* per ton	6	3
Fuel	0	6
Cost of charring	2	6
Royalties on peat	0	5
Patriotic royalty	1	6
Incidental expenses—wear and tear, &c.	0	10
	12	0

The tar obtained during the carbonisation, say at 5*s.* per cent. on $2\frac{1}{2}$ tons of peat, is 35 gallons, which, if sold at 3*d.* per gallon, is 8*s.* 9*d.*, leaving the cost of charcoal at 3*s.* 3*d.* only. A very satisfactory letter was read on the subject of making bar-iron for tin plate work in Wales by this charcoal.

A description of making the compound a solidified peat was given, which is as follows:—The peat, after being first dried on the bog, is ground in a mill, and then the dust is carried by a screen to a drying chamber, where it is quickly and effectually desiccated, the time for which does not exceed twenty minutes from the first delivery of the peat dust to the chambers, it then runs in a hopper over a press, (a diagram of which was given), which would turn out 1 ton per minute; block weight $3\frac{1}{2}$ lb. The invention of this press is due to Mr. C. Kingsford. The cost of the compressed peat is as follows:

			s.	d.
Cutting the peat on the bog, per ton	2	6	3	4
Lost by drying the dust „	0	10		
Cost of manufacture			1	6
Fuel			0	6
Royalties			1	2
			6	6

Philosophy of the Wave Line System. By Thomas Moy, London.

Mr. Moy argued that the pure wave line is the best form—treating water as subject to the same laws as solid bodies—that the duty a vessel has to perform is to turn aside two columns of water, one on each side of the keel—that the speed at which these columns are turned aside constitutes the chief element of calculation; and he exhibited plans of five vessels, each of which would put these columns of water in motion at 176 feet per minute, or two miles an hour, while they respectively travel forward at the speeds of two, ten, twenty, twenty-five, and fifty miles an hour, the last vessel requiring 1000-horse power; and concluded by showing, that in order to drive the *Great Eastern* at fifty miles an hour the column of water would have to receive motion equal to $6\frac{1}{4}$ miles an hour.

On the importance of regulating the Speed of Marine Engines. By Thomas Silver, of Philadelphia, U.S.

The author pointed out the defects in the common Watt or centrifugal governor, which was affected by the pitching of the ship in such a manner as to become almost useless under certain circumstances. Hence the necessity of some efficient means of limiting the action of the marine engine to the speed that its strength will bear has been heretofore one of the great wants of marine engineering, and deprives the steamship of many advantages that are its due. Having mentioned several instances in which vessels were wrecked and many lives lost solely from the action of the machinery, which could have been controlled by a proper governor, he stated that the U.S. steamer *Atlantic* had been running for two years past with the attachment of a form of governor which he had invented, and had not broken anything; and the officers of that ship had frequently stated that they could save two or three miles an hour by following seas by the use of this instrument. This had been proved to be the case by the fact that her eastern passages for the year 1856 were on an average each five hours shorter than those of the *Baltic*, which is known, when under the same circumstances, to be the faster ship. The paper then continued:—"The screw (and it will soon be the only plan of steam propulsion over the ocean) increases the demand for some practical improvement in the marine engine that will facilitate the proper application of the steam under all circumstances; and I therefore wish to explain a plan of governor the action of which is as analogous to the old centrifugal governor as the spring-balance of a watch is to the pendulum of a clock—the watch being rendered by that improvement quite as valuable for preserving the uniformity of time, whether in our pocket on a fast trotting horse, or under the pillow; whilst the clock must be confined to a fixed position, and this is attained on similar principles, differing in fact only in mechanical arrangement to make it applicable to governing the flow of steam—that is to say, in the governor which is now submitted to the section, the arms of an ordinary centrifugal governor, each extended to an equal distance beyond their axis of motion, and loaded at their four extremities with balls of equal weight, perfectly balancing each other. Thus the influence of the force of gravity is entirely evaded, and a spiral or reacting spring is substituted to resist the centrifugal force in the action of the instrument, each loaded arm oscillating in an opposite direction to the other, which serves to keep each of them at equal angles with the spindle that bears them. Hence the instrument will not only work with equal facility in any position, whether fixed, horizontal, perpendicular, or angularly, but it also can be thrown about at pleasure without affecting the truthfulness or sensitiveness of its operation; and as its centrifugal force is resisted mechanically, instead of by the force of gravity as in the ordinary governor, we can increase its powers of action to any extent; so also we can increase the force of the spring, and thus more nicely and readily effect the same object. This fact, connected with the driving point being in the centre of the rigid arms that bear the weight, renders the instrument extremely sensitive and quick in action. It is now applied for regulating stationary engines employed for driving metal rolling mills, printing presses, and in numerous other situations where the machinery had been entirely uncontrollable by the best forms of governors previously tried."

Proceedings of Various Sections.

On the Direction of Gravity at the Earth's Surface. By Professor Hennessy.

If the earth's surface be considered to coincide with that of the liquid which covers three-fourths of the entire spheroid, gravity should be considered as perpendicular to it at every point. If, however, the earth were stripped of all its seas and oceans, the surface would present considerable inequalities. From what is now known regarding the depth of the ocean, the continents would appear as plateaus elevated above the oceanic depressions to an amount which, although small compared with the earth's radius, would be considerable when compared with its outswelling at the equator and its flattening towards the poles. The surface thus presented would be the true surface of the earth, and would not be perpendicular to gravity. If a kind of mean surface be conceived intersecting this, so as to leave equal volumes above of elevations, and of depressions below it, it is not allowable to assume that such a suface is perpendicular to gravity. The mean surface of the solid crust of the earth would not be perpendicular to gravity, if, after the process of solidification had commenced, any extensive changes in the distribution of matter in the earth's interior could take place. If the fluid matter in solidifying underwent no change of volume, the forms of the strata of equal density within the earth would be the same at every stage of its solidification. But if, as observation indicates, such fused matter on passing to the solid crystalline state should diminish in volume, the pressure on the remaining strata of the fluid would be relieved, and they would tend to assume a greater ellipticity than they had when existing under a greater pressure. The general result of this action would manifestly be to produce a change in the direction of the attractive forces at the outer surface of the solid crust. The direction of a plumb line would be slightly altered so as to slightly increase the apparent latitudes of places over a zone intermediate between the equator and poles.

M. D'Abbadie stated several cases which he had met with, where monuments existed which showed that the direction of gravity at some former period must have been very different in relation to those particular portions of the earth from what it now was. Other members also noticed deviations of the plumb-line from its normal position, and some of them which seemed to depend on the season of the year.

Dr. Robinson stated that he was the first to direct attention to those changes of level which depended on the season of the year. This he was led to observe from the fact that the entire mass of rock and hill on which the Armagh Observatory was erected was found to be slightly, but to an astronomer quite perceptibly, tilted or canted at one season to the east, at another to the west. This he had at first attributed to the varying power of the sun's radiation to heat and expand the rock throughout the year; but he since had reason to attribute it rather to the infiltration of water to the parts where the clay, slate, and limestone rocks met in their geological arrangement. The varying quantity of this through the year, he now believed, exercised a powerful hydrostatic energia, by which the position of the rock was slightly varied.

Secular Variations in Lunar and Terrestrial Motion from the Influence of Tidal Action. By Mr. D. Vaughan, of Cincinnati, Ohio.

Laplace concludes from his elaborate investigations that the rotation of the earth is not affected by the occurrence of the tides; nor do his formulæ reveal any permanent alteration in the motion of the lunar orb which disturbs the repose of our oceans. These results, announced by so high an authority, might be received without a careful examination if the fundamental principles of natural philosophy did not discountenance the idea of an actual creation of power by lunar attraction. The tides constitute an important mechanical agent; and, could their whole force be rendered available, it would be found adequate to several hundred times the labour of the human population. So great an amount of motive power, whether appropriated to the great purposes of nature and art, or wasted in overcoming friction, cannot be produced without some expense; and my present object is to trace the change which it involves in the motions of the earth and the moon.

As the extreme disproportion between the momentum of the oceanic waters and that of the planetary bodies is the chief source of error in these investigations, I shall commence by showing how the tidal action should operate, if the moon moved round the earth in an exact circle, situated in the plane of the equator, and not more than 34,000 miles in diameter. Her periodical revolution in this case would occupy nearly twelve hours, and the lunar day would be about twenty-four hours in length. The tidal action on the seas nearest the moon would be almost twice as great as on those most distant; the former being about 5000 times, and the latter over 2500 times, the disturbing action now exerted by the moon on the watery domain. The aqueous appendage of our planet would, in this case, form two great moveable oceans, sustained on its opposite sides by the attraction of our satellite, and keeping pace with her movements. Without taking into consideration the oscillations of the solid part of the earth which might possibly occur in these circumstances, it is evident that there should be a general flow of the waters from west to east; and though the current may be alternately reversed in deep channels, the force propelling it in an eastern direction should always maintain the ascendancy. A vast body of water, circulating around the earth from west to east, could not fail to accelerate its rotary motion; although the result would not be exhibited by the formulæ of Laplace. The moon, in this case, would sustain a loss of momentum to a more considerable extent. It is well known that the attraction of mountains modifies the direction of terrestrial gravity in their vicinity; and that a plumb-lime on that part of the equator immediately west of the Andes would be slightly deflected to the east. In the case we have supposed, the direction of terrestrial gravity would experience a similar deflection at places in conjunction with the moon; from the attraction of the excess of waters which swelled behind her. Accordingly the lunar orb would be drawn, not directly to the earth's centre, but always to a point a little westward of it, and a constant loss of motion would be an inevitable consequence. It would be different if the earth could preserve an invariable form; for in that case, its attraction on a satellite being always directed to the centre, or alternately deflected east and west of that point, the loss and gain of motion should be evenly balanced after one or many revolutions. Other investigations lead to the same conclusion. A satellite revolving just beyond the confines of our atmosphere would alternately accelerate and retard the movements of one more distant; and physical astronomy shows, that in our planetary systems a like periodicity results from the inequality of the times in which the several planets perform their revolutions. But as the tide-wave rolls around the earth with the same mean angular velocity as the moon, their mutual action will not exhibit the periodicity which characterises planetary disturbances. In the analytical solution of this problem, the equation depending on the difference of motion of the moon and the tide-wave would acquire by integration a divisor infinitely small; and this proves its secular character. If Laplace finds no such divisors, it is because all the modifications in the action of the moon on the waters of the ocean are not embraced in his investigations on the subject.

Leaving the supposed case, we shall now pass to the actual condition of the agencies concerned in tidal phenomena on our globe. At her present distance the revolution of the moon occupies more time than the earth's period of rotation; and the tidal wave which has the greatest disturbing influence being always east of our satellite, must add to its velocity, while it retards that of the earth. We may remark, however, that the additional velocity imparted to the moon would give her a larger orbit, and increase the period of her revolution. Hence the orbital motion of the moon, as well as the rotary motion of the earth, sustain a loss depending on the difference of the tidal force on opposite sides of our globe, and so very insignificant, that some millions of years would be required to cause a reduction of 1 per cent. in the momenta of these vast bodies. I must, however, question the results of Laplace, who finds that the change in the length of the day has not amounted to one hundredth part of a second during the last 2000 years. This conclusion is based on a comparison of ancient and modern eclipses; and the time of the earth's rotation is thus ascertained from the revolutions of the moon, making corrections for the distubances operating on the latter body. But all the disturbing influences have not yet been taken into consideration; and as the one noticed in the present paper operates on the earth and moon, we cannot regard either of these bodies as an infallible chronometer for measuring the vast ages of eternity.

On the Influence of the Gulf Stream on the Climate of Ireland. By Prof. Hennessy.

He showed on a large map of the British Isles the isothermal lines, or lines indicating the equal degrees of temperature; and these ran, not horizontally in the direction of the parallels of latitude, as might be expected, but in curves almost concentric, and following very nearly the windings of the coast. These curves were laid down from the results of a long series of observations on the climate and temperature, by Dr. Lloyd, the President of the Association; and one of these results, founded on a series of both day and night observations, was, that the mean temperature of the sea off the west coast of Ireland was four degrees higher than the main temperature of the land. All these facts were explained by the phenomenon of the Gulf-stream, or warm current of water, which, as was well known to navigators, flowed from the Gulf of Mexico in the direction of this country and the north-west coast of Europe. That current of water, heated in the warm regions where it commenced, exercised its influence very sensibly on the atmosphere, raising its temperature, and charging it with vapours which were known to give out a certain amount of heat. In Dr. Wilde's historical 'Report on the Diseases and Cosmical Phenomena of Ireland,' presented with the census returns, they read of several extreme changes of temperature having taken place in remote ages in this country; and those might have been caused by the temporary deflection or deprivation of the Gulf-stream, arising from some perturbation in the tropical regions, and leaving this country for the moment in the same position it would be in if no Gulf-current existed.

On the Variation in the Quantity of Rain due to the Moon's Position in reference to the Plane of the Earth's Orbit. By C. Fulbrook.

The author called attention to an important difference in the amount of rain which falls in these latitudes at opposite parts of the moon's course with reference to the plane of the earth's orbit; —a result obtained by placing horizontally (from the daily register of Howard, in the vicinity of London) the amount of rain (when any) due to each day throughout a lunar course,—and so on for 100 courses in due order. The following table exhibits the result:—

Position of the Moon with reference to the Plane of the Earth's Orbit in its connection with the Rainfall of London and its vicinity, as deduced from a Register of the Weather during 100 courses of that Luminary.

Position of the Moon.	Days.	Amount of Rain.
In greaetst South Latitude.	1	
	2	
	3	
	4	
	5	47·60 inches in 500 days.
Ascending through Plane of Earth's Orbit.	6	
	7	
	8	
	9	
	10	
In	11	
	12	
North	13	
	14	
Latitude.	15	
	16	
	17	
	18	
Descending through Plane of Earth's Orbit.	19	26·42 inches in 500 days.
	20	
	21	
	22	
In	23	
	24	
South	25	
	26	
Latitude.	27	

This effect the author supposes to be due to alternate southerly and northerly currents depending on the ascent and descent of the moon through the plane of the earth's orbit. Be this as it may, it is reasonable to infer that when she is thus in some way producing an excess of rain in these latitudes, comparatively dry weather obtains in corresponding southern latitudes, and *vice versâ*; and that intermediate latitudes experience an intermediate degree of the effect. Meteorologists of other latitudes and distant countries, who may possess a register of the weather extending over 100 courses, or about 7½ years, should try the result for their respective latitudes, and transmit their conclusions to the author.

On Illuminating Peat Gas. By R. L. Johnson.

He stated that it is now nearly half a century since a Parliamentary Committee appointed by government to report on Irish peat named the town of Sligo and the hill of Howth as the extreme points of a straight line, and Galway and Wicklow Head as the extreme points of another straight line, between which two straight lines lay 6-7ths of all the peat in Ireland, the remaining 1-7th being distributed in other localities on either side of these lines. Having named the different localities where peat is distributed, the total amount of which in acres appears to be three millions, Mr. Johnson entered into a detailed description of the mode by which he obtained illuminating gas from common peat or turf, which he produced by the double decomposition of the constituents of the peat. He stated that works for the production of the gas have been erected, and are in actual operation in two places in Ireland. The gas produced was good, and its cost, as stated to him by a gentlemen who was using it, less than 2*s.* per 1000 cubic feet. He stated that from one single pound weight of common peat an hour's light may be produced; and that its cost being so very small it should ultimately be extensively used throughout Ireland, and in its production there was one-third of charcoal.

On some Facts connected with Slaty Cleavage and Foliation. By Mr. Sorby.

Mr. Sorby stated some other conclusions which have presented themselves to his mind regarding the ultimate structure of slate rocks, showing that two orders of structure are detected by the microscope: one referable to pressure on a plastic, the other to pressure on a partly rigid body. He mentioned the systematic presence of mica, varied by quartz, in certain slates, and stated his view of the origin of these two minerals by metamorphism from felspar clay. Experiments on the effects of pressure on plastic and rigid materials were given, and a tabular view of two varieties of structure due to pressure and metamorphism on rocks originally not essentially dissimilar.

On the Relation between the Cleavage of Minerals and the Cleavage of Rocks. By Professor King.

The principal conclusions are that mineral cleavage is a superinduced structure, the same as rock cleavage; and that rock cleavage is due to the same law, modified, that produced mineral cleavage. As regards what has often been termed slaty cleavage he considers that there are two kinds—a true and a false one; and he has come to the conclusions, that true slaty cleavage is ordinary rock cleavage, effected by compression applied perpendicularly, or nearly so, to the planes of the latter; and that false cleavage is simply due to pressure applied laterally to the horizontal direction of the planes.

On Improvements in Grove's Battery. By G. J. Stoney.

He first exhibited a few cells of Grove's battery in the ordinary way in which the plates of zinc and platina are arranged; if any accident occur to any one cell or plate it cannot be removed from the battery without taking down, cell by cell, the whole system that precedes it. Much inconvenience also is experienced from the fuming of the acids when the operator has finished his day's work, and in taking the plates in the ordinary maner each out of its place and dipping it into water. In the improvement which Prof. Stoney has devised, stout iron wires are bent into the form
123 To 1 and 2, plates of zinc are soldered, and to 3 a plate of platina, and so on with each of the rest of the elements. He had feared there would be much difficulty in soldering the platina plate to the bend of the iron wire 3, but it was found not to be so, as upon dipping the iron into chloride of zinc and then laying the platina plate against it, it was found that the soldering iron, with a small globule of solder, made a perfect joint along the entire extent. To prevent any chance contact of the wire 3 with 1 or 2 of the next element, a little cylinder of gutta-percha was put over each of these wires 3 which carried the platina plate. In putting the elements of the battery together, the platina plate 3 of each element was simply inserted between 1 and 2 of the next element, and so on throughout, and each element was then perfectly distinct from every other, and could be taken out or put in, or the cells belonging to it re-arranged as to charge of acids or otherwise, as occasion might arise, without interfering with the rest. When it is desired to stop work, the whole of the formed wires, with the zinc and platina plates attached to them, are lifted together out of their cells by an oblong mahogany frame, one side of which slides in a groove, so that the sides at first are at a sufficient distance to go over the entire system of 's; one side of the frame is then brought under one line of the bends of the wires, and the moveable side is then pushed in so as to come under the bends on the opposite side; the entire frame is then lifted with all the plates at once, and they are all plunged together into a trough of water placed near. Thus the fuming is almost entirely avoided.

A Theory of the Grand Currents of Atmospheric Circulation. By J. Thomson.

As this theory is intended to form the subject of a paper soon to be submitted to the Royal Society, a brief exposition of Mr. Thomson's views, and of the chief point of novelty of his theory, will suffice for publication at present. It has been ascertained as a matter of observation, that in latitudes extending from about 30° to the poles, the winds, while prevailing from west to east, prevail also in directions from the equator towards the poles. Now this motion towards the poles appears not to have been hitherto satisfactorily explained. In fact, it is the contrary motion to what is naturally to be expected when the theory of Halley, which was given about the year 1686, and which appears to afford the true key to the explanation of the trade winds, is followed up with respect to the circulation of the air in other latitudes than those in which the trade winds occur. According to this theory so applied, it would naturally be expected that the air, having risen to the upper regions of the atmosphere in a hot zone at the equator, should float towards the north and south polar regions in two grand upper currents, retaining, as they pass to higher latitudes, some remains, not abstracted by friction and admixture with the currents below, of the rapid equatorial motion of about 1000 miles per hour from west to east, which they had in moving with the earth's surface at the equator. Also, it would be expected that the air in the polar regions should have a prevailing tendency to sink towards the surface of the earth, in consequence of its increased density caused by cold; and that it should tend to flow from the polar regions along the surface of the earth, towards the equator, with a prevailing motion from west to east in advance of the earth, until, by friction and impulses on the earth's surface, the motion in advance of the earth, brought from above by the air in its descent, and communicated further to it by friction and admixture from above as it passes to lower latitudes than its places of descent, is exhausted; or, in other words, until it reaches the latitude in which the trade winds commence to blow from the east, and until it has communicated, in blowing from west to east on the earth's surface, a torsional force to the earth, just sufficient to balance the opposite torsional force communicated to the earth by the trade winds blowing from east to west.

Now this theory, obvious as it appears in the form adduced, is found in one essential point to be controverted by observations. This point is what was stated in the outset of the present article, namely, that the prevailing winds on the surface of the earth in latitudes higher than 30° are, while blowing from the west, as should be expected, found to blow more towards the poles than from the poles; and thus do not move as if impelled along the surface of the earth from polar to equatorial regions by an augmented pressure due to a condensation by cold in polar regions, and a diminished pressure due to rarefaction in the equatorial regions.

Observations being thus at variance with the only obvious theory proposed, the circumstance in question has been commonly regarded as rather paradoxical; and Lieut. Maury, one of the most recent writers on the subject, has, in his much-valued treatise on the 'Physical Geograpy of the Sea,' found himself forced into supposing an entire reversal in latitudes above 30°, of the great circulation just described. Mr. Thomson regards Lieut. Maury's supposition as being entirely unsupported by the known physical causes of the atmospheric motions. He, on the contrary, maintains that the great circulation already described does actually occur, but occurs subject to this modification, that a thin stratum of air on the surface of the earth in the latitudes higher than 30°—a stratum in which the inhabitants of those latitudes have their existence, and of which the movements constitute the observed winds of those latitudes—being, by friction and impulses on the surface of the earth, retarded with reference to the rapid whirl or vortex motion from west to east of the great mass of air above it, tends to flow towards the pole, and actually does so flow, to supply the partial void in the central parts of that vortex, due to the centrifugal force of its revolution. Thus, it appears that, in temperate latitudes, there are three currents at different heights:—that the uppermost moves towards the pole, and is part of a grand primary circulation between equatorial and polar regions;—that the lowermost moves also towards the pole, but is only a thin stratum forming part of a secondary circulation;—that the middle current moves from the pole, and constitutes the return current for both the preceding;—and that all these three currents have a prevailing motion from west to east in advance of the earth.

This is the substance of Mr. Thomson's theory; and he gives, as an illustration, the following simple experiment:—If a shallow circular vessel with flat bottom, be filled to a moderate depth with water, and if a few small objects, very little heavier than water, and suitable for indicating to the eye the motions of the water in the bottom,* be put in, and if the water be set to revolve by being stirred round, then, on the process of stirring being terminated, and the water being left to itself, the small particles in the bottom will be seen to collect in the centre. They

* A few tea-leaves taken from a teapot will suit the purpose well.

are evidently carried there by a current determined towards the centre along the bottom in consequence of the centrifugal force of the lowest stratum of the water being diminished in reference to the strata above through a diminution of velocity of rotation in the lowest stratum by friction on the bottom. The particles being heavier than the water, must in respect of their density, have more centrifugal force than the water immediately in contact with them; and must, therefore, in this respect have a tendency to fly outwards from the centre, but the flow of water towards the centre overcomes this tendency and carries them inwards; and thus is the flow of water towards the centre in the stratum in contact with the bottom palpably manifested.

ON SUPERHEATED STEAM.*

By Thomas Prosser, C.E., New York.

The subject of superheated steam is far from being a new one; but inasmuch as another of those oft-recurring efforts to which an imperfect knowledge of the physical laws which govern it is now being made, I have ventured a few *more* words of advice,† in the hope of staying the delusion somewhat, to prevent a useless expenditure of time and of money, with a *fearful sacrifice of life itself*, which must inevitably result from the extensive adoption of superheated steam produced in the manner generally contemplated.

The superheated is probably the only state in which steam should be admitted into the cylinder of a steam-engine, for the purpose of fully developing its mechanical effects in the most economical manner, provided that it can be done without increasing the danger which necessarily attends its use in any state.

Instead of superheated, however, the subject has been treated more like supernatural, for if the *gain* (that is the term applied) observable when steam is so used is really attributable to it as the primary cause, we have an effect from a cause which is in no way adequate to its production, so far at least as our knowledge of the physical nature of steam extends. The effect, therefore, is supernatural.

It would be no difficult task to show the delusion under which the experimenters themselves have laboured in all those cases which are relied upon to prove the enormous *gain* obtained by using superheated steam; but it would be an endless repetition. I prefer therefore to state what we do know, if any reliance is to be placed on the experiments of Regnault and others, viz.,—that all dry gaseous bodies are expanded nearly alike by the absorption of the same total amount of heat, and that there exists no reason whatever for supposing that steam acts otherwise when superheated.

There is no dogma better supported by inductive reasoning than this, as a physical fact, for although there are no experiments which entirely agree with it, the differences are so small as to be within the possible errors of experiments of so much delicacy. At all events, even the experiments themselves, however selected, do not justify the claims set up in favour of surcharged steam, hot air, carbonic acid gas, alcohol, or ether, and the failure of all of them points to the one same cause.

If steam is an exception to the general rule, we have no reliable experiments which prove it, for those which have been supposed to do so are of no value whatever.

The solution of the difficulty is simply this : superheating the steam prevents its condensation in the cylinder, and therefore avoids a loss; that is all which it can do,—and enough too, for that loss is so enormous, that the advocates of the air-pump condenser are compelled almost to ignore it, or to acknowledge this new "spirit" of evil and of error. Of evil, because of the extreme danger attending its production; and of error, because aiming at the curing of an evil, instead of preventing its existence, for, says the good old proverb, "Prevention is better than cure."

When we reflect upon the fact that the air-pump which is used to exhaust receivers in the production of ice, and the air-pump of a steam-engine condenser, are of precisely the same character, need we surprised (or should we not be surprised if it were otherwise) that a chilling effect is produced upon the inside of a cylinder at a high temperature, and ever exposed to its influence? Surely, the steam which comes in contact with the cylinder and piston must be condensed, and to some extent lose its mechanical power. That the interior as well as the exterior surface of the cylinder has to be warmed, is self-evident, but there is a vast difference between doing it by the condensation of the steam, at a time when it should be exerting its utmost mechanical effect upon the piston, and doing it through the medium of the superheat, while the steam itself is left in full power, uncondensed.

Superheated steam therefore prevents waste, but the processes by which it is generally proposed to superheat it are attended with imminent danger, not only on account of the rapid corrosion of the metal in contact with the steam while being superheated, but also on account of the great immobility of the particles of steam when so superheated, and their low additional specific heat, which prevents absorption as fast as the metal will allow the heat to pass, and thus renders it liable to become red hot.

Now, expanding high-pressure steam before admitting it into the cylinder has precisely the same beneficial effect in preventing condensation, and is not attended with the danger of superheating: but then comes the bugbear of *wire-drawn steam*. Now, what does it matter if the steam is throttled, provided we get all the power required from it? If *none* is condensed in the cylinder, all the power in the steam has been utilised. The dense steam will not cost more to make in proportion to its value than any other less dense.

Steam at 200° C. has a pressure of 15·38 atmospheres, and its *total heat* amounts to 667·5° C. according to Regnault. By throttling so as to wire-draw it, as it is called, it assumes the state of *superheated* steam, in consequence of having more heat than is contained in normal steam when so expanded, while at the same time it is deficient of water or density. Supposing it has retained its original amount of *total heat* without any cooling excepting that occasioned by expansion to four times its volume, the temperature will fall from 200° C. to about 158·3° C., while the density and pressure will be one-fourth of the original steam. Clearly this must be *superheated steam*, for normal steam has no such proportions as we have assumed between its total heat, density, and pressure. But allow this expanded steam to cool down to the point of deposition, which is about 140° C., and pressure 3·576° C., and the same authority as before quoted will inform us that the total heat in such steam is but 649·2° C., having lost 18·3° C. (= 667·5 − 649·2) of total heat by the reduction of its temperature from 200° C. to 140° C. (= 60 per cent.) This loss of total heat, which must go into the metal of the cylinder and piston before any condensation can take place, amounts to about 1 36th of the total heat contained in the steam before expansion, and is abundantly sufficient to prevent any condensation in the cylinder, working with ordinary and *further* expansion.

The mechanical effect of the expansion between the boiler and cylinder is lost, but not more so than if it had never been created, since it costs no more to produce high than low pressure steam. The same weight of fuel will evaporate the same weight of water under all pressures, and therefore, the hotter the water is, the more rapidly and effectually will it abstract heat from the fuel, for it really contains more of it; and as the fuel is the only source of supply, there must be greater economy in burning it under hot than cold water;—and this agrees with Leslie's experiments, which show that water at the boiling point abstracts heat five times more rapidly than it does at the freezing one.

Of course the boiler must be stronger in proportion to the elasticity of the steam to be generated in it, but that need form no objection now, as the use of cast-steel instead of iron will fully compensate for the difference. Cast-steel boiler plates are now being used by the English government, and it is to be hoped that this element of safety will ere long be adopted by our own, for with this material a boiler can be made which *cannot* be burst by mere steam pressure. The author has one of iron which he thinks may claim the same immunity—at all events, he is willing to test it against any other in the United States.

Although, therefore, there are no objections to the making of this high-pressure steam, there are some to the using of it, without *letting down*. In the first place, it may blow off the cylinder cover of a good many engines such as are now built, if it did not burst the steam-chest before reaching it, or even the cylinder itself. In the second place, it may burn up hemp packing, for the temperature is greater than any cooking oven (200° C. = 392° Fah.), although not half so hot as air and surcharged steam has been *done at*.

* From the 'Journal of the Franklin Institute.'

† A paper bearing on this subject, entitled "a New Method of Applying and Condensing Steam," by the same author, appeared in the *C. E. and A. Journal*, Vol. XIX. (1856), p. 236.

Nevertheless, if high-pressure steam is required in the dry state, it can be obtained with safety and simplicity from a multitubular boiler, similar to the one which supplied steam to the fire-engine exhibited in the Park some time since, which raised steam from cold water in five minutes from the time of lighting the fire, in the regular, safe, and honest way, with the tube-plate sufficiently covered by the water, and not in that extremely dangerous manner which many others do it, by first heating the metal to almost a red heat, and then projecting the water upon it. The steam from this fire-engine boiler has moreover, after having been at work some time, left the exhaust-pipe and *heater* perfectly dry.

The proportions of such a boiler as will give the required results, appear to be about 1 foot of grate to 60 or 70 feet of recipient heating surface, of which at least one-third should be above the water-line and in among the steam for the purpose of drying it through the medium of the hot gases after they have passed through the water, and have become sufficiently cooled to be used with safety for that purpose. These are equal to the best locomotive boiler proportions, but the application is very different, as the boiler is upright, and the uptake is immensely expanded just below the water-line at the instant the gases are in a state of intense ignition.

I have stated nothing in this communication but simply physical facts, and yet I know very well that a majority of engineers of the present day will condemn them as heretic, and probably knock them on the head with the sledge-hammer of *practical experience.* "If you are right," said one of our most eminent engineers, "we are all wrong." Even so. But *truth*—ah!—*will prevail*; which I intended to prove by some poet, but having forgotten his poetry, will merely reiterate, *will prevail,* without however committing myself to the precise time—when.

BEAUFUMÉ'S PATENT GAS-FLAME FURNACE.

By A. Guesnet, French Admiralty Engineer, and Ch. Sochet, Director of Naval Construction, France.

In accordance with the stipulations of an agreement dated 23rd February 1856, M. Beaufumé delivered at the Imperial Arsenal of Cherbourg, a heating apparatus constructed according to a new system of which he is the inventor. This apparatus has been applied to the boiler of the Northern Forge, where the experiments of which we shall proceed to give an account, were made.

Instead of burning the fuel directly below the boiler, M. Beaufumé first transforms it into gas in a separate apparatus; and then conveys this gas to the boiler, where its complete combustion causes the generation of the steam. This separate apparatus, which M. Beaufumé terms a Gasifier, consists of a furnace constructed very like that of a locomotive, with a water-space substituted for the tube-plate. Coal is heaped upon the firebars to a considerable height, say 20 to 28 inches according to the quality of the coal. The air necessary for the gasification is supplied in suitable quantities below the firebars, by means of a blowing fan. The oxygen of the air supplied causes very active combustion amongst the lower layers of coal in contact with the firebars, converting the coal into carbonic acid gas; and this gas in passing through and amongst the upper layers, which ought always to remain black, becomes converted into carbonic oxide and accumulates in the upper part of the furnace mixed with nitrogen and doubtless hydrogen also. These gases, the temperature of which is but slightly elevated, are conducted to the boiler through a wrought-iron pipe, and enter the boiler furnace after having been thoroughly mixed, in a chamber termed the Burner, with a suitable proportion of air supplied by the blowing-fan. After having been once ignited in the boiler furnace, the gases continue to burn as fast as they are supplied. The flames produced act on the heated surface of the boiler; and the gases remaining after combustion pass through the flues and escape into the atmosphere under the pressure due to the blowing-fan, no chimney being required.

The gasifier, in consequence of the water-space with which it is surrounded, is itself a small boiler, the water in it absorbing the heat developed in the gasifying process, and utilising it by forming a considerable quantity of steam, which is added to that of the large boiler. The furnace of the gasifier is supplied with fuel through a passage in the top of the apparatus, this passage crossing the steam space and opening into the furnace, whilst it is fitted with doors or valves at both extremities, so that the fuel can be introduced into the furnace without opening a communication with the atmosphere.

A few simple and inexpensive alterations require to be made in the brickwork setting of ordinary boilers in order to adapt them for being heated by gas. The firebars being removed, a brickwork platform is constructed in their place, and on this platform a number of brickwork passages are formed, with openings arranged to allow a portion of the ignited gases to come directly into contact with the boiler surface. These passages are quite indispensable, and form what may be called a heat-regulator. They heat the gases, which arriving in too cold a state would not be completely burnt did they not come in contact with highly-heated surfaces before being ignited.

The benefits which M. Beaufumé proposes to obtain by means of the system the principal features of which we have described are—a very active and complete combustion, without an excessive supply of air, and always regular,—a complete consumption of smoke,—and finally a very considerable saving of fuel.

The object of the experiments made at Cherbourg has been to investigate the action of the apparatus, and to verify its economy and freedom from smoke.

The boiler of the Forge is of 12-horse power; it has a total heating surface of 167½ square feet, and when arranged in the ordinary way it has a grate surface of 12¼ square feet.

The gasifier supplied by M. Beaufumé has a grate surface of 5¼ square feet, and a depth of fuel of 27½ inches can be placed in it without interfering with its proper action. The total height of the apparatus, including the ash-pan and the space taken up by the passages through which the air is introduced below the firebars, is 11½ feet, and taking extreme external measurements the space occupied amounts to 290 cubic feet. Finally, to place the apparatus and to allow sufficient room for attending to it, a space measuring at least 10 feet by 6½ feet, is required, without including that taken up by the blowing-fan and donkey-engine which drives it. The cylinder of the donkey-engine is 3·9 inches in diameter, and the stroke 7·9 inches; whilst the maximum speed is 170 revolutions per minute with a pressure of five atmospheres, the blowing-fan being made to turn at the rate of 1000 revolutions per minute by means of a belt and pulley. The blowing-fan is 2 feet in diameter by 1 foot in width, and the pressure of the blast produced when the fan makes 1000 revolutions per minute is equal to a column of water 1·97 inches high.

The labour of the fireman attending to the apparatus consists in raising the fuel to a platform on a level with the charging passage, and in introducing it through this passage after ascertaining the height of the fuel inside by means of a rod. From time to time he must poke up the black coals lying above the incandescent mass, to prevent their arching over so as to form a hollow; he must examine how the gases burn in the boiler furnace, regulate the speed of the blowing-fan, and adjust the registers upon the various air and gas pipes; he must attend to the water supply of the large boiler, and also to that of the gasifier boiler if the water in the two does not communicate; and finally, he must clean the firebars of the gasifier more or less frequently during the day, according to the quality of the fuel employed, English coal requiring this operation twice in the day, at mid-day and in the evening. The Beaufumé apparatus requires more attention, and gives perhaps a little more trouble than an ordinary boiler: still an ordinary fireman is quite capable of attending to it.

When the boiler and gasifier are cold, that is, when the fire has been extinguished for more than twelve hours, it requires considerably more time to get up the steam than with the ordinary furnace, for it is at first necessary to work the furnace of the gasifier like an ordinary furnace to get up steam of the pressure of two atmospheres, and this requires about 25 minutes. Before that, it is not possible to set the blowing-fan in motion, nor to produce gas capable of being burnt under the large boiler. This is one of the inconveniences attending the Beaufumé apparatus; but, at the same time, when the fire in the gasifier can be kept in during the interval between working hours, as M. Beaufumé proposes, this inconvenience does not exist with a boiler working every day, and in which steam is kept up during the night, so that the donkey-engine can be started the first thing on the following morning. This is what takes place at the Forge, and it is only on a Monday morning that 15 or 20 minutes more is required to get up steam.

The Beaufumé apparatus has also another inconvenience which is felt every time the fuel is stirred. This operation necessitates the opening of small apertures for the introduction of the poker, permitting large quantities of carbonic oxide to escape, the presence of which in the boiler-house is injurious to the fireman, unless the atmosphere is renewed with sufficient rapidity.

Finally, that nothing may be omitted, we must mention certain trifling accidents which are apt to occur with the Beaufumé apparatus. These are miniature explosions, which take place on igniting the gases in the boiler furnace, when the precaution is not taken of shutting off the supply of air until the moment when the light is applied, and when in consequence the furnace and flues are filled with carbonic oxide mixed with air. There is, however, not the slightest danger attending these explosions, for the flames do not reach far, on account of the very slightly elevated temperature of the gases.

We shall now proceed to note the results obtained with the Beaufumé apparatus, and which are also appended in a tabulated form. In order to obtain a standard for comparison, preliminary experiments were made with the boiler heated by the ordinary furnace, to ascertain what quantity of steam per pound of coal could be raised under these circumstances. The brickwork was in rather a bad condition, and, as will be seen in the series No. 1 of the table, only 4·85 lb. of water were converted into steam of a pressure of five atmospheres per lb. of Newcastle coal.

In the series No. 2 of the table will be found the results obtained on applying the Beaufumé apparatus. When employing the same coal, the quantity of water converted into steam of a pressure of five atmospheres per lb. of coal, which was increased at each experiment in consequence of repeated improvements in the working of the apparatus, finally reached 8·26 lb. This figure shows that the Beaufumé apparatus realises a saving in fuel of 41 per cent. in the production of a given amount of steam. It is, however, necessary to make a deduction for the steam used by the donkey-engine driving the blowing-fan, which reduces it to about 7·8 lb., a result which still shows a saving of 38 per cent.

In these two series of experiments the production of steam was estimated by the quantity of feed-water used—doubtless a very imperfect method, but the only one at our command, owing not only to the irregularity in the amount of power used by the machinery, but also to the fact that the quantity of steam produced by the Beaufumé apparatus was far more than could be used.

During the whole of the experiments with the apparatus the consumption of smoke was complete, a very light smoke only being seen to issue from the chimney when the fuel was stirred, caused by the temporary production of an excess of gas compared with the air supplied. This smoke was almost imperceptible, and moreover lasted but for an instant.

During this series of experiments it was ascertained that the temperature of the residuary gases on leaving the flues was still sufficiently high to melt zinc; there was therefore undoubtedly a considerable loss of heat, as these gases should not have had a temperature of more than 150° Centigrade (302° Fah.) This arose in consequence of the heating surface being insufficient, and shows that the figure 38 per cent. already mentioned, whilst it represents the greatest saving that was actually obtained, is probably not exaggerated. With these results before us we may therefore expect to realise this saving, as compared with the mean production of an ordinary boiler.

The series No. 3 of the table gives the results of further experiments made with the Beaufumé apparatus, but with other than Newcastle coals. The first experiment, made with small coal, which cannot be burnt without great difficulty in ordinary furnaces, gave 7·24 lb. of water converted into steam of a pressure of five atmospheres per lb. of coal. Reducing this figure to 6·8 lb. to allow for the steam used by the donkey-engine, we find that the employment of this kind of coal in the Beaufumé apparatus still allows a saving of 28 per cent. to be realised, as compared with the quantity of coal consumed in an ordinary furnace to obtain the same quantity of steam. The second experiment, which was made with Cardiff coals, gives 8·3 lb. water converted into steam per lb. of coal, showing a saving of a little more than 38 per cent. after making an allowance for the donkey-engine; a result confirming that obtained with Newcastle coal. We had not time to repeat the experiment with Cardiff coal, but it is likely that on a second trial a still greater saving would have been shown, for it is only after several trials that the best way of working with each particular kind of coal can be determined. This Cardiff coal also seemed to behave better in the Beaufumé apparatus; it did not require to be stirred up so often, and yielded fewer ashes than the other coals, though all kinds gave much less than in common furnaces. The last experiment in this series No. 3, was made with a new kind of coal submitted for trial, and called Newall's Llanelly coal. It gave less favourable results than the other kinds, and nearly the same as the small coal. It is probable that if there had been time a better result might have been obtained.

We have said that the Beaufumé apparatus experimented with was much too powerful for the boiler of the Forge. In order to determine, approximately at least, its maximum power, it was determined to apply it to a marine boiler; and for this purpose one of the four boilers of the *Antelope* was selected, being at hand in the boiler yard, in good condition, and ready to work. This boiler was arranged by means of a little brickwork so as to be heated by gas from the Beaufumé apparatus. For this purpose the firebars were removed and replaced by a brickwork platform, arranged horizontally at a distance of 20 inches below the roof of the furnace, and on this platform were formed the heating passages furnished with apertures for the escape of the gas. The ash-pits were thus rendered of no use, and might have been dispensed with, so as to save about 23 inches in height and 114 cubic feet in space.

The results of experiments made with this boiler are given in the series No. 4 of the table. The results obtained were a mean of 9·20 lb. of water evaporated per lb. of Newcastle coal, and a maximum per hour of 1884 lb. of water evaporated with a corresponding consumption of 225 lb. of coal. The water was evaporated under atmospheric pressure in the boiler, and under a pressure of 5 atmospheres in the gasifier. The boiler was placed in the yard of the establishment, and was consequently unfavourably situated, as the air (which was more or less cold, according to the weather) caused much loss of heat from the external surface of the boiler. These various circumstances were too uncertain to admit of corrections being applied on account of them to the figures given in the table; but we think that 1969½ lb. of water per hour converted into steam at a low pressure may be considered as the maximum performance with the Beaufumé apparatus; which, supposing an evaporation of 6·6 gallons per hour to be equivalent to 1-horse power, gives 28½ horses as the maximum power.

Finally, it follows from these experiments, that 40 lb. of coal per square foot can be burnt on the firebars of this apparatus, whilst in ordinary furnaces only half this quantity can be burnt.

With reference to the evaporation per lb. of coal, which is as high as 9·89 lb., we possess no standard of comparison to enable us to appreciate it with exactitude. We have formerly obtained an evaporation of 7·2 lb. water per lb. of Newcastle coal, in a boiler of the same power and at atmospheric pressure, but this boiler was arranged so as to avoid loss from radiation. Compared with this example, the saving realised by the Beaufmué apparatus notwithstanding the unfavourable circumstances under which it was tried, was 27 per cent.

In these experiments the heat developed was utilised to as great an extent as possible, for the gases left the boiler at the low temperature of not more than 150° Centigrade (302° Fah.) The heating surface was in this case very great as compared with the quantity of gas produced; so that the closing up of several tubes, tried at the request of M. Beaufumé, who was present at the experiments, had a very slight effect; for it will be seen from the table that whilst the evaporation per lb. of coal increased as the number of tubes was reduced, this increase was accompanied by a decrease in the evaporation per hour, notwithstanding the diminished coldness of the weather.

In none of the experiments made with the tubular boiler, even when some of the tubes were closed, were the flames seen to enter freely and continuously into the tubes. This was caused, in M. Beaufumé's opinion, by the smallness of the tubes, which were only 2½ inches in diameter, and were further contracted by the ferules. We cannot be sure of this, however, for it is possible that on account of the very great size of the furnace as compared with the quantity of gas introduced into it, the latter was completely burnt before reaching the tubes. It is at the same time probable that small tubes are unfavourable to the development of flame, and that it will consequently be better that the tubes should be of large diameter as far as the flames extend, in order to insure the complete combustion of the gases, provided the hot residuary gases are made to pass through tubes of smaller diameter so as to deprive them of as much heat as possible. In an experiment made subsequent to those which have been described the flame of the gas produced in the Beaufumé apparatus was not completely extinguished after traversing a distance of 6½ feet along a tube 4 inches in diameter. This is a valuable datum for use in studying the application of this new heating apparatus to tubular boilers.

Results of Experiments.

Duration of Experiment.	Total amount of Fuel consumed.	Description of Coal used.	Water evaporated. During the experiment.	Water evaporated. Per hour.	Water evaporated. Per lb. of Coal.	Observations.
Series No. 1. The Boiler of the Forge heated by the ordinary furnace.						
H. M.	lb.		lb.	lb.	lb.	
8 30	970½	Large Newcastle	4620	543·5	4·865	
8 31	1014½	Large Newcastle	4905	561·9	4·835	
Series No. 2. The Boiler of the Forge heated by the Beaufumé Apparatus.						
8 45	908½	Large Newcastle	5640	644·4	6·21	
8 30	1058½	Large Newcastle	7110	836·5	6·71	
8 30	1021	Large Newcastle	6621	778·5	8·26	
Series No. 3. The Boiler of the Forge heated by the Beaufumé Apparatus.						
8 30	847	Small coal.	6131	875·6	7·24	
8 30	811½	Cardiff.	6744	791·8	8·30	
8 0	761	Newall's Llanelly	5518	689·7	7·25	
Series No. 4. A Tubular Boiler heated by the Beaufumé Apparatus.						
7 0	1500	Newcastle	12751	1821·6	9·035	Weather cold
5 15	849	Newcastle	7353	1400·4	8·066	Weather cold
7 15	1235	Newcastle	12218	1676·2	9·820	Weather cold
7 0	1235	Newcastle	11618	1659·7	9·407	Weather cold
6 0	1058½	Newcastle	9788	1631·3	9·245	Weather cold
5 0	1058½	Newcastle	9420	1884·0	8·897	Weather temperate
9 0	2029	Newcastle	17719	1969·5	9·038	Weather temperate
2 30	476½	Newcastle	6921	1885·7	9·898*	Weather temperate
3 45	653	Newcastle	6923	1846·0	10·600†	Weather temperate

* 36 out of 106 tubes closed. † 42 out of 106 tubes closed.

NOTE.—To reduce the quantities of water evaporated in these experiments to the quantities which the same amount of heat would evaporate from 212°, add 18 per cent. to the results of Series Nos. 1, 2, and 3, and 16 per cent. to the results of Series No. 4.

From what has been said it is obvious that M. Beaufumé's heating apparatus works with perfect regularity, is quite free from smoke, and effects a great saving. The saving derived from it as compared with the ordinary system of heating reached as much as 38 per cent. in our experiments, and there is no doubt that the very great saving of one-third may be reckoned upon with certainty.

There are no difficulties in working the apparatus, it requires perhaps a little extra care and attention, but not so much as to constitute a matter for serious consideration.

It has the advantage, above all, of being able to use economically fuel of a kind which can only be burnt in ordinary furnaces with great difficulty, such as small coal.

It has the inconvenience of throwing a quantity of carbonic oxide into the boiler-house; which, although not of much importance on land, might be serious on board ship. This defect is less the less frequently the fuel is stirred up, and with Cardiff coals it scarcely exists, as they do not require stirring up. We must also remark, that although M. Beaufumé's apparatus has reached a practicable state, it is still too recent an invention to be incapable of improvement; and M. Beaufumé hopes, and we believe it quite possible, to remove the defect in question altogether.

With this apparatus the getting up of steam at starting requires no more time than with ordinary furnaces, when the boiler works every day; but it is otherwise when the apparatus is cooled down, and no motive force is at hand to drive the blowing fan, before the gasifier is itself capable of driving it. An extra half-hour is under these circumstances always required to get up steam in the boiler. This is doubtless a great inconvenience, but it would disappear if a small donkey-engine, with a small boiler capable of getting up steam very rapidly, were employed specially to set the apparatus going.

Finally, this apparatus takes up a little more room than is ordinarily required.

We do not think that the inconveniences we have pointed out can be compared with the advantages of regularity, freedom from smoke, and great saving which it possesses, more particularly over all land boilers; and we consider this new system of heating so decided an improvement upon other systems, that it will be desirable to make some attempt to introduce it for marine purposes also.

We must not conclude without mentioning that the Beaufumé apparatus may be employed in the arsenal in other ways besides heating steam boilers. It could probably be used with great advantage in the furnaces of the Forge, and it would be advisable to try it for this purpose at Guérigny.

THE METROPOLITAN BOARD OF WORKS.

ENGINEER'S DEPARTMENT.

MR. J. W. BAZALGETTE, C.E., has made a Report (dated June 10th, 1857) to the Metropolitan Board of Works, upon the works executed and business transacted in the Engineer's department, between 1st January 1856 and 25th March 1857. In referring to the sewerage of the metropolis, he says:—

"At the meeting of the Board held on the 1st January 1856, I received instructions to make temporary arrangements for proceeding with the execution of the contracts entered into by previous Metropolitan Commissioners of Sewers, and then in progress; and for the maintenance of the main sewers enumerated in Schedule (D.) of the Metropolis Local Management Act, until the Board should have appointed its officers and made its permanent arrangements; and on the 5th of the same month I reported that there were 166 miles of main sewer placed by the Act under the charge of the Board: viz. 106 on the north side of the river, and 60 on the south side; besides twenty-seven contracts for the construction of new sewers, which had been entered into by previous Commissioners of Sewers, some of which were nearly completed, and others only recently commenced. These new sewers are mainly district sewers, and have been built in about 200 different streets, extending over various parts of the metropolis.

"Under the above-named contracts upwards of 18 miles of new sewers have been constructed, at a cost of 98,946*l.* 19*s.* 8*d.* The cleansing of 166 miles of main sewers has cost 7318*l.* 5*s.* 7*d.*, and the repairs to the same have amounted to 3949*l.* 4*s.* 1*d.*; in addition to which, the pumping at the Ravensbourne outlet and incidental works have cost 677*l.* 19*s.* 6*d.*; making a total expenditure upon sewerage works of 110,892*l.* 8*s.* 10*d.* This amount does not include the cost of attending to the flaps and penstocks of the 64 outlets of main sewers, which being paid in salaries has hitherto been included in the cost of superintendence; but which, being actual labour performed in the sewers, is in reality a work of maintenance rather than of supervision.

"The condition of the 166 miles of main sewers has engaged the attention of the Board; and, in pursuance of an order, longitudinal and cross sections, showing the general construction of these sewers, were prepared and lithographed for the use of the metropolitan and district boards.

"Since the completion of the main intercepting scheme, the present condition of all main sewers under the jurisdiction of the Board has been examined, and the works necessary to repair and render them efficient, having reference to the main intercepting sewers, designed and estimated. This last has also involved the preparation of very elaborate detailed drawings, estimates, and calculations of drainage areas, which are now nearly completed, and will very shortly be laid before the Board; and inasmuch as a large proportion of the works about to be recommended may be executed independently of any scheme of interception, it is probable that in the course of the present summer large and important works will be commenced, from which extensive and permanent benefit will be immediately derived.

"Maps of some of the districts, which were not completed by the Metropolitan Commission of Sewers, were completed by this Board, giving in detail the sizes and levels of their sewers. A complete copy of the subterranean survey, to the scale of 5 feet to a mile, has been prepared to supply the place of the only previously existing map, which was nearly worn out. This survey covers about 800 sheets of double-elephant paper, closely covered with minute drawings and figures, and is a most valuable document. Various plans, showing main and district sewers, for Sir Benjamin Hall and the Referees on the Main Drainage, and for other purposes, have been completed."

IMPROVEMENTS IN THE METROPOLIS.

MR. FREDERICK MARRABLE, Superintending Architect to the Metropolitan Board of Works, has, in pursuance of instructions from them, made a Report on the transactions in his department from January 1856 to June 1857, in carrying out the provisions of the Metropolis Local Management Act and of the Metropolitan Building Act. We shall quote at some length from this report, classing the subject under different heads.

District Surveyors.—In alluding to the duties of district surveyors, Mr. Marrable states that the contrariety of the business and incomes of some of the districts requires the attention of the Board, and that in pursuance of the 32nd section of the Building Act they should alter the limits of some of the districts. From a list of the gross total of fees received by the district surveyors for the year 1856, it appears that in sixteen districts the fees do not exceed 200*l.* each, five of which are under 100*l.*, and from which amount the expenses of office have to be deducted, thus making them considerably smaller; that in eleven districts the fees do not exceed 300*l.* each; in twelve districts the fees do not exceed 400*l.* each; in seven districts the fees do not exceed 500*l.* each; and that in nine districts the fees vary from 500*l.* to nearly 1000*l.*, and one only reaches 1317*l.*

New Streets.—The crowded and dangerous state of the traffic in some of the main thoroughfares in the City, and on the Southwark side of the river, towards the railway stations at London bridge, early demanded the attention of the Board to provide some remedy, either by the construction of new streets, or the improvement of existing communications.

1. As the improvement of Southwark, by opening up a new street from the vicinity of the railway stations to the several bridges and the west-end, had been long contemplated, and funds, being special grants from Parliament with accumulations of interest since 1841, being partly provided for that specific purpose, the Board proceeded first to consider the wants of that locality. All the plans that had been from time to time proposed, as different means of opening the thoroughfare from the High-street in Southwark towards Westminster bridge were considered; and a plan prepared by Mr. Pennethorne, in 1853, appearing at first to possess great advantages over all others, a detailed plan and estimate were ordered to be prepared. This line commenced at Northumberland-street, in the Strand, and proceeded on the line of the Hungerford bridge until it reached the York-road, where, by a slight curve, it joined a perfectly straight line from the corner of the churchyard of St. John's church, in the Waterloo-road, to the Town-hall in the Borough. The cost of the portion of the line between the High-street and the York-road was estimated at 895,104*l.*; the return 631,794*l.*; the net cost, less government grant of 90,000*l.*, 173,310*l.*

There were other plans having the same object in view, viz.: the improvement of the thoroughfares in Southwark referred to by Mr. Tite before a committee of the House of Commons, May 1855, but which only provided for widening the present line of Charlotte-street and Union-street, between the Blackfriars-road and the High-street; that of Mr. G. Ledwell Taylor, and that of Mr. Bailey, both following nearly the same line as that above detailed, but the latter having reference more particularly to a railway station on the Thames, on the site of the present Hungerford bridge. A plan by Mr. Wade takes somewhat the same line from the High-street to the Waterloo-road, whence it runs off by a curve to the foot of Westminster bridge. Mr. T. Taylor projected another line nearer the river, but there were difficulties in the way of the execution of that line that could only be overcome at a very heavy expense.

When, however, the line originally projected by Mr. Pennethorne was fairly before the Board in detail, there appeared many serious objections to it. It did not take up the line of Stamford-street, so clearly pointed out by the Act of Parliament making the first grant of 30,000*l.* towards opening a communication between Southwark and Westminster, "by way of Stamford-street." It did not appear to the Board sufficiently to tie the bridges together, so as to take the utmost advantage of them; and the Board were fearful, and with much reason, that the ground on so long a line of street would probably remain long unoccupied, the capital employed unprofitable, and the road itself a waste; and with the example of Victoria-street, Westminster, before them, they deemed it expedient to adopt a shorter line by which less property would be destroyed, particularly among the dwellings of the working classes, and one where they might reasonably expect to realise the ground rents within a few years. Other surveys and estimates were prepared, both starting from a point in the Blackfriars-road opposte to the end of Stamford-street, and terminating in Wellington-street, Borough, at the end of York-street, nearly opposite the South-Eastern Railway Station. One of the lines, although much straighter than the other, was found to interfere with some properties of great value and very difficult to deal with, showing an estimated cost of 737,300*l.*, less a probable return of 195,585*l.*, leaving a net cost of 541,715*l.* The other line, lying a little to the south, although presenting a considerable curve on the plan, showed few disadvantages, and was estimated to cost 519,424*l.*, less probable return 198,753*l.*, the net cost, after deducting the government grant of 90,000*l.*, being 230,671*l.* This line was ultimately adopted by the Board, and is now before parliament.

2. A new street having been long contemplated, to open up a communication from St. Martin's-lane at the point of intersection by Long-acre and Cranbourn-street, and thence running in a south-easterly direction and terminating at the north-west end of King-street, Covent-garden, in June 1856 a correspondence passed between the First Commissioner of Works and the Metropolitan Board of Works; and as it appeared that a surplus would remain of the fund called the London Bridge Approaches Fund, after the payment of all existing charges upon that fund, which surplus was to be applied to carrying out the improvement above mentioned before it could be applied to any other purpose; and as it further appeared that the Duke of Bedford was willing to contribute 15,000*l.* towards the same object, the Board directed the superintending architect to report upon this subject. A survey and estimate were accordingly made, and the line adopted which had been proposed by Mr. Pennethorne, and referred to in the seventh report of the Metropolis Improvement Commissioners. The outlay for this line of street, 135 yards in length, is estimated at 91,820*l.*, the return at 46,800*l.*, and the net cost 45,020*l.* This plan is included in the Bill now before Parliament, in order that the funds previously provided may be transferred to the Board to enable them to execute the works.

3. In the beginning of May 1856 the board of works for the Holborn district memorialised the Metropolitan Board relative to the removal of the block of houses known as Middle-row, Holborn, and as to several other suggested improvements within the same district; and the committee of works having investigated the subject, reported that it was important to effect the removal of Middle-row as speedily as possible. A plan and estimate were accordingly prepared, and laid before the board. The cost of the property, including all interests, goodwills, &c. was estimated at 46,625*l.* The estimated cost of this improvement not exceeding 50,000*l.* (the limit of works to be undertaken by the Board without further authority), they have instructed the architect, in conjunction with the solicitor, to endeavour to effect conditional arrangements for the purchase of the property, without incurring the expense of a Bill in Parliament.

4. As it appeared that much of the traffic from the west-end of the metropolis towards the Eastern Counties Railway, and the Kingsland, Hackney, and City roads, Shoreditch, Bethnal-green, and St. Luke's, might be diverted from the Strand and City thoroughfares, by opening a thoroughfare or making a new street in as direct a line as practicable from the end of Old-street to the new street from Farringdon-street to Clerkenwell,—the matter was referred to the committee of works and improvements, for investigation and report. In accordance with this reference a plan and preliminary report were prepared by the superintending architect, and submitted to the Board in February last, recommending the opening of a continuous line of thoroughfare from the west end of Old-street, St. Luke's, to Hart-street, New Oxford-street, by rebuilding and setting back the houses on the one or other side of the narrow parts of the line, and forming a portion of a new street from the end of Wilderness-row to Clerkenwell-green, near the Sessions-house, and cutting another short opening through Lower Saffron-hill and Back-hill; by which means a wide and continuous thoroughfare would be secured at a comparatively small cost considering the importance of the object and the great advantage it would be to the public. This matter awaits the further consideration of the Board; the architect having been instructed to prepare a detailed survey and estimate of the whole line.

5. The vestry of the hamlet of Mile-end Old-town and the boards of works for the districts of Poplar and Limehouse, in

July 1856, memorialised the Board to cause a new road to be constructed from Limehouse to Mile-end-road, so as to form a junction with Grove-road, and to widen the latter, with a view to affording a better access to Victoria-park. This matter has been much considered in the localities, and also by the committee of the Board to whom it was referred, together with two other lines that were suggested by some of the inhabitants of Ratcliffe, &c. The subject is still under the consideration of the committee, who have directed a survey of a line proposed by the superintending architect to be made, as that line appears to possess some advantages over the others.

6. Another short line of communication between the Commercial-road and Whitechapel is also under the consideration of the Board, and the necessary surveys are now in hand. This will be the completion of the improvement undertaken by the government some few years ago, and will be of great benefit to the traffic in this locality.

7. The inhabitants and owners of property in Union-street, Deptford, having arranged amongst themselves to subscribe money and property to remove certain old houses which encroached upon and obstructed the line of street, applied to the local district board of Greenwich, who submitted their concurrence therein to this Board for co-operation and assistance, as the improvement would very greatly tend to facilitate the traffic in that street. The whole money expenditure would not exceed 150*l.* The Board therefore entered into the proposed arrangements for effecting this improvement, which has been carried out accordingly.

8. The vestry of Bermondsey applied to the Board in November last, relative to the purchase of premises in Fendall-street, for the purpose of widening that street, the cost of which would not exceed 160*l.* In the consideration of this proposition the opinion of the clerk of the Board was obtained as to the power of the vestry to raise any sum which the Board might require them to contribute towards the improvement in question, and generally as to the powers of vestries and district boards as regards the raising of funds for local improvements. In that opinion the clerk stated "there were valid grounds for the opinion that the vestry or district board of any parish or district within the limits described in the General Paving Act (57 Geo. III., c. 29, 1817) namely, the city of Westminster and borough of Southwark, the parts within the bills of mortality, and the parishes of St. Pancras and St. Marylebone (excepting certain estates in St. Pancras, and the parishes of Islington and Hackney), are empowered to take houses and lands by agreement for improving the streets of that particular part of their parish or district which comprises the area or part of the area defined by the former local Act; to pay for them by moneys raised on that area, and to execute the necessary works themselves; and that it is competent to this Board, under the 144th section of the Metropolis Local Management Act, to contribute to their cost." On the matter being thereafter discussed, the Board resolved to contribute one-third of the estimated expense of purchasing the premises as proposed.

9. A plan for the improvement of Lower East Smithfield, at the corner of Burr-street, Whitechapel, was lately submitted to the Board, proposing to add a slip of ground (varying from 10 ft. 6 in. to 5 ft. 6 in.) to the public way by the setting back of a warehouse about to be rebuilt. The street being near St. Katherine's docks, and often crowded with carts and wagons loading or unloading at the warehouses on either side, every foot of space becomes of great importance to the thoroughfare; and the committee of works and improvements, to whom the subject was referred for report, have recommended the Board to contribute a portion of the cost of such improvement, as, should the warehouse be rebuilt on its old site, any widening of the street at a future time would be attended with very great expense, if not altogether impracticable.

Subways.—Shortly after the Board had determined that new streets should be formed in Southwark and near Covent-garden, they took measures for inserting in the Bill to be laid before Parliament a clause giving the Board power to deal with the subsoil of the new streets in the construction of subways, if deemed advisable, and to retain or dispose of the property in the subsoil, in order that an opportunity might be afforded of endeavouring to obviate the constant necessity of breaking up the pavement whenever it was desired to get at any of the gas or water pipes; and advertisements have been issued offering liberal premiums for designs for the best method of so disposing of the sewers, gas and water pipes, and any other useful suggestions that may be proposed by competitors for laying out the ground beneath the surface of the streets.

Width of Streets.—Early in the experience of the Board it became necessary to enact a bye-law to regulate the width of new streets in the metropolis, as the rules that had existed under the former Building Act were not re-enacted in the present Act, and parties were proceeding to lay out ground for streets and alleys of less than the accustomed width. The rules of the former Act were therefore re-enacted as a bye-law, in pursuance of the powers vested in the Board by the Local Management Act; but as something more complete was still required, especially as regarded the mode of measurement, and to secure the full minimum width of thoroughfare, independent of any gardens, areas, or other open spaces, the bye-law was revised, and, after much consideration, was finally confirmed by the Board; and, having been approved by the Secretary of State, it became law on the 1st of May 1857, and will be found appended hereto. By this law the Board will be enabled to exercise some control over the very irregular manner of laying out ground for building purposes in the metropolis which has long prevailed, and to secure the requisite width of thoroughfare independent of gardens or other spaces in front of houses.

Street Nomenclature.—The powers given to the Board to name new streets, and to re-name existing streets, where more than one street in the metropolis is called by the same name, have been acted upon to a certain extent, the Board having in April 1856 referred the matter to a committee, with instructions to communicate with Post-office and other authorities thereon, and to report upon the subject to the Board. A correspondence was opened with the several vestries and district boards under the Local Management Act with a view of obtaining correct lists of the names of streets in the several localities of the metropolis; and lists were received from many. The secretary of the Post-office also expressed the anxiety of the Postmaster-General to obtain a reform of the street nomenclature of London, by doing away with the multiplication of the names for streets now carried to a perplexing extent, especially if accompanied by a more accurate numbering of houses, as a means of promoting the expeditious and correct sorting and distribution of letters. The subject has been noticed in several reports by the Postmaster-General to Parliament; and it appears that the clause was inserted in the statute through the instrumentality of Lord Canning, when Postmaster-General, in order to have the power vested in some central authority, in the hope that it might be exercised on some comprehensive and general principles.

The matter having thus far proceeded, was taken up in committee by Mr. D'Iffanger with great zeal and ability; a report was produced, and ordered to be printed, and from which a few extracts may not be out of place.

From detailed lists furnished by the Post-office authorities, it appears that "there are already in the metropolis 571 streets, designated by 17 names only, and that of one of these names there are no fewer than 62 repetitions scattered over the various districts. This of itself shows the enormous amount of inconvenience, loss of time, and waste of labour that must inevitably arise, both in the delivery of letters and the transaction of the daily business of the community, from a practice so replete with all the elements of confusion and mistakes."

The Board, desiring to proceed with caution in the performance of this very difficult duty, have selected the New-road, in the parishes of St. Marylebone and St. Pancras, for the first alteration of name as an experiment, and have determined that the portion of the New-road between Edgware-road and Osnaburgh-street be called Marylebone-road; the portion between Osnaburgh-street and King's-cross, be called Euston-road; and the portion between King's-cross and the Angel Inn at Islington, be called Pentonville-road; and that all the separate names of places at present existing in the line of the said New-road be abolished. This operation will substitute three names for 50.

On the application of the inhabitants of other parts of the metropolis, the Board have ordered the change of other names, subject (pursuant to the statute) to the approval of the Commissioners of Her Majesty's Works and Buildings. The several names of Clarke's-place, Hedge-row, York-buildings, Gloucester-place, Oddy's-row, Islington-green, Frederick's-place, Commerce-row, Barnsbury-place, Upper Barnsbury-place, Trinity-row, Hopkin's-buildings, San's-buildings, Sebbon's-buildings, and Wells-row, on the west side of Upper-street, Islington, are to be abolished; and the whole of the west side of such street from the

Liverpool-road to Holloway-road, is to be called Upper-street, Islington.

Notice of these changes, and of the date when such alterations will take effect, is to be given by public advertisement, and also by circular letter served on the several occupiers; and such names will be accordingly affixed on conspicuous parts of some houses or buildings in such places, and notices then served on the several occupiers of the houses and premises, directing them to mark the same, within one week after notice, with the proper numbers.

"Still greater errors arise from the imperfect numbering of houses than from the multiplication of streets bearing the same name. The returns received from the various district boards show to how large an extent this evil prevails. In the parish of St. George-in-the-East alone there are 81 streets irregularly numbered, and 40 streets contain houses without numbers. St. Mary, Rotherhithe, returns 69 streets incorrectly numbered, and 32 not numbered. The Post-office authorities have also furnished a return showing that the great thoroughfare of Oxford-street affords a striking example of incorrect numbering, and one which must not only cause great inconvenience to the public, but present to a postman, new to the beat, a vast amount of difficulty, and lead to errors requiring the labour of weeks to correct. In this street there are 54 houses without numbers painted on them, and 23 without numbers at all. Many parts of the street are numbered in all diversities of repetition and irregularity."

"Although such anomalies are very injurious, the large extent of the work must prevent any general interference with the numbering of those streets in which no alteration is proposed in the names; and it would not be desirable to commence the renumbering of any street until its name has been determined on by the Board. In conformity with a suggestion of the Post-office authorities, the numbering of all new streets—of all streets to which new names shall be given—of the New-road (in connection with other changes to be made therein), and of all streets named after others in the same line—the odd numbers will be placed on the left hand, and the even numbers on the right, commencing always at the end nearest to St. Paul's Cathedral." Other expedients may be adopted to facilitate the ascertaining of the direction in which streets run and intercommunicate.

Difficulties may attend the transition period of these alterations, but experience indicates that they will be more imaginary than practical, as the operations ordered by the Board will be duly recorded and a careful register kept, as required by the Local Management Act, which may be easily referred to. The reading of the names on the street corners will for a few years be accompanied with the old names in a minor position, and proprietors of directories may be induced to follow the same course until the public have become familiarised with the alterations.

The Post-office authorities state that it is of great importance to the Post-office service to have the names of streets clearly and frequently exhibited, as there are about 900 letter-carriers daily engaged in the delivery of letters within the town limits alone of the metropolis. In a force of this number, constantly exposed to the changes of the weather, there are many casualties which must be supplied by other letter-carriers, comparatively unacquainted with the localities on which they are called to serve; and unless the names of the streets are distinctly marked these substitute letter-carriers lose much time in acquiring the necessary knowledge—familiar enough to the regular men—but otherwise very perplexing and difficult for strangers to find out.

The Postmaster-General in his third Report to Parliament (1856-7), notices that it would not suffice to add the locality to the duplicate names now existing, such as King-street, Cheapside, King-street, Covent-garden, for "the necessity for such distinction is frequently unknown, especially by persons living at a distance, and in fact it is in numerous instances disregarded. Not only should the names of no two streets be identical, but the distinction between them should be broad and clear. Repeated complaints have been made in the neighbourhood of Westbourne-terrace, on account of delays in delivering arising from the great similarity in several of the names thereabout—such as Westbourne-park-cottages, Westbourne-park-crescent, Westbourne-park-place, Westbourne-park-road, Westbourne-park-terrace, Westbourne-park-villas."

Forecourts and Projections.—That feature of the suburban metropolis, which has added so much to the width and beauty of its approaches in many parts—viz., the formation of gardens and open spaces in front of houses in the main thoroughfares, has also created much inconvenience when the necessity arose of forming shops or places for business in such localities. Hence much local and general legislation has been, from time to time, directed to control the erection of buildings beyond the regular lines of buildings, and also shop-fronts and other projections from such buildings. The Metropolitan Paving Act of 1817 contains stringent provisions relative to projections which might obstruct the circulation of light and air, or be inconvenient or incommodious to passengers along carriage or footways in certain parts of the metropolis. In 1828, the Local Act for consolidating the Metropolis Turnpike Trusts contained provisions to prevent buildings being erected within fifty feet of the New-road, and within forty feet of the City-road, upon any new foundation. But this law has been defeated by the construction put upon these latter words by the magistrates, whereby fence walls have been construed as buildings, and persons have been allowed to encroach so far as such old foundations could be found. By the Metropolitan Building Act of 1844, further regulations were made to restrain projections from buildings; but, after a short administration of its provisions, it was found that shops built on forecourts, areas, or gardens, and standing on their own foundations, were not such erections as could be brought within the term, projections from external walls, as used in the Act. For several years, therefore, whilst the law was under consideration for amendment, the builders, architects, and surveyors in the metropolis were unrestrained in their endeavours to encroach upon or break the lines of building in the metropolitan streets and roads.

The legislation of 1855, both in the New Building Act, and also the Metropolis Local Management Act, placed the jurisdiction relative to lines of frontage of buildings in streets in the Metropolitan Board of Works; and now "no building can, without the consent in writing of this Board, be erected beyond the regular line of buildings in the street in which the same is situated, in case the distance of such line of buildings from the highway does not exceed thirty feet, or within thirty feet of the highway, where the distance exceeds thirty feet, notwithstanding there being gardens or vacant spaces between the line of buildings and the highway." The effort of the legislature is not, however, complete. The means of enforcing this provision is given to the local authorities; and the district surveyors under the Building Act, who are placed under the Metropolitan Board of Works as to matters of building, are not enabled to act under the Local Management Act, and can but imperfectly assist either the central or local authorities in the matter, while the term "regular line of buildings in the street" is open to all sorts of interpretations, as any deviation from the regular line in the whole length of a street is contended for as destroying the existence of "a regular line" altogether; and in many instances the provisions of the Act are thereby rendered nugatory.

Notwithstanding such difficulties, the Board, through their superintending architect and the surveyor appointed to assist him, cause a personal inspection of every locality to be made before considering any application to extend a building beyond the regular line; and they have endeavoured to meet the justice of every case brought before them, and have granted or refused consent according to the circumstances of each application, restraining where encroachment was sought, but generally permitting were the line was already broken, or might be improved by the proposed erections; and sometimes obtaining for the public a concession of space to widen streets or round off obstructive corners, greatly to the improvement of the thoroughfares in such instances.

Of such applications there have been no less than 342; and in all cases eight days' notice of these applications is sent to the vestry or district board, inviting the suggestions and opinions of the local authorities before arriving at any decision.

Parks.—In July 1856 the Act amending the Local Management Act removed all doubts that had been entertained regarding the powers of the Board to incur expenses in providing parks, pleasure-grounds, places of recreation, and open spaces for the improvement of the metropolis or for the public benefit of the inhabitants thereof. The Board were thus enabled to proceed to consider the best means of securing parks or open spaces in such neighbourhoods as stood most in need of them, or where building progress would render their future attainment very difficult. Several memorials were addressed to the Board upon that subject, and their committee of works and improvements instituted careful inquiries with the view of ascertaining what districts of the metropolis were most urgently in need of parks or open spaces for the purposes of public health or recreation, and what land could be found available for that object. They also received deputations, consisting of members of the vestries and of inhabitants of Islington and Stoke Newington, on the subject of the Finsbury park; from Bermondsey, respecting the site suggested for a park in that locality; and from Hampstead, with reference to the preservation of the heath and a portion of the adjacent land for public use and enjoyment. They received detailed explanations from members of those deputations on the various points referred to them for investigation, conferred thereon, and visited the sites recommended. They afterwards reported to the Board that it was deemed desirable for the better sanitary condition of the metropolis, and for facilitating the means of healthy recreation for the public, that parks should be established in certain parts of the metropolis hitherto neglected in that respect.

Eligible sites were proposed at Rotherhithe and Bermondsey. The cost of forming a park of adequate dimensions for this locality would not be less than 100,000*l.*

The park reported as next in point of urgency was that proposed for Finsbury; aud an open space of about 250 acres, lying west of the Green-lanes, or Southgate-road, and in the parishes of Hornsey and Islington, was considered eligible for the purpose. The cost would probably not exceed 230,000*l.*, and it was represented that her Majesty's government would contribute 50,000*l.** A bill for powers to form this park is now before Parliament.

The purchase of Hampstead Heath, and of such adjoining land as it might be desirable to connect therewith, was recommended to the Board, as the Heath presents many advantages for promoting the health and recreation of the inhabitants of the metropolis; and the purchase thereof, if delayed, will involve a very much larger expenditure than would be required at the present time. The expense was estimated at between 150,000*l.* and 200,000*l.*

Bye-Laws under the Act for the better Local Management of the Metropolis.

Formation of New Streets.

In pursuance of the powers vested in the Metropolitan Board of Works by the Act of Parliament passed in the 19th year of the reign of her present Majesty, intituled "An Act for the better Local Management of the Metropolis," it is hereby ordered by the said Board as follows, that is to say:

Four weeks at least before any new street shall be laid out, written notice shall be given to the Metropolitan Board of Works, at their office, No. 1, Greek-street, Soho, in the county of Middlesex, by the person or persons intending to lay out such new street, stating the proposed level and width thereof, and accompanied by a plan of the ground, showing the local situation of the same.

Forty feet, at the least, shall be the width of every new street intended for carriage traffic; 20 feet, at the least, shall be the width of every new street intended only for foot traffic: provided that the said width respectively shall be construed to mean the width of the carriage and footway only, exclusive of any gardens, forecourts, open areas, or other spaces in front of the houses or buildings erected or intended to be erected in any street.

Every new street shall, unless the Metropolitan Board of Works otherwise consent in writing, have at the least two entrances of the full width of such street, and shall be open from the ground upward.

The measurement of the width of every new street shall be taken at a right angle to the course thereof, half on either side, from the centre or crown of the roadway to the external wall or front of the intended houses or buildings on each side thereof; but where forecourts or other spaces are intended to be left in front of the houses or buildings, then the width of the street as already defined shall be measured from the centre line up to the fence, railing, or boundary dividing or intended to divide such forecourts, gardens, or spaces from the public way.

The carriage-way of every new street must curve or fall from the centre or crown thereof at the rate of three-eighths of an inch at the least for every foot of breadth.

In every new street the kerb to each footpath must not be less than four nor more than eight inches above the channel of the roadway, except in the case of crossings paved or formed for the use of foot passengers; and the slope of every footpath towards the kerb must be half an inch to every foot of width if the footpath be unpaved, or not less than a quarter of an inch to every foot of width if the footpath be paved.

In this bye-law the word "street" shall be interpreted to apply to and include any highway (except the carriage-way of any turnpike-road), and any road, public bridge (not being a county bridge), lane, footway, square, court, alley, or passage, whether a thoroughfare or not, and a part of any such highway, road, bridge, lane, footway, square, court, alley, or passage.

In case of any breach of the regulations contained in this bye-law, the offender shall be liable for each offence to a penalty of 40*s.*, and, in case of a continuing offence, to a further penalty of 20*s.* for each day after notice thereof from the Metropolitan Board of Works.

Construction of New Sewers.

No new sewer shall be made without the previous approval of the Metropolitan Board of Works; and all vestries and district boards proposing to construct new sewers shall, before commencing any works for that purpose, submit to the said Board plans of the streets or places in which it is proposed to construct new sewers, drawn upon tracing cloth, to a scale of 5 feet to the mile, with the position of the proposed sewers shown thereon, and longitudinal sections of such sewers drawn to the same horizontal scale, and to a vertical scale of 11 feet to an inch, with the heights from Ordnance datum to the invert of the proposed sewers figured, and the rate of inclination specified therein. Also cross sections of the proposed sewers drawn to a scale of half an inch to a foot, with a statement of the thickness, and a description of the materials intended to be used in their construction.

When it shall be intended to abandon wholly or in part, or to extend, contract, or alter any design for a sewer previously submitted to and approved by the Metropolitan Board of Works, notice in writing of such intention shall be given to the said Board, accompanied by plans and sections as hereinbefore described showing the extension, contraction, or alteration which may be intended; and no such abandonment, extension, contraction, or alteration shall be permitted without the previous approval in writing of the Metropolitan Board of Works.

Three clear days' notice in writing shall be given to the Metropolitan Board of Works by a vestry or district board previously to the connection of any sewer or drain with a main sewer; and the necessary junction for that purpose shall be made by such vestry or district board to the satisfaction of the Metropolitan Board of Works.

For regulating Communications with Main and other Sewers.

That where it is intended to lay house drains into main sewers, the following be the form of notice to be given by vestries and district boards:

To the Metropolitan Board of Works.—

Application having been made to the vestry or district board of
by of for leave to lay
down a pipe drain inches in diameter, to and from
the house situate into the main sewer,
situate the said vestry or district
board of therefore hereby give notice, in accordance with the regulations of the said board, that the said communication with the said sewer will be made by them at the expiration of three days from the service hereof.

Dated this day of 185 .

The following formalities shall be observed by persons wishing to branch sewers into main or other sewers, and by persons proposing to branch drains into main sewers:

All persons wishing to make or branch a sewer either into a sewer vested in the Metropolitan Board of Words, or into a sewer vested in any vestry or district board, shall in the first instance lay the plans and sections relating thereto before, and apply for the sanction of, the vestry or district board in which such last-mentioned sewer shall be situate; and no such sewer shall be begun to be made until the sanction of such vestry or district board shall have been given.

Before any vestry or district board shall sanction the construction of any such sewer, they shall submit the plans and sections thereof, when the same shall have been approved by them, to the Metropolitan Board of Works for their sanction, in the same manner as if such sewer were proposed to be constructed by such vestry or district board.

All persons wishing to make or branch any drain into a sewer vested in the Metropolitan Board of Works, shall, seven days before commencing any works for that purpose submit a proper plan and description in reference thereto before, and apply in writing for the sanction of, the vestry or district board in which such sewer shall be situate; and no such work shall be commenced until the sanction of the said vestry or district board shall have been given.

General Rules relative to Applications with reference to Buildings to which the Rules of the Metropolitan Building Act are inapplicable.

That the following rules and regulations with respect to the applications to the Board under the Metropolitan Building Act (and the 143d section of the Metropolis Local Management Act) be adopted, and that they be printed and issued to the public (sect. 57, Metropolitan Building Act 1855):

All applications must be made in writing, on foolscap paper, setting forth the nature of the building, work, or other matter, the situation and district in which the same is to be built, and describing all necessary particulars as to the proposed mode of construction, stating under which section of the Act the sanction is sought: to be accompanied by plans and sections drawn to a scale of one-eighth of an inch to a foot (when practicable), with dimensions and thicknesses figured thereon, together with a block plan to a smaller scale, showing the situation of the building with reference to adjoining buildings, and to the ground of any adjoining owner.

In the event of the sanction of the Board being granted, duplicate drawings or tracings must be supplied by the applicant for enrolment in the office of the Board, and for transmission to the district surveyor for his guidance.

Applications that are not received at the office of the Metropolitan Board of Works at least eight clear days before the next meeting of the Board, cannot be entertained at that meeting.

Notice of Application to be given to Vestry or District Board.

That on the receipt of any application to extend buildings beyond the general line of frontage, such application be communicated to the vestry or district board of the parish or district in which the locality is situate, and that they be apprised that this Board will be prepared to receive any suggestions they may deem it desirable to make upon the subject, and will take such suggestions into consideration before finally deciding upon the application.

Erection of Furnace Chimney Shafts.

All builders or other persons who may be desirous of erecting any chimney-shaft of a steam-engine, brewery, distillery, or manufactory, the same being buildings to which the rules of the Metropolitan Building Act, 1855, are inapplicable, shall, before commencing any such building, make an application to this Board, requesting their approval thereof, setting out a plan of the proposed building, and such other necessary particulars as may be required by the Board (Sect. 56, Metropolitan Building Act, 1855).

Fees for Special Services by District Surveyors in Supervision of Furnaces and Chimney-Shafts.

That the following fees be demanded and received by every district surveyor under the Metropolitan Building Act, 1855, who shall perform any of the services hereinafter enumerated, the same being special services required to be performed under the first part of the Metropolitan Building Act, 1855, for which no fee is specified in the first part of the second Schedule to the Act, viz.:

For the supervision of furnaces and chimney-shafts.

For every furnace and chimney-shaft belonging thereto,—	£	s.	d.
Not exceeding 75 feet in height	1	10	0
Not exceeding 100 feet in height	2	0	0
For every 10 feet in addition, up to 150 feet	0	2	6
For every 10 feet in addition, above 150 feet	0	5	0

Proceedings in case of Disagreement as to mode of Constructing Public Buildings.

In any case in which a disagreement shall arise between the district surveyor and the builder, or building surveyor, under the provisions contained in the 30th section of the Metropolitan Building Act, as to the mode of constructing any public building upon which the decision of this Board becomes necessary, the question shall be brought before the Board by a memorial setting forth the facts of the case, accompanied by plans and explanations, upon receipt of which the Superintending Architect shall communicate with the other party, and require him to furnish similar information in support of his case; and when the same shall have been received, the whole matter shall be laid before the Board, before whom the parties shall be required to appear, and, if deemed necessary, with witnesses.

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* This proposed grant has since been repudiated by the House of Commons; and the Board have determined upon taking the whole cost upon themselves.

TEES HARBOUR OF REFUGE.

MR. J. FOWLER, C.E., has made a Report to the Tees Conservancy Commissioners, dated July 1857, on the formation of a harbour of refuge at the mouth of the Tees. He says:

"The Tees may be very briefly described as rising in Cumberland, 60 miles from the sea, passing a circuitous course of 100 miles, draining about 700 square miles of country, and having a tidal development of 27 miles in length from the Fairway buoy to Highford above Worsal. The estuary embraces an area, covered at high water, of 8000 acres. Spring tides rise at the bar 16 ft. 6 in.; at Middlesbro', 14 ft. 3 in.; Stockton, 12 feet; Yarm, 7 ft. 5 in.; and at Worsal, 25 miles from the sea, 6 ft. 6 in.

"The average rate of spring tides immediately below the light ship is 4 miles per hour, and on the bar the rate is about 3 miles; and the depth varies from 6 to 12 feet, the average being about 8 or 9 feet.

"The quantity of water flowing over the bar during a 16-feet tide is upwards of 100,000,000 tons, or 400,000,000 tons every twenty-four hours, which with a rate of 3 miles per hour, is equal to 1,145,500-horse power, exclusive of land water, which during the floods of winter is sometimes equal to an additional 201,460 horse power.

"No one will deny that such an immense power, if judiciously regulated and applied, is capable of producing almost unlimited results. That the greater part of this immense body of water passes in out of the Tees to no useful purpose, so far as regards the bar, will be admitted by all acquainted with the river. In order, therefore, to bring this hitherto wasted power into useful operation, I propose to construct a pier from Seaton Snook across the North Gore in a circular direction, for the purpose of arresting the water that passes to and from the Tees over the North Gore, and of directing the whole of the flood and ebb tides in one direction, which will have the effect of maintaining a well-defined channel more to the southward than the present channel generally is, and consequently easier of access in an embaying wind. The permanency of direction, and the increase of power obtained by the pier, will give an additional depth on the bar of 6 or 8 feet over the maximum, or from 18 to 20 feet at low water spring tides. For the purpose of assisting the direction of the tide outwards, and to get clear of the scarps at the 7th and 8th buoys, and also to obtain a more yielding bottom for the enlargement of the anchorage within, by scourage, I propose to construct an inner work or guiding wall from a point near 'Jack in the Box' to the 5th buoy pool, by which I propose to conduct the channel by an uniform and gentle curve to the westward of the 9th buoy rocks, and into the 5th buoy pool, in such direction as shall scour it out on the side on which it is capable of enlargement without artificial means. The form of the channel and the nature of the bottom prove that the depth at low water will be from 12 feet at the upper end to 18 or 20 feet at the commencement of the lower pool, in which the depth would remain as at present, from 3 to 6 fathoms, but the area would be greatly extended; an anchorage would be obtained of 3 miles in length, with a depth at low-water springs of 2 to 6 fathoms.

"The situation of these works, as well as the nature of the ground, at once suggest the mode of construction that ought to be adopted; and no better material can be obtained with which to construct the works than slag from the blast-furnaces; my experience warrants me in stating that it will answer the purpose well,—being hard and rough on the surface, it is consequently not easily moved, and it can be obtained in blocks of any size (5-ton blocks are now being made at some of the furnaces). The quantity also is ample, there being twenty-nine furnaces now in blast on the banks of the river, and other four in course of construction, which will yield about 9500 tons per week, sufficient to construct the pier in eleven months.

"The cost of constructing the north pier of slag, paving its surface, and forming a platform and parapet of timber on piles, will be 70,000*l.*

"The inner works or guiding-wall will cost 11,000*l.*, that is, to make a third tide-wall, sufficiently marked out by beacons, from 'Jack-in-the-box' to the 5th buoy.

"I am not of opinion that a south pier should be constructed at present; but if, after the north pier has been constructed, it should then be considered necessary, I would construct it as shown upon the plan; if done in a similar manner to the north pier its cost would be about 80,000*l.*

"In conclusion, I would beg to add, that these works will render the entrance of the Tees such as that it may be safely taken at almost any state of tide by the mercantile shipping trading upon the coast; and so long as the level of the country remains unchanged, or the Tees runs to the sea, and the sea continues to rise and fall, the improvement will be permanent, for the existing currents are not to be destroyed, or their power diminished, but directed to do work in the proper place, and to the best advantage, differing widely in these respects from harbours formed upon a plain coast by projecting works from the shore, and destroying the original currents which maintained the depth, their ultimate result being the filling up of the sheltered ground."

PETERHEAD HARBOUR OF REFUGE.

Messrs. D. & T. Stevenson, Civil Engineers, Edinburgh, have made the following report to the Trustees of the Harbour of Peterhead, dated August 1857. They say—

"With reference to our report of 1847, on the improvement of the Harbours of Peterhead, and the inquiry on Refuge Harbours at present being instituted by Parliament, we have been requested by the trustees to state if our views, as to the extension of the harbours, have undergone any change; and we have now to report, for their information, that we entirely adhere to the opinions expressed in the said report, as to the suitableness of Peterhead for the establishment of a harbour of refuge.

"We have had pretty large experience of the east coast of England and Scotland, having been professionally consulted on, or having executed works at, about forty harbours between Hartlepool and the Orkney Islands; and we have seen no reason to change our opinion that Peterhead is the best site for a refuge harbour, between the Firths of Forth and Cromarty, for the shipping frequenting the eastern shores of the country.

"We must refer to our report for a detailed statement of the grounds on which this opinion is based; and we can only now state, generally, in a nautical point of view, that Peterhead commands a stretch of dangerous coast of 250 miles, extending from the Firth of Forth to the Firth of Cromarty, on which coast there is no harbour that can be regarded as a harbour of refuge, while vessels leaving Peterhead have a most favourable loose both for the north and south, and many vessels being up for shelter at present in Peterhead Bay, even in its unprotected state. In an engineering point of view, the situation is also peculiarly well adapted for the construction of the harbour works. On this point we can speak with confidence, the whole of the recent works constructed at Peterhead since 1846, at a cost of about 60,000*l.*, having been executed under our directions. The granite obtained in the vicinity is the best material that can be employed for the construction of breakwaters. The bay is well indented, the locality entirely free from sand, and the water deep.

"In our report of 1847, two schemes for a harbour of refuge are proposed, one estimated at 227,905*l.*, and enclosing an area of 12 acres, and the other, estimated at 450,912*l.*, and enclosing an area of about 40 acres; the entrances of both harbours having a depth of seven fathoms at low water of spring tides; to these areas the present harbours, amounting to about 18 acres, must be added in computing the total amount of harbour accommodation which would be afforded were either of the schemes carried out.

"With reference to those estimates, made in 1847, we have to explain, that the main breakwaters, as then proposed, were designed as regular piers, having a parapet and roadway; but if it were resolved to restrict the outer harbour to a sheltering basin protected by breakwaters without parapets, such as we have recently designed for Wick Bay, the expense of the work would be materially decreased. In absence of working drawings or minute calculations, we should estimate the smaller design at about 140,000*l.*, and the larger at 250,000*l.*, if constructed according to that plan.

"The trustees are aware of the great advantage that has followed the deepening of the north harbour and the junction of the north and south harbours, so as to secure a double entrance, both of which improvements have been carried out since 1847. For an expenditure not exceeding 12,000*l.*, the south harbour might be deepened to 6 feet at low water, and then the harbours of Peterhead, with their access both to north and south, would, with the addition of a refuge harbour of even moderate extent in the south bay, afford every requisite facility and protection to shipping."

EXPERIMENTS ON THE VALUE OF WOOD GAS.*

Report of Prof. Wolcott Gibbs, and Dr. F. A. Genth, to the Trustees of the Philadelphia Gasworks.

Our investigation consisted, first, in careful analyses of pine and oak wood gases; and, secondly, in photometrical measurements, executed with great care and fidelity, and showing the illuminating power of the two varieties of wood gas in terms of the standard sperm candle. The wood gases analysed by us were collected in Philadelphia, in glass tubes carefully sealed before the blowpipe, and which on examination previous to the analysis were found to be free from flaws and perfectly tight. The pine wood gas was collected February 1, and the oak wood gas February 2. Both gases were manufactured at the old city gas-works, in retorts of the form patented by Dr. C. M. Cresson.

The pine wood employed was the so-called "old-field Virginia pine," cut a little over one year, and dried in the arches under the retorts, the temperature being about 60° Fah.; it was probably not drier than wood under a shed. The oak wood was of the second growth, in small sticks and of ordinary quality.

Both gases were purified by dry lime alone. The analyses were made in New York, the photometric measurements in Philadelphia, February 13 and 14. In our analyses we have exclusively employed the method first introduced by Bunsen, and since then used by Frankland, Wetherill, and other chemists in pursuing similar investigations. We have satisfied ourselves by direct experiments that this is the only one capable of yielding accurate results. The absorption of olefiant gas and hydro-carbon vapours by means of bromine appeared to furnish so rapid and simple a mode of determining these substances, that we considered it necessary to pay particular attention to this point. Experiments however showed that while the method when skilfully employed does yield results of sufficient accuracy for ordinary purposes, it is far from giving the precision required in scientific investigations. In like manner we have found that the absorption of carbonic oxide by a solution of subchloride of copper in hydrochloric acid is not to be relied upon when great accuracy is desired. The specific gravities of the gases were determined in the usual manner without previous drying.

The following are the analytical results obtained expressed in volumes:

	Pine Wood Gas.	Oak Wood Gas.
Hydrogen	32·71	30·44
Light carburetted ditto	21·50	33·12
Olefiant gas and hydro-carbon vapours	10·57	6·46
Carbonic oxide	27·11	26·11
Carbonic acid	4·90	0·48
Oxygen	0·66	None
Nitrogen	2·55	3·39
	100·00	100·00
Specific gravity	0·663	0·580

The photographic measurements were made in the dark chamber of the laboratory of the old City Gas Works, Philadelphia. Ritchie's photometer was employed, the standard being a sperm candle burning 120 grains per hour. It is also proper to state that the wood gases used in all these experiments flowed through about 500 feet of pipe before reaching the burners, about one-half of the pipe being exposed to the air of the atmosphere, while the other half passed through a cellar. The gas, as in the case of that taken for the analyses, was the average of eight retorts with four hours' charges.

The photometrical experiments were made by both of the chemists reporting to you, and are believed to be entirely reliable, every care having been taken to secure accuracy. The wood gas was of course burned from its own burner.

The experiments with the pine wood gas were made when the temperature of the atmosphere was 15° Fah., and the temperature of the cellar through which one-half of the supply pipe passed, 45° Fah.

The first series of nine experiments gave for the pine wood gas, when burning at the rate of 4·6 cubic feet per hour, an average illuminating power of 18·3 standard sperm candles; when burning at a consumption of 5 feet per hour, the average illuminating power was 18·2 candles.

The experiments with the oak wood gas were made when the external temperature was 15° Fah., and the temperature of the gas itself 48° Fah.

* From the 'Journal of the Franklin Institute.'

The mean of ten careful determinations gave an illuminating power of 19·17 candles;—the average illuminating power of the Philadelphia City gas being between 17 and 18 standard candles.

As the circumstances under which both series of photometric determinations were made were in all respects unfavourable to the wood gas, these results are to be considered as below a fair average. It is proper also to state that photometric measurements made with both kinds of wood gas, at the time when the two gases were collected for analyses, gave for the oak gas an illuminating power of 27 candles, the average of five observations; for the pine gas an average of 31 candles in one experiment.

In conclusion, we have only to express in a few words the opinion which our experiments have compelled us to adopt, namely, that the illuminating power of wood gas is fully equal to the average of coal gas.

We submit also for your inspection the results of our analysis of the gas of the Manhattan Company, New York, which, perhaps, may not be without interest.

Hydrogen	42·98
Light carburetted hydrogen	40·11
Olefiant gas and hydro-carbon vapours	10·54
Carbonic oxide	3·48
Carbonic acid	1·06
Oxygen	None
Nitrogen	1·83
	100·00
Specific gravity	0·570

Operations in Wood Gas at the Philadelphia Gasworks, June 1857.

The results tabulated below are taken from the books of the Philadelphia Gas Works. The product is from three beds of cellular retorts, with three retorts in each. In two of the beds the retorts are adapted to the use of wood 6 feet in length, the others to lengths of 8 feet; the latter requires no more labour or fuel than the former, whilst the product is one-third greater. In case of renewal, it is proposed to make all the retorts of capacity sufficient for 8 feet lengths, when a greater economic result may be expected.

Date.	Wood carbonised.	Gas produced.	Number of retorts in action.	Wood used as Fuel.	Quantity of Lime to purify.	Make in feet.
June	lbs.	1000 cb. ft.		lbs.	bushels.	per lb.
1	5850	30	6	4000	48	5·11
2	5250	26	6	4667	48	4·95
3	6300	29	6	5333	48	4·60
4	6300	27	6	5333	48	4·28
5	6300	27	6	5333	48	4·28
6	9000	40	9	5333	48	4·44
7	9000	44	9	5333	72	4·88
8	9000	47	9	5333	48	5·22
9	9000	44	9	5333	72	4·88
10	9000	48	9	5333	48	5·33
11	9000	45	9	5333	72	5·00
12	9000	43	9	5333	48	4·77
13	9000	44	9	5333	72	4·88
14	9000	45	9	5333	48	5·00
15	2600	14	3	5333	72	5·38
16	8400	44	9	5333	48	5·23
17	9000	45	9	5338	72	5·00
18	9000	45	9	5333	48	5·00
19	9000	47	9	5333	72	5·22
20	9000	43	9	5333	48	4·77
21	9000	49	9	5333	72	5·44
22	9000	50	9	5333	48	5·55
23	9000	46	9	5333	72	5·11
24	9000	46	9	5333	72	5·11
25	9000	44	9	5333	72	4·88
26	9000	45	9	5333	72	5·00
27	8400	42	8·5	5333	72	5·00
28	9000	46	9	5333	72	5·11
29	9000	49	9	5333	72	5·44
30	9000	44	9	5333	72	4·88
	247,400	1288,000	8·28	149,324	1848	5·00

3720 bus. charcoal coarse. 960 bus. charcoal fine. Tar 450 gallons.

The wood for carbonisation and fuel is of the variety known in the market as "shore pine," and is of a decidedly inferior quality; it is freshly cut and exposed to the weather. Much better results are obtained during a dry season, both as regards the make of gas and quantity of lime required for purification. It is decidedly to the interest of the manufacturer to purchase well-seasoned wood, and protect it by proper shedding. Should a future opportunity offer, the results of experiments upon various kinds of wood, as well as an average of the products and also a maximum working for a considerable period, will be given in like form, from which a much better idea of the commercial value of the apparatus may be derived. The cost per 1000, it may be perceived, by the use of this apparatus, is considerably below that of coal gas, whilst the light produced foot per foot is almost identical. The hydrate of lime, which is employed in purifying, is converted into a carbonate, and may be restored and re-used by burning in a suitable kiln and slaking. The demand for the by-products has so far exceeded the supply; but should they at any time become unsaleable, the cost of the gas would be about one dollar per 1000 feet, without making any reduction for the value of the charcoal as fuel.

Financial Exhibit of Wood Gas Department for Month of June 1857.

Dr.	$	*Cr.*	$
To 136·8 cords of wood (carbonised and fuel) at 4·11	570·45	By 1,238,000 feet of gas at 2·00 per thousand	2476·00
" hauling 136·8 cords, at 0·25	14·20	" 3720 bushels charcoal at 10c.	372·00
" 1848 bushels lime for purifier at 9c. ...	166·32	" 48 loads fine charcoal at 25c.	12·00
" wages, stokers, purifiers, &c.	367·88	" 1848 bushel lime at 4c.	73·92
" coke for drying wood	18·00	" 15 barrels tar (30 gals. each), at 1c. per gal.	4·50
" wear, tear, & renewals	107·00		
" balance net gain ...	1694·57		
	$2938·42		$2938·42
		By net gain month June	$1694·57

The cost per thousand feet (sales of by-products deducted), is 67 cents, leaving, after making a proper allowance for distribution, a clear annual income of $16,600 from nine retorts, the cost of which with their connections, would be about $2500.

CRESSON'S CELLULAR GAS RETORT.*

The Committee on Science and the Arts constituted by the Franklin Institute, to whom was referred for examination the "Cellular Gas Retort" invented by Dr. Charles M. Cresson, of Philadelphia,—report:

That the invention consists in arranging a system of cells in the walls and especially in the bottoms of the retorts, which cells are so connected, by omitting the dividing walls alternately at the two ends, as to constitute a continuous passage, opening at one end into the retort, and at the other giving exit to the gas into the main. In this way the gas is maintained for a considerable time at a moderate red heat while it slowly traverses this passage. In the retorts in use at the Philadelphia Gas Works the cells are in the bottoms of the retorts only, and are eight in number in each retort, each 2 inches wide, 4 inches deep, and 6 feet long; so that the gas is made to traverse slowly a space of 48 feet, and during the time thus occupied is subjected to a regulated and moderate temperature.

The effect of such an arrangement is twofold: in the first place, it must modify to a considerable extent the temperature of the body of the retort itself, which has thus interposed between it and the heat of the furnace flues the gases contained in the cells. The retorts will thus be less violently and more steadily heated, and the nature of the gases developed may, as is well known, be thus considerably modified. Secondly, it would seem possible that a material change in the chemical nature of the gases may be produced by the maintenance of this temperature for a considerable time.

Heretofore these retorts have been exclusively employed in the manufacture of gas from wood, and the practical result has been, that whereas according to the experience of the gas works in the city of New York, the gas from wood manufactured in the ordinary retort cannot be economically used, owing to its low illuminating power,—the gas from wood manufactured in this city in the cellular retort, exhibits at the present prices of wood and coal a slight superiority in economical value over coal-gas. The wood used has been principally common pine; and as the apparatus has been used merely as an adjunct to the coal works, and is comparatively on a small scale, no provision has been made for properly seasoning, drying, or splitting the wood. For the most part the wood has been distilled in large sticks, dried for a few hours only, and requiring some four hours to exhaust the volatile matters. Experiment however has shown that the capacity of the apparatus can be largely increased by diminishing the diameter of the wood, and by thorough drying. By proper attention to these points the same weight of charge can be burnt off in one hour and a half, with an increased yield of gas per lb. In this way a retort that will yield ordinarily 4500 cubic feet of gas in 24 hours, can be made to produce over 9000 cubic feet in the same time. By careful working 10,000 cubic feet have been obtained with the same amount of fuel and labour as are ordinarily used for two-thirds that amount of coal-gas.

The following are the statements of the results actually obtained with these retorts:

Experimental Trials.

April 29 and 30, 1856. 6 retorts—duration of trial 48 hours.
Large pine wood—3 hours charges
14,400 lb. of wood produced 76,000 cubic feet of gas
Being 5·27 cubic feet to pound, or 15,800 cubic feet to cord
6333 cubic feet to retort in 24 hours

June 12 and 13, 1856. 6 retorts—duration of trial 48 hours.
Pine wood split and partially dried—3 hours charges
1200 lb. of wood produced 76,000 cubic feet of gas
Being 6·33 cubic feet to pound, or 18,900 cubic feet to cord

July 31, 1856. 6 retorts.
Pine wood split small and dried—hourly charges
14,400 lb. produced 62,000 cubic feet of gas
Being 4·30 cubic feet to pound, or 12,900 cubic feet to cord
10,333 cubic feet to retort in 24 hours
In this trial the charges were not thoroughly burnt off, the charcoal being smaller but of better quality

March 1, 1855, to *March* 1, 1856.
Wood used in retorts, 2,806,578 lb.
Gas produced, 11,860,425 cubic feet
Fuel used (coke exclusively), 33,906 bushels
Average make per pound for year, 4·09 cubic feet, equal to 12,200 cubic feet per cord
Maximum monthly make, 4·83 cubic feet per pound, equal to 14·490 cubic feet per cord
350 cubic feet of gas were produced for each bushel of coke used as fuel

March 1, 1856, to *March* 1, 1857.
Wood used in retorts, 1,840,265 lb.
Gas produced, 8,306,000 cubic feet
Fuel used (wood exclusively), 1,380,000 lb.
Average make per pound for year, 4·51 cubic feet, equal to 13,530 cubic feet per cord
Maximum monthly make, 5·61 cubic feet per pound, equal to 16,830 cubic feet per cord
Average charge, 137 lb. per retort
Average number of retorts in action, 6
Yearly production per retort, 1,384,333 cubic feet
Average duration of retorts, 12 months
18,000 cubic feet of gas produced per cord of wood as fuel

As every invention by which the price of gas is diminished,—either by increasing the yield, by diminishing the first cost of the apparatus or the expense of its maintenance, or by substituting other materials for those which have been heretofore exclusively used in this manufacture,—is of the greatest importance to the community, the committee deem the gas retorts of Dr. Cresson to be a very valuable improvement, and recommend them to the attention of those engaged in the manufacture of illuminating gas.

* From the 'Journal of the Franklin Institute.'

Barnstaple New Waterworks.—The works of this Company are to be completed at a cost of 9000*l.* The water will be brought from the river Yeo, about five miles up from the town, in open conduit for about two miles, so as to afford irrigation to that land which is now comparatively barren, and thereby lessening the amount of compensation to the owner. The reservoir will be in Rawleigh-park. The plans are by Mr. Rowe.

THE ARCHITECTURAL EXHIBITION.

The Exhibition for 1857-58 will be opened to the public, at the Galleries of the Society of British Artists, Suffolk-street, Pall-Mall, on the 17th December, and will remain open till the 20th February, 1858. The following regulations have been made by the committee, for the guidance of exhibitors:

All drawings, models, photographs, &c., must be delivered at the Galleries on the 1st or 2nd of December, before 6 p.m., and none will be received later.

Every drawing or strainer must have the description legibly written, with the name and address of the exhibitor at the back; and it is particularly desired that the same description be lightly *pasted on the front*, for the purpose of the Catalogue, and to be cleaned off afterwards.

It is requested that drawings should not have a paper margin of more than 3 inches beyond the line of colour, and in all cases where it is possible, it is most desirable that plans and sections intended only to illustrate arrangement, should be drawn to a small scale; (much space has before been lost by neglect of the requirements as to margins, and a want of it must in many cases cause plans and sections to be left unhung when they are drawn to a large scale.)

Drawings before exhibited in London are inadmissable. (This regulation is temporarily waived in favour of the great competition for the Government Offices, and for the Memorial Church at Constantinople.)

Any number of drawings illustrating one design may be included in one frame; but when several subjects are collected together, such frame or strainer must not in any case contain more than 5 superficial feet.

All strainers which are not framed and glazed should have a plain gilt moulding round them.

All contributions to the Department for Models, Carvings, Decorations, Specimens of Manufactures, and Inventions connected with Building, are to be delivered and fixed in the spaces allotted between November 2nd and December 1st.

Two rooms, as before, will be retained for the above. In applying for space it should be stated whether floor, ceiling, wall, or counter room is required. All setting-up, fixing, &c. must be done by and at the expense of exhibitors, and all workmen and assistants so employed will be allowed to attend during a period which will be duly announced; and the time for completion must be rigidly adhered to, much inconvenience having before been occasioned through neglect on these points. The rates for space will be as before.

The names of gentlemen who will deliver lectures on the Tuesday evenings will be announced in due time. Prof. Donaldson, Mr. Crace, and others have already kindly consented.

RATING OF MINES.

The Select Committee appointed by the House of Commons to inquire into the law and practice with respect to the rating of royalties of mines have made their report to the House after hearing a great number of witnesses from all parts of the country. They say the evidence has shown that the liability of mines to be rated to the poor and other parochial rates is full of anomalies, and (except in the case of coal mines) depends more on the form of agreement between the lessor and lessee than on any general rule of rateability. Although mines (other than coal mines) are not as such rateable, yet, where the royalty or due is reserved in kind, it is held to be rateable on the legal principle, that the lord who receives it is an occupier of land, and as such is subject to be rated for his occupation under the statute of the 43rd of Elizabeth. The reservation of royalties in kind appears, from the evidence, to be still the practice in Derbyshire, and in some districts of Cornwall, and to have been the universal practice in Cornwall till the year 1832. Where the royalty is reserved in the shape of a money payment, such liability is held not to exist. Open mineral workings, quarries, and coal mines are deemed to be rateable, and are rated, in all cases. The committee is of opinion that there are no valid grounds for these distinctions. That so long as coal mines, and open mineral workings, and quarries are assessed to the different local rates, the committee see no reason why the rating should not be extended to all other mines. That open mineral workings or quarries and close mines should, as far as rating is concerned, be placed on the same footing. That evidence has been given of peculiar customs existing in Derbyshire, and that the lord's dues, arising from lead mines in that county, are taken in kind, and assessed both to the poor and highway rates. It has been contended with great force before the committee, that in the assessment of mines the principle should be recognised, that the working of a mine, of whatever description, is the using up of the corpus of the estate, and not of the mere annual produce capable of reproduction. The committee are of opinion that in making the assessment on mineral property, of whatever description, all plant and machinery, locomotive or stationary, in any way connected with or belonging to the mines, and which is incidental and necessary to the working thereof, should be assessed as a whole, together with and as part of the mine, and not separately.

THE NORTHUMBERLAND DOCK, TYNE RIVER.

The opening of this dock, situate at Hayhole, took place last month. Preparations for the commencement of this undertaking were first made on the 9th August, 1853; and on the 10th April, 1854, the cofferdam, 1320 feet long and 5 feet wide was completed. The first stone of the 52-feet lock was laid on 13th September, 1854, by J. Cowen, Esq., Chairman of the Tyne Commissioners. The area of the tidal basin is two acres, and is 475 feet long, and 175 feet wide, with a 70-feet entrance. The lock is 250 feet long and 52 feet wide. The area of the dock is 55 acres, and at present it is capable of accommodating 400 sail of vessels. The average depth of water at high-water neap tides on the sills of the entrances is 18 feet; at spring tides 24 feet. The channels through the entrances of the basin and lock were opened on the 22nd of June 1857, and about that time the closing of the ends of the embankment was commenced. Since the river embankment was completed it has been tested by a pressure of twenty-five feet of water, and it has been found to be perfectly water-tight. During the progress of the works the deep water channel along the staiths was not decreased, but rather improved; and it is an important fact that the ordinary shipment of coals at the staiths has not at any time been interfered with.

At the time the docks were commenced, upwards of 1,200,000 tons of coals per annum were shipped, and on its completion the shipments amounted to 1,400,000 tons, showing an increase during the progress of the works of 200,000 tons of coals. The following collieries at present ship coals in the dock:—Cramlington, Seaton Burn, Seaton Delaval, Buddles West Hartley, Plummers East Holywell, Seghill, Carr's Hartley, and Netherton. The Blyth and Tyne Railway Company also ship coals there.

Mr. John Plews is the engineer-in-chief of the dock; Mr. John Plews, jun., the resident engineer. The contractor for the whole work is Mr. David Thornbury, of Waslinborough, near Lincoln. The contractors for the iron gate are Messrs. Hawks, Crawshay, and Co., Gateshead. The cost of the dock is estimated at about 200,000*l*. The money for constructing the docks has been raised by the River Tyne Commissioners by bonds; and so soon as the capital and interest are repaid it will become a free dock, the necessary charges for expenses having only to be paid.

CAST-IRON RAIL FOR CITY PASSENGER RAILWAY.

C. Brigham, United States, *Inventor*.

Its peculiarities are: no ties needed, a flange cast on the under side gives sufficient base; at the top, on each side, are a series of angular projections flush with the top or head of the rail on the outer side, while on the inner side they are below (about half an inch) sufficiently to clear the wheel flanges; between the projections on the outside cubical blocks are to be fitted, and on the inside the ordinary cobble stones are to be put.

It is claimed that the cast-iron projections will prevent the wearing of the stones into ruts by vehicles, the spaces between the projections being about 9 inches; wheels of ordinary vehicles would not sink or wear away the stone blocks to any injurious amount before the abrasion would be arrested by the wheels coming in contact with the hard material of the casting. It is expected that the difficulty experienced in crossing railroads on an angle will be greatly reduced from the trifling difference in the level of the inner and outer projections, which represent the paving on the inside and outside of the road, and which will not pe increased by ruts.

REVIEWS.

The Atlantic Telegraph: a history of preliminary experimental proceedings, and a descriptive account of the present state and prospects of the undertaking. Published by order of the Directors of the Company, July, 1857. Jarrold. 8vo pp. 69.

Observations on laying Telegraphic Cables in the Deep Sea. By JAMES BODIE, Master R.N. Devonport. 1857. pp. 9.

Of the two works before us, the former was published before and the latter after the occurrence of the accident which frustrated the recent attempt to connect England and America by a submarine telegraph. Mr. Brodie's small pamphlet relates only to the laying of the cable. The publication of the Atlantic Telegraph Company is occupied with an account of electrical experiments and inventions, and of investigations of the physical geography of the Atlantic, and treats only briefly of the subject to which recent experience gives the most interest—the means of depositing the cable safely in its submarine bed.

The electrical investigations of the Company's officers appear to have been conducted with great skill and care, if we may so judge from the manner in which the processes employed are here explained. The principal results arrived at respecting the celebrated "plateau," said to be 400 miles wide and to extend all the way from Newfoundland to Ireland, we presume to be also accurate, though we confess to some doubts respecting the accuracy of the method here explained for sounding great depths. The descending plummet is a cannon-ball suspended from a strong line, and also carrying down a length of light twine marked off in fathoms and unrolled from a reel:

> "The practice, in using this deep-sea sounding apparatus, is to fasten it to a very strong line prepared for the purpose, and capable of sustaining a strain of better than half a hundredweight, although 600 fathoms of it only weigh about a pound. The cast of the ball is made from a boat, which is kept from drifting by oars while the descent of the plummet is in progress; and the descent is timed fathom by fathom, so that the influence of cross currents in drawing out the twine may be allowed for, simply by comparing the rate at which it runs for each given depth with the rate at which it ought to go. Currents necessarily sweep out the twine at an uniform rate, while the cannon-ball as necessarily, on account of increasing friction, drags it out at a diminishing rate, which is accurately known from previous investigations."

It will be seen that this mode of computation assumes two things—that the rate at which the cannon-ball descends is known—and that the velocity with which the currents sweep out the twine is uniform. How the rate of descent of the cannon-ball is ascertained we are not informed, but we are certain that the investigation must be a very difficult one on account of the various resistances to which the ball is subject. If, however, the velocity of the plummet be accurately known, what is the necessity of using the twine as a measure of distance? By observing the time of descent of the plummet, the distance could be immediately deduced from the known velocity. If the investigation led to the conclusion that the plummet moves continually at a diminishing rate, as here stated, that investigation is certainly incorrect. The motion of the cannon-ball at the commencement of its descent is *accelerated* by gravity and resisted by the water with a resistance which increases with the velocity. Setting aside the effect of currents, the resistance will increase till it be equal to the force of gravity, and after that the ball will move with a uniform "terminal" velocity. The velocity cannot ever be, as here stated, "a diminishing rate;" and if the investigations in question lead to a result so clearly erroneous, the method of investigation must be erroneous also.

Again, it is assumed that the currents "sweep out" the twine at a uniform rate. Why? If the twine were not attached to the reel or plummet, but carried freely by a current it would move at the same rate as the current, and therefore uniformly, if the rate of the current were uniform. But when one end is attached to the reel and the other to a plummet, the tension of the twine prevents it from moving at the same rate as the current, and there seems no longer any obvious reason why the unrolling from the reel should be uniform. Other causes which would tend to vary the velocity of unrolling are the descent of the plummet continually to greater and greater depths in the water,—the motion of the plummet produced by the current,—and lastly, the variations of the velocity and direction of the current (or currents) until still water is reached. On the whole, it seems very certain that either the exposition just quoted of the method of sounding the Atlantic is not a fair one, or that the results obtained are not reliable. We are not aware whether the experiment has ever been tried, but it appears to us that far more trustworthy results would be obtained by sinking a cylinder containing a water-tight piston acted on by a spring in the cylinder and externally by the hydrostatic pressure. The compression of the spring, if registered, would show the hydrostatic pressure at the bottom of the ocean, and therefore its depth. The result would be unaffected by the effect of currents and uncertainty arising from the sounding line continuing to descend after the plummet reached the bottom of the sea.

In the work under notice it is remarked that the latter source of error is avoided by the contrivance of the subsidiary twine, which the plummet ceases to draw down after reaching the bed of the sea; but it is observed that for an unknown time subsequently the twine may continue to be unwound by action of currents.

We pass on to consider the topic which, at present at least, is of the greatest importance and interest—the mode of laying the cable safely. On this subject the work here reviewed presents some mechanical theories which are strangely inaccurate. After stating the weight of the rope per mile, the writer observes that,

> "The greatest depth over which the vessels will have to pass in depositing the cable in the Atlantic will be a little more than two miles; consequently, if enough of the rope were suffered to hang motionless from one of the vessels to reach the bottom in this depth, the strain needing to be borne by the rope would be under a ton and a half. During the process of paying out, however, the cable will be constantly in motion, with only a sufficient restraining power upon it to control and regulate its egress from the ship, until this is a rate slightly faster than the progress of the vessel. *The strain will hence really be considerably less than a ton and a-half for two miles.* Here, again, another modifying influence also comes into play to act still further in relief of the strain. The cable will not only be somewhat buoyed up, so to speak, by the water, —it will also be buoyed up by the influence of friction. It will never descend, as it is payed out, in a vertical line, or reach the bottom in a course even approaching the vertical direction. *This will be because friction of the sides of the cable against the water will retard the sinking of the mass.*"

In this paragraph are two serious errors, which we have marked by italics. Firstly, it is assumed that because the cable will be subject to "only a sufficient restraining power" the strain will be considerably less than the tension of the cable if suspended at rest to a like depth. But in fact the tension of the chain moving under the supposed circumstances will be greater or less than the statical strain, according as the velocity of descent is diminishing or increasing. We suppose there is no proposition of dynamics more elementary than this—that if a body be moving in a straight line under the action of two opposite forces, and that line be retarded, the accelerating force must be less than the retarding force, and *vice versâ*. Hence, if the cable descend with a diminishing velocity, the retarding force acting on the vertical part—viz., the tension at its upper end—must be greater than the accelerating force of its weight; and conversely, if the cable move with acccelerating velocity, the tension will be less than the weight. In a paper in our September number the error here noticed has been already pointed out, and the strains due to different degrees of retardation pointed out.

We must here also repeat, that the indicator which shows the retarding friction applied by the break is an utterly fallacious measure of the tension of the cable. That tension, it has just been shown, may be greater or less than the weight suspended; so also it may be greater or less than the friction applied by the break. Consider the motion of that portion of the cable which is subject to this friction. It will assist in understanding the question, without at all affecting the result, to suppose that this portion of the cable is straight. Then the forces acting on this straight piece are the tensions at either end of it, and the friction of its surface. The tension at the end next the coiled cable may be neglected as inconsiderable. There remains the tension at the end next the descending cable accelerating this portion, and the friction retarding it. If the former be greater than the latter, the motion is, on the whole, accelerated. Conversely, the tension of the chain is greater than the amount of retarding friction when the velocity is increasing, and *vice versâ*.

Mr. Bodie states that when the cable was in 2000 fathoms water the strain upon it was increased to three tons. If the velocity were increasing, the tension of the cable was therefore more than three tons. In the official account before us the cable is said to be capable of bearing a strain of four tons. How could the engineers hope to avoid a fracture if they gave their subordinates a power of subjecting the cable to a strain so near its breaking weight? We cannot help thinking that in the next attempt at submergence the breaks should not be under such control, but should be *self-regulating*, so that the velocity of paying-out should bear a constant relation to the velocity of the ship. This object might be accomplished in many ways—for instance, by causing the paying-out apparatus to be turned by a steam-engine.

In the second place the paragraph last quoted seems to assume that the curvature of the chain in some way diminishes its tension. The tension is thereby, in fact, increased. By the known properties of a catenary the vertical tension at the upper end is equal to the weight between that point and the lowest point of the chain. Therefore the longer the course of the chain by reason of its curvature, the greater would be its statical tension; and if the chain be moving uniformly, the dynamical is the same as the statical tension.

The great mechanical desideratum with reference to the safe submergence of the cable is, as is stated in the official work before us, to render the cable as strong as possible relatively to its weight in water—that is, to render as small as possible the ratio of the number of pounds of its weight per mile in water to the number of pounds of tension it will bear without fracture. But has this been done in the present case? The dimensions of several of the component parts of the cable are, strangely enough, omitted in the official account before us. We believe, however, that of the total diameter of the cable the thickness of the outer coating of iron wire is between one-fourth and one-fifth. It follows that more than one-third of the whole bulk is composed of this iron wire. Also we infer, from some statements in this official account, confirmed by Mr. Bodie's paper, that the specific gravity of the whole cable is about three times that of water. If iron, having a specific gravity 7·8 that of water, occupy one-third the bulk of a body of which, as a whole, the specific gravity is three times that of water; the specific gravity of the remainder is three-fifths that of water.

It appears, then, that the cable without its outer coating of iron would actually float in water. It is quite obvious, therefore, that so far as relates to the submergence, all danger of fracture due to the weight of the chain in water might have been avoided by making the outer coat of less thickness. All that was requisite was such a thickness as would make the specific gravity somewhat greater than that of water. With this option as to the thickness of the iron wire, why the directors chose to give it such a thickness that the tension in salt water due to the weight, is, according to their account, "fourteen hundredweight per mile," whereas that weight might have been as small as they pleased, we are at a loss to imagine. This thickness was not intended as a protection for the cable *after* submergence; for we are informed that this iron investment was intended only as a protection, "and to confer upon the cable a convenient amount of proportionate weight during the process of submergence. When the cable is once fairly laid in the still soft depths of the Atlantic and on its Diatom-strewn shelf, the rust may eat the iron external coat as soon as it pleases." (p. 46.)

The newspapers have published letters suggesting contrivances more or less impracticable for giving the cable buoyancy. The newspaper correspondents appear quite ignorant of the fact that before the outer coating of wire was added the cable was too buoyant. Speculations founded on such imperfect knowledge of data may well provoke a smile; but we cannot help regarding much more seriously the mistake which the engineers of the Atlantic cable have committed with all the data before them.

Mr. Bodie proposes to give buoyancy to the cable as it exists by covering it with spun yarn, so as to make the total thickness ⅞-inch. We cannot tell whether it would be cheaper and easier to do this, or to remove some of the superfluous iron wire. Some of his practical suggestions are sensible enough, but we confess that in Mr. Bodie's calculations we have no confidence. He says that the cable, of which the specific gravity is 2·952 that of water, will take *one hour and thirty minutes* to descend 2000 fathoms. The time is here ridiculously over-estimated. By the known formula, if a body descend a distance h in t seconds under the action of gravity, $gt^2 = h$, where g is the force of gravity. In air $g = 32$; in water, for a body having the supposed specific gravity, $g = 21$ approximately; and the time of descent of a plummet to the supposed depth, according to that formula, would be less than half a minute. The descent of a uniform cable moving freely under the action of gravity would probably, for the reasons stated in the paper in our November number on this subject, be still more rapid. There is a difficulty in estimating the effects of fluid-friction; but at all events, we shall be quite safe in supposing the time of descent not to be so many seconds as Mr. Brodie has reckoned it to be minutes. He gives a table of similar results, founded apparently on a proposition which has the merit of originality,—"that bodies heavier than water descend at an uniform rate through all depths of the ocean."

Mensuration, Plane and Solid, for the use of Schools and Colleges, Civil, Military, and Naval. By the Rev. J. SIDNEY BOUCHER, M.A. Longman. 1857. 12mo pp. 176.

In Mr. Knight's valuable and interesting book entitled 'The Old Printer and the Modern Press,' the following curious remark occurs: "Families have been raised to affluence by the enormous circulation of a Spelling-book or a Dictionary. A successful Grammar is a fortune. He who can produce sensible and amusing Reading Lessons is better paid than a Secretary of State." We imagine that other causes besides their intrinsic excellence contribute to the success of elementary works of instruction; but if they depended merely on their own merits, we think Mr. Boucher's work would have a fair chance of turning up a prize in the lottery of literature to which Mr. Knight refers.

The work before us treats of the mensuration of plane and curved surfaces and the cubature of solids, so far as those subjects can be treated without the aid of mathematics. Of course, in such a work, clearness of explanation and judicious arrangement are primary requisites. It would be a hard task to impose on a reviewer the complete perusal of every elementary work which he reviews, but from having examined a considerable portion of this work, we have derived a strong impression that it satisfies the requisites just mentioned. What, however, has particularly struck us with respect to this work is the excellence of the examples. Many of them are so interesting that they may be read for mere amusement, and so *suggestive*, that readers advanced beyond mere pupilage may study them with profit.

It is a great matter, as we have always insisted, that the writer of a students' book should know a great deal more of his subject than he teaches. The more comprehensive knowledge insensibly affects the language of teaching. The following extract from Mr. Boucher's book is perhaps a trivial instance of this source of perspicuity, but it serves as an example of our meaning. Mr. Boucher thus treats that class of problems of which the following are instances:—"A fills a cask in $\frac{7}{12}$-hour, and B in ⅝-hour; find the time of filling it jointly." "A hare starts 75 yards before a dog, but runs only 5½ feet to the dog's 6¾ feet; how soon will she be caught?"

"When two or more agents are employed upon the same piece of work with a view to its more speedy completion, as when two pipes are used to fill a cask, &c., and it is required to know how soon it can then be done, the common-sense principle of 'finding the value of one' must be resorted to, the *one* in this case being the quantity of work done in one minute, hour, day, &c., by all the agents working together."...... Again, in the "measurement of time and distance as connected with rate of speed," "the grand point is to find the value of *one*—*i. e.*, either the time spent in the joint performance of *one mile* or the joint distance done in one hour; for since A and B are *meeting* each other, the whole distance is traversed by neither of them singly, but by the combined exertions of both." In the last sentence the rule might be expressed more generally to include the case of A and B going in the same direction. The key to the general problem is to find their *relative* velocity—that is, the variation of the distance between them expressed by reference to a unit of time or a unit of distance.

If Mr. Boucher's work reach a second edition, we should be glad to see some explanation of the extraordinary diversities of English tables of measures which are the torment of youthful arithmeticians. It *is* hard to remember a multitude of facts, such as the number of feet to the mile, and of square yards to the acre, without some aid to the memory. The *history* of the measures would afford that aid. We are persuaded that our ancestors must have had some motives, good or bad, for adopting measures and their divisions, and of this opinion various numerical relations between different kinds of measures affords evidence.

SUBDIVISION OR "DISTRICTING" OF LONDON BY THE GAS COMPANIES.

This important subject is attracting attention at the present moment over the whole of London, and with respect to it the metropolitan mind never stood in greater need of instruction and guidance. A severe castigation, from the pen of Mr. F. W. Beaumont, C.E., of the directors of the London Gas Company, in the columns of the *Gas and Water Times*, we noticed in No. 262 of this *Journal*, for January 1856, and the efficacy of which the great improvement that has since taken place in the finances of that company goes far to attest. Very recently that gentleman has again taken the subject in hand in a valued contemporary. The strict impartiality with which the reciprocal conduct of the gas companies and gas consumers hitherto has been shown up by Mr. Beaumont, the identity of their interests proven, and not only the course of conduct which they ought respectively to pursue towards each other pointed out, but also the best means of insuring these courses being followed and rendered effectual towards producing justice in return. The author is evidently one who means honestly, and has deeply studied and reflected on the subject.

Had the gas consumers no better reason for immediately looking to and continuing to watch their own interests, the surreptitious manner in which the gas companies have carried out their "districting" operations on the north side of the Thames, would be more than sufficient.

Many of the consumers are only now finding that during the whole of the last quarter they were supplied by a different company to that with which they had contracted and who previously supplied them; one of the reasons for which obviously was to prevent their dissatisfaction at being handed over *nolentes volentes* from being increased by supposed unfavourable comparisons between the qualities of the gas supplied by the two companies. Mr. Beaumont has plainly demonstrated that their trickiness has uniformly recoiled on themselves, and so it will in the present instance; the consumers generally being disgusted at their cunning as well as irritated by their superciliousness. Whereas, had an amicable appeal been made to them, and the fact explained to them that placing the companies in a better position would operate to the advantage of the consumers; inasmuch as without injuring them at present it would lessen the risk of any necessity arising in future for an increase in the prices, and would lessen the road rates, &c.; so large a majority would have acquiesced, that the companies would have been able to carry their object by public acclamation.

Mr. Beaumont's article has roused the committee of the South London Gas Consumers' Mutual Protection Association, who have resolved upon taking steps at once to extend their society to the whole of London, on the footing recommended by Mr. Beaumont. This association has already been of great use, and we sincerely trust they will carry out the great object with spirit, determination and temper, so as to bring a useful and powerful society into successful operation; and we earnestly recommend consumers generally to give their hearty co-operation and assistance; they will effect great economy, and keep the gas supply in healthy action.

The whole of Mr. Beaumont's remarks will well repay perusal; we content ourselves however with the following extracts, which give what Mr. Beaumont proposes to have done, with many of his principal reasons for recommending it.

Subdivision or "Districting" of London by the Gas Companies among themselves.

The adoption and permanent consolidation of some wisely provident, comprehensive, and stringent measures for the better regulation of the relations of the general public with the gas companies, have long been grievously wanted, and the lack of them has not only been heavily felt, but has also been the proximate cause of the gas lighting of London and other places having cost at least three times the amount of capital that ought to have been expended on it, and for which it could have been much more efficiently performed than it has. The excess of cost has so effectually prevented any adequate return being obtained for it, as seriously to impoverish very many of the shareholders, ruin the most sanguine and hopeful, and drive not a few into workhouses; whilst the highly satisfactory results of the subdivision of the south side of London by the several companies among themselves, has so palpably and unmistakeably demonstrated the fallacy and destructiveness of the mad system of competition, which the short-sighted and impolitic extortion of the original companies had previously enabled crafty, designing, dishonest men to call into existence and foster, ostensibly for the good of the public, but in reality merely for their own selfish ends, that the companies now supplying the north side of the river have determined to adopt the same system, and are at this moment carrying out the details.

Fortunately, the public mind is not at present in that impressionable and exciteable, but epileptic state, which would admit its being mesmerised by jugglers, so that we may speak out without fear of the truth being successfully perverted to illegitimate purposes—least of all, perhaps, to a free-trade *furore* for a manufacture of new gas companies, from "a pious horror" of monopoly. In order, therefore, that the public may be able to comprehend, as well as non-professionals can do, the real position of the case between the gas companies and themselves, we will give them the following information, remarks, and advice:—

1st. Any number of consumers can be supplied from *one* work through *one* set of mains; therefore, any greater number of establishments merely represents so much more capital on which interest has to be paid by the consumers, in the shape of an increased price for the gas supplied to them, *or otherwise*, as the cost of a *vehicle for conveyance, with works, management, &c.*, is as much an element of this charge as are the prices of coals and other materials used in the process of manufacture.

2ndly. A certain amount of leakage is unavoidable; but this may vary from 5 to 45 per cent., and is in nearly all cases proportional to the number of miles or yards of main; therefore, doubled, trebled, &c., directly according to the number of different companies supplying the same district; but, indirectly, immensely more, because the animosity generated between the companies by the spirit of rivalry, competitition, &c., equally pervades their workmen, who, never belonging to a class capable of understanding that it is not wise "to throw stones in a glass-house," or of appreciating the golden rule, "to do as they would be done by," are the opposite of particular as to how much mischief they do to any opposition company's mains when opening on to their own.

3rdly. The injury done to the roads and streets by rival companies is very great, through their own canvassing, and the caprice or dishonesty of consumers. Instances are not wanting of a single consumer going consecutively to three distinct companies within two months, the street being "pulled up" each time, so that the roads are never consolidated, a greater or less number of trenches in process of subsidence constantly rendering them uneven; indeed, we have heard a very able road surveyor say that rival companies always make the inhabitants pay more in road rates than *the nominal saving* in the price of gas, *supposed* to be consequent on the competition, can possibly amount to. These subsidences also not unfrequently disturb and jar the joints of the mains.

4thly. Justifiably or unjustifiably, rancour, ill-will, and retaliation are uniformly begotten by the circumstances by or under which "an opposition company" is called into existence, and as "boards have no consciences"—an aphorism, unfortunately but too fully exemplified and borne out by recent occurrences—those men are employed as officials who will be least scrupulous in promoting their own supposed interests by carrying out, *per fas aut nefas*, what are erroneously deemed to be the interests of the respective companies, which include the infliction of the greatest amount of undetectible or difficultly-detectible evil on "the other company," and the most effectually humbugging the greatest possible number of consumers. These operations being reciprocal, their effects are physically felt by all concerned; but as none have clean hands, the fear of being met by a *tu quoque* restrains them from exposing or taking legal proceedings against each other, on most even of the few opportunities which are afforded by discoveries of *legally proveable* delinquencies; and when they do so, the exposures are of the most disgraceful, blackening, and damnifying description, as the published evidence in the comparatively recent case of the Imperial Company *versus* the London Company has so thoroughly shown; that it will probably be a long time before the public are again treated to such "a dainty dish of scandal." The doings of fifteen or twenty years are disclosed, and not only *not* denied, but "the statute of limitations" is actually pleaded as compensation, and a cross action brought upon similar charges; the litigants are sent out of court by a "reference to arbitration," the fight is continued before the arbitrators, but at more and more distant periods, until at last both parties compromise themselves by compromising the affair, and the "birds of a feather" once more "flock together," and, joining the other companies in the present endeavour to retrieve their respective properties from the common depreciation, become part of the virtual association with whom the consumers have now to deal.

5thly. Not only has the honesty of the companies and their servants been seriously impaired by competition, but temptations have been offered to the general public, *and freely taken advantage of*, to cheat them out of their gas, by having it surreptitiously laid on, and asserting when the inspector of any one of the companies called, that they were supplied by one of the others; and that it was only by co-operation between the inspectors of the different companies in each district that a stop was put to these unscrupulous frauds. Nor is this all: various tricks have been more or less successfully played with the meters, so as to cause them to allow portions of the gas to pass without registration; to which competition is to a degree an incentive, inasmuch as it produces a fear of giving offence, which deters inspectors from being as scrutinous as if there were no risk of losing a consumer, as they feel certain they should if they were to show suspicion of an innocent person. True, this ought not to be, but it is so; and therefore is, in so far, a shield to the guilty from detection. Indeed, to such an extent was this over-accommodativeness carried, that when a man had got so "over head and ears" in debt to one company that they "cut off" their gas from him in despair, he had but to apply to another company, who would instantly and unhesitatingly supply him, without asking any inconvenient questions; and as three companies were common—and we have even known five—in the same street, he had no difficulty in making a selection which next to victimise. And such being the case with some of the consumers with whom the gas companies have to deal, they naturally feel themselves, *pro tanto*, countenanced by a reciprocity in improprieties.

6thly and lastly, though not least; the evil effects of all this flagitious fraudulency are not confined to the gas companies themselves and their officers, or even to the pockets of the shareholders, though upon these they are bad enough; but they extend to society at large. There is no vice of which the growth is not increased by practice, and what either small or large bodies of men do collectively the majority do individually when they dare and can;—the malpractices therefore of a board of directors have an immediate and powerful tendency to corrupt each member individually. We need not be told that everything they do must be originally propounded or supported by some one or more of their number; that is obvious, and only illustrative of the old proverb, "One scabbed sheep mars a whole flock." Therefore, as competition multiplies the opportunities and strengthens the inclination for malice, craft, and mischief, so ought it to be discountenanced at all times, but more especially at the present, when public confidence both in public and private boards has been so justly and severely shaken. Example is better (*or worse*) than precept, and it cannot be supposed that the examples shown in the ill-disguised or undisguised acts of the managers, officers, and workmen of these large, important, and influential bodies are without their effects in the propagation and dissemination of depravity.

Such are a few of the reasons adducible against direct competition in the supply of gas; they have always existed, are perfectly unanswerable, and might and ought to have been put forward by the directors of the older companies in their opposition to the formation of new ones, instead of the mendacious pamphlets published with false returns of the costs of manufacture, which were made to appear 50, 100, or 200 per cent. beyond the truth, in order to bolster up by a pseudo-justification the enormously extravagant price which they were charging to the public,—the fact evidently being that they were so conscious of their grasping and extortion, that—blind to the true interests of those whose agents and representatives they were—they sought rather to conceal their want of straightforwardness as tradesmen, than to place their manufacture upon a sound and healthy basis. That a culpable neglect to do this characterised the management of the companies generally is indisputable, *as the recognised and admitted loss by leakage* was until very lately *from a third to a half* of the gas made, on account of the disgracefully slovenly manner in which their mains were laid, partly from the gross jobbery connived at, and partly from the incompetence of the superintendents,—cabinet makers, schoolmasters, pianoforte makers, &c. having been installed as "engineers" to gas companies, by the able, honourable, and disinterested men whom the too confiding shareholders had placed upon their boards of direction.

It may be said that we see the same system of appointing incompetent or half qualified men, pursued by other bodies besides boards of directors of gas companies,—that carpenters, shoemakers, and every conceivable class, are made surveyors of roads, locomotive superintendents, &c.; in short, *as a rule*, everybody is appointed to everything *except what he is fitted for*; that the honourable exceptions are so few, that they do not even serve to make these atrocious misdoings and their consequences sufficiently glaring, sufficiently offensive, and sufficiently felt, to be watched and guarded against; for did not the same incongruity of selection obtain with regard to members of public boards, directors of companies, &c., these incondite presentations could not be made.

Had the directors of the older gas companies been men with the most moderate quota of foresight, prudence, or grasp of mind, or even ordinary "men of business," they would have seen that, with a newly-introduced and useful article of consumption, their proper policy was to endeavour to keep the market as much as possible to themselves; not by trying to frighten others from embarking in the manufacture by unprincipled misstatements with regard to its cost, which they at the same moment neutralised by the fictitious price they demanded and obtained for it and for their shares, but by making and supplying it at the lowest possible rate, so as to get and keep all the consumers, and thus compel new competitors to sue for their patronage at a disadvantage: nay, more, had they followed this wise course, they might have been able to induce the legislature to withhold from other companies powers which, as in the case of railways, too close a proximity might render dangerous. They would have seen that to charge an exorbitant price for their gas—whether from a desire to make a dishonestly large profit, or in order to counterbalance the wasteful expense of unskilful manufacture—was but to hold out a premium for the formation of competing companies, either by those who wished to share in the "golden harvest," or by others whose intelligence or science made them aware that the commodity could be well supplied at "a lower figure," and that a decrease in the then high price would produce a more than corresponding increase in the number of consumers; and not only to hold out a premium, but to guarantee a reward by exasperating all beyond whose reach the luxury was placed by its price.

Again, if we excuse the earlier gas companies for not perceiving these principles at the outset of their career, it is impossible to believe that actual experience did not make them acquainted with them very soon after they began to trespass on each other's districts; indeed, we know that such was the case, as the price of gas was thereby reduced nearly 25 per cent., yet with more than the pertinacity of fools, did they one and all, and still more unaccountably, *company after company*, as they were successively formed, adopt and cling to the same blind, fatuous, and tortile policy, and combat step by step, for thirty years, both the conciliatory and compulsory efforts of their customers to obtain better treatment and more equitable terms, until the public—overdoing their part, as the gas companies had overdone theirs—succeeded, though at great cost to themselves, in reducing the price of gas to little more than one-fourth of the original charge, and the revenues of companies—both new and old—to so low an ebb that some of them were scarcely able to pay a dividend of 1 per cent. on their share capital, and one or two even below that. This brought them to their senses to a certain extent, but to a certain extent only, still so far as to induce the subdivision of London south of the Thames, which was carried into effect in August 1853.

The agreement not only bound the companies severally and reciprocally not to trespass on the districts thereby allotted to the others, but with a highly commendable, though somewhat incongruous prudence and foresight, specified also that a public meter-tester should be employed and paid by the four companies, by whom the meters supplied to the consumers should be tried, so as to insure as far as possible correctness in their registration; an officer was also to be similarly appointed and paid to test the lighting power and chemical purity of the gas, so that they might keep a check on each other; and had the results of his examinations been regularly published, this arrangement would have been highly valuable and important, both to the companies and the public, but mystery has always been one of those very gross improprieties by which the companies have so effectually excluded themselves from the respect of the public. Mystery, or a desire to conceal, naturally implies that there is something to conceal, and that a general or particular knowledge of that something would be productive of benefit, which it is desired to withhold, or of injury, retaliation, or punishment, which there is an equal anxiety to avoid. It was also stipulated that the price should be uniform, and that no alteration should be made in it except by the general consent of the four boards of direction and the "trustees of the public."

These terms have hitherto been kept in tolerably good faith, but they show how severely the companies had suffered at each other's hands, and how little confidence they felt in each other's discretion, having been dictated by a fear that one or more of them, deeming all further competition and interference at an end, might raise the price, lower the quality, or, with a view to lessening the leakage, reduce the pressure, and consequently the supply, so as to irritate the consumers into starting an additional company, which, being unrestricted to district, would re-involve them in their old "game of forfeits;" and that this fear was not altogether groundless may be inferred from the reported statement of an over-sanguine chairman at a meeting of proprietors, that "there was nothing to prevent the directors from raising the price of gas to 20*s*. per 1000 feet if they thought fit to do so."

Whilst the companies were thus assiduously exerting themselves to promote and secure their collective interests, they were not idle individually in arranging boundaries, &c., between themselves and the small suburban companies which had posted their works on the outskirts of the others, or these, again, between themselves; so that by thus gradually and continually strengthening and consolidating their power, influence, friendship, unanimity, and co-operation, they may, as opportunities offer, be able to get a better price for their gas, or, should occasion demand it, be capable of withstanding a reduction or an opposition. In addition to these, many minor cases occur, wherein they will be in a position to play into each others hands with advantage.

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When the districting bill was withdrawn, the agitation was so far continued as to enable them to take advantage of the field and materials thereby afforded for the formation of a "Gas Consumers' Mutual Protection Association," which they intended "to render effective by an extensive organisation;" the committee being, in the words of their own prospectus, "*Conscious that in unity alone will be found the strength requisite to resist the encroachment of the powerful interests combined and arrayed against the consumers and ratepayers.*" The objects of this body (after a silly "protestation against monopoly," and vapour about "free-trade principles") were declared to be—that "the attention of a Managing and Finance Committee should be constantly directed to the quality and price of gas; its unsatisfactory and uncertain supply; the extraordinary *and inexplicable increase of registration by meters* (experienced by almost every consumer); the unjust system of enforcing payment of arrears upon in-coming tenants; and the illiberal practice of charging 30*s*. per annum upon consumers, however small their consumption; and especially to every subject of complaint submitted to them by members of the Association."

This Association is in the best position at present, if it know how to avail itself of that position, to take the initiative in forming a "London Gas Consumers' Society" (we detest *ass*-ociations and long rigmaroles of names as empty as high-sounding, and serving only to expose the kindred emptiness of those who beget them). That the Association can do so, and that such a society, *properly conducted*, will be effective in obtaining what is required by consumers (which is tolerably well epitomised in the extract we have given above from their prospectus), may be inferred with sufficient certitude.

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In the beginning of our remarks on the present relation of the gas companies to the public, we showed, under six distinct heads, that competition between gas companies is suicidal to themselves and disadvantageous to the public, and that therefore the public will best consult their own interests by allowing each gas company to enjoy a monopoly of its own district under proper supervision and regulations—that is, that the companies shall employ the best known means of manufacturing the best gas in the most economical manner, and shall then give a full supply of it to the public on such terms as shall leave no more than a reasonable profit to themselves.

We then showed that the companies have long since forfeited the respect and confidence of the public, and that the present districting arrangements have been entered into solely with a view to their own aggrandisement, and to the gradual consolidation of a confederation sufficiently gigantic and powerful to be able to override any ordinary attempt at the method hitherto adopted to reduce prices, and ensure civility and good treatment, by the creation of rival establishments; and, further, that these very rival establishments have, in their turn, as soon as the "brush" with the former occupants of the locality was over, adopted the very system of overreaching and surcharging to cure which they were called into existence; and we may here add that the Surrey Consumers' Company, which is the last of these rival companies started upon so-called "free-trade principles," was compelled to become the most active in promoting the districting arrangement, if they did not originate it, as the only means of saving them from bankruptcy; which it has so effectually accomplished that they are now paying 8 per cent dividend.

We have likewise shown that by their conduct with regard to their bill before Parliament, and their mendacity respecting it, and also by the tact, astuteness, and pliability with which they have avoided or withdrawn from any collision with the consumers since their coalescence, the companies have proven themselves as little trustworthy as before it; and, moreover, that they have been, and are, playing a very deep game to involve the consumers in a network from which they shall not be able easily to extricate themselves, and of which the present extension of the districting is to those who can read it, a still further *denouément*. Our readers will have also perceived that their appointments of officers, and their manufacture and distribution of gas, are in many (we do not say all) cases as little creditable to them as their quondam dealings with each other, and their general conduct to the public.

Not only have we shown all this, but we have also candidly, though in perfect friendship, exposed the blunders of the only section of the consumers, whose instinct for self-preservation has been sufficiently strong to induce them to meet combination with combination. So few bodies of individuals, however seemingly well organised, wriggle into satisfactory operation and progress —not to say prosperity—without blundering through a state of probation, that as a rule it seems almost impossible to succeed otherwise; and therefore, as the Consumers' Association has already manifested a sufficient amount of stupidity and perverseness to enable us to hope that they have passed the Nadir of their course, and are now able, ready, and willing to make themselves useful by going to work in earnest, at once to accomplish the objects for which they have associated themselves, we prefer seeing them expand into a society which shall embrace the whole metropolis, to having a new one started which should have to pass through its ordeal of errors, improprieties and oversights; but if they have not sufficient public spirit and self-respect to do so, then the latter alternative must be adopted, notwithstanding that "competition" in defensive operations is as little likely to be beneficial as competition between the companies. "Union is strength;" but it may come too late, when the companies have got their staff and *matérial* into working order and begin the aggressive, to be able to withstand them successfully with inexperience and defective organisation. "Prevention is better than cure," and the more so that its accomplishment is not at all incompatible with perfect harmony, whilst a "cure" could not be effected without discord and ill-will.

We will now, therefore, state the mode in which this society ought to be formed, and close with a few observations on its permanent government and operations. By the "Metropolis Local Management Act" the lighting of the thirty-eight districts into which the metropolis was thereby divided was entrusted to their respective vestries and boards, who are, therefore, as the representatives of the ratepayers; bound to attend to the quality and supply, as well as to the cost of the gas. One of the vestries, with a laudable desire to perform this duty efficiently, consulted a man of some eminence as to the proper mode and its expense, which latter they found, from his report, to be much greater than they were justified in incurring. But that which is too costly for each vestry or board individually, would be scarcely felt if spread over the whole, and therefore it would be highly advantageous to them to pay the society a small amount to perform this duty for them, which the society could cheaply and efficiently do, and ought at the same time to keep itself right with them and the public, by receiving at its Board of Management one member from each vestry and district board of works, stipulating that he should not be a gasfitter, or *in any way* connected with the companies. A certain number should also be elected by the private subscribers; all the above being honorary appointments.

This being done, an engineer, secretary, solicitor, and collector would form their permanent staff; but commission agents should be appointed in various parts of town to solicit subscriptions. It should then be the duty of the engineer to report to the committee bi-monthly on the lighting power and chemical purity of the gas, with its pressure and all other requisite particulars taken indiscriminately at different points in every locality supplied by each company, and these reports, or an abridgment of them, ought to be regularly supplied to the leading journals for publication. It is, unquestionably, a gross imprudence in any individual or body to permit themselves to be supplied with an article upon the quality of which they have no check. The supply of gas is a continuous daily operation, and therefore the check ought to be continuous also; and as we find the freedom of the press and of public opinion are engines quite capable of controlling much more powerful bodies than even the gas companies, there can be no doubt of the efficacy of the publication of the returns in exciting an emulation in the manufacture and distribution of the gas between the managers and other officers of the different companies, which would produce much greater benefits to the consumers, both pecuniarily and otherwise, than any reduction in the present price could possibly effect. The amount paid for gas is but one element in its cost, as is evidenced by the fact that those who burn the Cannel coal gas at the west-end, at 6*s.* per 1000 feet, find that they have *for the same amount of light of a better quality* no more to pay at the end of the year than if they had used the common gas at 4*s.* 6*d.* per 1000 feet.

The committee would also watch all legislation on the subject; and in the event of an opposition company becoming indispensably requisite from any cause in any particular locality, the society would be able to give unerring data, and otherwise to render important assistance. The other points mentioned in our quotation from the prospectus of the Association would be regularly and duly attended to, and an apparatus kept for testing the meters of the subscribers. In short, if this society be properly, honestly, independently, energetically, and practically carried out, it will very soon have the effect of placing the gas supply to the metropolis on a sound and healthy basis, and will be of immense advantage to the gas companies themselves, by protecting them from calumny and undue vituperation.

We must not be misunderstood as inveighing against legitimate competition where it is admissible. We have been writing on the subject of gas, and have confined ourselves to it.*

TAYLOR'S COMPENSATING CRANE.

Mr. J. Taylor, of Middlesborough-on-Tees, has patented an improved crane, which consists of an ordinary crane with the addition of a second chain barrel set in motion by the ordinary barrel, but revolving at a less velocity. A chain from this second barrel is carried over a pulley on a second short jib projecting from the after part of the crane, and to this crane a series of weights are to be fixed according to the weights which the crane is working. The second barrel is thrown into and out of gear by a clutch or friction sheave, and when not in gear is held by a brake, or by palls. When goods are being lowered by the crane, their weight will raise the weight on the second barrel, and this again will wind up, or assist in winding up the chain on the first barrel as soon as it is released from the load and the brake relieved: at the same time the crane is to a great extent balanced by the weights on the second barrel, and there is less work for the brake to do. In some cases, however, it may not be convenient to apply a second jib, as for example in warehouse cranes. In such cases the second barrel and the weights may still be used for winding up the chain or rope, and for partly counterbalancing the descending load, the chain from the second barrel being taken over a pulley fixed in a convenient place. In many cases one constant weight is sufficient, such weight being adjusted in the first instance to wind up the chain at a convenient speed, and being governed by the brake. In raising a load the second barrel can be disconnected and the crane used in the ordinary way, or the weight on the second barrel can be used to assist in lifting the load.

* We had almost omitted to mention that we are indebted to the *Building News* for the above extracts from Mr. Beaumont's paper.

BUTCHER'S COMPOSITION FOR COATING IRON.*

The Committee on Science and the Arts constituted by the Franklin Institute, to whom was referred for examination "a Composition and Process for Coating Sheet Iron to be used for Roofing," invented by Messrs. Butcher and Son, of Philadelphia, —report:

That the iron is prepared by heating to a point below redness, and plunging it into a bath of preparation or coating, consisting of linseed oil, gum elastic, lead, and other ingredients made known to the committee; the iron thus coated is finished by baking until the surface is dry, it then presents a tolerably even surface of elastic varnish or japan, which possessing considerable flexibility enables the iron to be folded short without cracking or scaling, and from its close adhesion to the iron prevents the action of atmospheric moisture.

The numerous joints made when turned plates are soldered together to form a roof are a very objectionable feature in the use of that material, as the roof becomes leaky mostly at the soldered joints, which is due to galvanic action, from moisture getting to the metal through the imperfect coating of paint which is applied with a brush, and cannot be covered so well as in the process patented by Messrs. Butcher.

The length of the sheets of prepared iron is such that but few joints are required in a roof of ordinary size, and these are made by folding in such a way as to allow for expansion and contraction due to atmospheric changes.

The spouts or guttering made of prepared iron appears to be far more durable than tinned iron, as the tube is coated after it is formed, and is protected by the composition within and without.

. The committee can see no reason why the prepared iron of Messrs. Butcher should not be used as a valuable material for roofing, especially as a substitute for tinned plate, as its first cost is less, and having fewer joints must be less liable to leak.

RESTORATION OF ETON COLLEGE HALL.

The interior of the hall of Eton College has lately been almost rebuilt from the designs of Mr. Woodyear. The old roof has been removed, and one of open timber-work substituted, with a turret lantern in the centre. There are two new windows, east and west, executed in stone, and at the west end a light canopy, in Gothic oak framework, replaces the previous heavy one. At the east end a gallery has been erected over the space dividing the hall from the buttery, &c. It is of carved oak, the front panelled with shields of Henry VI. The gallery is supported by a screen of lancet arches, the upper portion alone being open, forming a cloister between the steps ascending to the hall, and those descending to the kitchen, &c. The hall is entered by a pair of Gothic doors in the middle of this screen; the hinges are of polished steel.

It will probably be recollected that around the whole of the hall runs a panelling of oak about 8 feet in height, consisting of small panels about the size of school-boys' slates, cut all over with the names of Etonians of several generations; and here, during the improvements now in progress, a singular discovery was made. At the back of this panelling on the north and south sides, and also at the dais end of the hall, were found massive stone fireplaces about 12 feet in width, the mediæval carvings of each being as perfect as if from the hands of the sculptor yesterday. In neither of them was there any outlet for a chimney, or the slightest discolouring from smoke. The discovery has given rise to a great deal of conjecture, the general supposition being that the fireplaces are contemporary with the foundation of the college in 1441, and consequently of an antiquity of over four hundred years; if so, the perfect appearace is absolutely marvellous. It is well known the original intention of the founder was to have built the whole of the college with stone, but, from some unexplained cause, the entire use of stone in construction was abandoned, and bricks came into use. Mr. Britton, in his 'Architectural Antiquities of Great Britain,' quotes manuscript accounts in the British Museum of the expenditure of the building of Eton College, containing some interesting information on this point. The outer walls of the college hall (still remaining in their original state) afford undoubtable proof of the abandonment of the stone and introduction of the brick, and most strange is the wed-

* From the 'Journal of the Franklin Institute.'

ding of the two materials, no attempt having been made to give a finish to the former, the bricks being built into the stone in a very incongruous manner. There is little doubt this hypothesis respecting the stone fireplaces is the correct one.

Mr. Woodyear, on the discovery, so modified his plan as to include the fireplaces in the design: a tesselated pavement is to be added. The alterations have been effected at the cost of the Rev. J. Wilder, one of the fellows, who has also recently placed three memorial windows of stained-glass in the south side of the college chapel.

NEW BARRACKS AT GOSPORT.

Considerable progress is making in the completion of the new barracks at Gosport. In the design of these buildings every kind of modern improvement has been adopted. A separate pavilion is allotted for the married privates, and another for the non-commissioned officers, whose position will thus be more elevated than when obliged to associate with the private soldiers. These barracks are only to have one story above the basement, so as to be kept as much as possible under shelter of the ramparts, and the tops are to be rendered bomb-proof, by being arched and covered with an arrangement of concrete and earth. The utmost attention has been paid to sanitary measures. The rooms will be so arranged as to admit of most complete ventilation, and the water-closets and sinks will be disposed in such a manner as to prevent effluvium arising from them, which is often the cause of much annoyance in old-fashioned barracks. The drains will be carried into Portsmouth harbour, 2 feet below low water-mark; and an excellent plan has been adopted for flushing them. A tunnel has been made from the moats surrounding the fortification (which are supplied from Haslar Lake) through the land into the drains, and when it is required to flush them, the water in the moat will be retained until the tide in the harbour has fallen several feet, when the sluices will be opened, and an impetuous stream of water forced through the drains, carrying with it all impurities. The arrangements for supplying water to these barracks have not yet been decided upon. It is understood that the Admiralty contemplate leading water down to the Royal Clarence-yard from the high land near Fareham, which, if carried out, will probably be the source from which the new barracks will be supplied.

INSTITUTION OF CIVIL ENGINEERS.

The Council of the Institution have recently awarded the following premiums, for Papers which were read during the past session:—

1. A Telford Medal, to Daniel Kinnear Clark, Assoc. Inst. C.E., for his Paper "On the Improvement of Railway Locomotive Stock."
2. A Telford Medal, to Robert Hunt, F.R.S., for his Paper "On the Application of Electro-Magnetism as a Motive Power."
3. A Telford Medal, to George Rennie, M. Inst. C.E., F.R.S., for his Paper "On the Employment of Rubble-Beton or Concrete in Works of Engineering and Architecture."
4. A Telford Medal, to William Bridges Adams, for his Paper "On the Varieties of Permanent Way practically used on Railways."
5. A Council Premium of Books, suitably bound and inscribed, to Frederick Richard Window, Assoc. Inst. C.E., for his Paper "On Submarine Electric Telegraphs."
6. A Council Premium of Books, suitably bound and inscribed, to George Barclay Bruce, M. Inst. C.E., for his "Description of the Method of Building Bridges upon Brick Cylinders in India."
7. A. Council Premium of Books, suitably bound and inscribed, to Augustus Stephen Lukin and Charles Edward Conder, for their Paper "On the Disturbances of Suspension Bridges, and the mode of counteracting them."
8. A Council Premium of Books, suitably bound and inscribed, to William Bell, for his Paper "On the Laws of the strength of Wrought and Cast Iron."
9. A Council Premium of Books, suitably bound and inscribed, to Francis Roubilliac Conder, Assoc. Inst. C.E., for his Paper "On the Laying of the Permanent Way of the Bordeaux and Bayonne Railway."
10. A Council Premium of Books, suitably bound and inscribed, to Thomas Dunn, Assoc. Inst. C.E. for his Paper "On Chain-Cable and Timber Testing Machines."

The first meeting of the members of the Institution for the session 1857-58 will take place on the 10th instant.

THE NEW CATHEDRAL OF ST. MARY'S, OSSORY, IRELAND.

The new Roman Catholic Cathedral of Ossory was consecrated on the 4th ult. The foundation-stone was laid on the 18th of August 1843. It is in style early Gothic; in length 170 feet; breadth across nave and aisles, 66 feet; and across transepts 99 feet. On plan it is cruciform, with a tower 30 feet square interiorly, supported on massive moulded piers and great arches at the intersection of the transepts, and a chancel 35 ft. 3 in. by 30 feet, with a semi-decagon end and sacristy, &c., in connection therewith. The nave, 33 ft. 6 in. in width, is separated from aisles (16 ft. 9 in. in width) by two ranges of arches, five at each side, resting on clustered piers 20 feet in height, and at distances of 17 feet from centre to centre. The roofs are of open timber-work, that over the nave presenting a series of curved principals, with elaborate carving in the spandrils, moulded purlins, and ridge-piece; and sheeted wainscot ceiling concealing the actual construction, which is above the apex of the vault, and consists of an ordinary king-post truss, with principals. The great western window is of six lights, with wheel tracery in the head, and is filled with stained glass. Over the great altar, which is an elaborate specimen of art, brought from one of the principal manufactories in Rome, and composed of the rarest Sienna, Carrara, and scagliola marbles—are lanceolated windows, also filled with stained glass; and the chapels, dedicated to the Blessed Virgin and St. Joseph, have also handsome altars, and are embellished. Galleries are introduced into the space usually occupied by the triforium, and have doublet opes with traceried heads. The clerestory windows are triple and lancet-headed. The tower rises to a height of 186 ft. 6 in., and contains a belfry. Doors, with side pillars of chiselled marble, lead to the transepts. The organ is situated beneath the great western window, but will be replaced by one of greater power. Externally, the walls are embattled in portions, and have hooded buttresses, string and plinth courses, &c. At the western extremity is a great entrance door, with deeply-recessed jambs, having three-quarter shafts, from which spring the moulded ribs of the arch; also two other minor doorways leading to the aisles; and at each angle of the projection, which shows the same width as the nave, and terminated by a gable, are octagonal buttresses, surmounted by pinnacles, and containing winding-staircases leading to the organ-loft.

The total expense of this building was 25,000*l.* which is considered remarkably moderate for the enormous quantity of work executed. There has not been any chief contractor, and the clerk of works is Mr. Cody. The architect, Mr. W. D. Butler, also designed and superintended the College of Kilkenny, built some years since, and an important structure in the Jacobean style, presenting some 300 feet frontage. It is, however, to be regretted that the tower and wings, as shown in the original drawings, were dispensed with.

WEARMOUTH BRIDGE ALTERATIONS.

The Town Council of Sunderland have resolved to advertise for estimates for the alterations about to be carried out on Wearmouth Bridge, under the superintendence of Mr. Robert Stephenson. The leading feature of the plan is the widening of the bridge, 3½ feet being added to the carriage-way, and 2 feet to each of the footpaths, representing, in all, an additional width of 7 ft. 6 in. The levels will be very materially altered. At present the gradient is about 1 in 8, but this incline will be so far raised as to reduce the gradient to 1 in 50, the steepest portion at each end being raised upon arches of brick. The all-important object of strengthening the structure is amply provided for. Instead of the cast-iron rings which at present fill in the spandril part of the arch, lattice-work of malleable iron will be substituted; and three massive tubular girders will be thrown from north to south —one on each side of the east and west ribs, and another in the centre. The surface of the bridge will be covered with corrugated iron plates, upon which will be placed a bed of concrete; and, above this, on the carriage-road, there will be a pavement of wood, set with asphalte. During the progress of the alterations, a temporary bridge, 12 feet wide, will be formed on each side of the present structure. The cost of the whole will be about 20,000*l.*

THE DESIGNS FOR PROPOSED STREET SUBWAYS.

The Committee appointed by the Metropolitan Board of Works to consider the designs for subways in new streets in the metropolis, have made their award. Thirty-nine competitors sent in designs, from which the following selection was made.

No.	Motto.	Name and Address.	Guineas
	First Class Street.		
19.	(Juvenis) Unus inter multos...	H. D. Davis, Maida-hill west...	100
32.	Strada Nuova	James T. Knowles, Raymond-buildings, Gray's-inn	50
11.	Ferimur per opaca locorum .	Frederick and Alfred Warren, Duke-street, Adelphi	10
	Second Class Street.		
3.	Gracious be the issue.........	W. H. Cullingford, Pembridge villas, Bayswater	50
26.	Selim's Duplicate System ...	Wm. Reddall, Chapel-place, Poultry	20
24.	Aux grands maux les grands remedes	S. Hughes and G. Hopkins, Park-street, Westminster	5

The Committee consisted of Messrs. R. Stephenson, T. Hawksley, G. Lowe, T. H. Wyatt, J. Thwaites, W. Cubitt, A. Wright, J. W. Bazalgette, and F. Marrable. They remark, in making their award, that "the difficulties in the way of arriving at a satisfactory decision have been very great; no general principles were found to apply, nor was it possible either to approve or condemn all the parts of any of the designs submitted to competition: the Committee have therefore selected those designs which appeared to them to be most susceptible of such practical adaptations as would render them most generally applicable to the circumstances of the metropolis."

The thirty-nine designs are now exhibiting in the lecture-room of the Society of Arts, Adelphi. The feature common to nearly every design appears to be a centre tunnel; and in the majority of instances there is so great an attempt at utilising every part of the space which the designs have to deal with, that the streets constructed according to their ideas would be little less than a series of viaducts; and taking the traffic of an ordinary second-class street as a basis for calculations, there can be little doubt that the expense of building the arches would, from the great strength required, be immense. It appears that a governing principle has been recognised by the competitors of offering a minimum accommodation for stowage of gas and water mains, instead of wisely preparing for the maximum, for the future as well as present requirements. Economy of working at the lowest price per lineal yard has been allowed to defeat the real object of subways, which should have ample space and provision for the pipes of various companies; for if limited to one gas company or one water company's monopoly, there would be liability to accident to the pipes of that company, when the street would be at once deprived of gas or water, or perhaps both at the same time.

The question now is—Has a wise judgment been given in awarding the prizes? We think not, more especially in the case of the first prize, No. 19, that of Mr. Davis ("Juvenis, Unus inter multos.") We would be the last to depreciate merit, but a design should certainly have originality to recommend it to notice. In this design we cannot recognise anything more than a reproduction of a sectional drawing from Jasper Rogers' pamphlet, 'Facts and Fallacies of the Sewage System.' This drawing has suffered in its apparent copying, the number of mains being reduced, and an alteration, which is certainly not an improvement, being made in the form of the under drain, which cannot be called a sewer, being thoroughly inadequate to contain the sewage waters and rain-fall combined of a first-class street. Mr. Davis proposes the formation of a continuous subway or passage, 9 feet wide, under the centre of the road, and above the sewer. On either side of the passage are to run water-mains, and above them gas-mains, supported upon stone corbels. Vaults are to be constructed the whole length of the street on either side of the passages, to afford increased cellarage to the houses. The subway is wide enough to allow a man to walk in the centre, and the gas and water pipes are to be fixed in such a manner as to be easily accessible for repairs. Telegraphic wires are to be carried along the subway on projecting stone corbels. Entrance to the subway is to be obtained by vaults reserved at the intersections of streets, at distances of about 400 yards. The cost, including vaults for the houses, is stated at 36*l.* per lineal yard. If there be any merit, it belongs to Jasper Rogers; but it does appear to us that many other more deserving competitors have been unnoticed whose plans bear evident marks of thought and matured deliberation; but the manner in which competition designs have lately been treated will, we fear, act as a serious check in preventing many clever men from entering the lists for competition designs for the future.

Mr. Knowles ("Strada nuova") fifty guineas prize, forms a central subway 15 feet wide, with vaults on either side, the expenses of which are to be defrayed by the owners of buildings fronting the streets. Ventilating shafts at the intersections of streets at certain intervals, for main sewers, are to be carried sufficiently high to discharge all noxious gases into the atmosphere above the surrounding housetops. The estimated cost is 22*l.* 14*s.* 7*d.* per lineal yard, exclusive of the expense of constructing the private vaults, or 16*l.* 5*s.* 7*d.* per yard for second-class streets.

In the design No. 11 (Messrs. Warren), the house vaults are as usually constructed, and a gangway 4 feet or 5 feet wide, is formed against the end of them, in which are placed the water and gas mains. The sewer is in the centre of the road, ventilated by openings in the road, or by lamp-posts, and shafts carried up in the chimney-stacks of some of the houses abutting on it. The houses are to be drained in pairs by 6-inch pipes, running into a 9-inch pipe, which is to be connected with the sewer; and the water-supply is to be by a 9-inch main on one side, with a 4-inch rider ditto on the other, always charged at every lamp-post in case of fire, for road-watering, &c. The cost of this arrangement, including a cast-iron paving for the carriage-way, but exclusive of the water and gas main castings, is computed at from 38*l.* to 39*l.* per lineal yard.

Mr. Cullingford ("Gracious be the issue") fifty guineas prize, proposes the formation of a passage over the main sewer, along which the pipes for the supply of water and gas and the telegraphic wires can be fixed. He suggests that the sewers and passages should be ventilated by means of flues, carried into the chimneys of each alternate house, side by side with the kitchen flues, with which they should be carried up to the top of the building. The cost applied to a first-class street is 15*l.* per lineal yard, and 12*l.* per yard for a second-class street.

Mr. Reddall ("Selim's duplicate system") twenty guineas prize, suggests the formation of continuous passages below the footpaths, of sufficient capacity to contain water and gas pipes, and to allow of repairs and alterations. He also recommends means for preventing the escape of effluvium from the sewers, and proposes a system of ventilation very similar to that suggested by Mr. Cullingford. The estimated expense is 23*l.* per lineal yard for a first-class street.

In the design, No. 24 (Messrs. Hughes and Hopkins), the whole of the ground is cleared away, the interval between the backs of the vaults being used for the subway; the sewer, instead of being sunk, will stand *on* the paving of the passage-way, the gas and water mains resting upon it. The cost is calculated, with the vaults under the road, as at 45*l.* per lineal yard, exclusive of the vaults, but with tunnel communication to each house at 39*l.*

We noticed a set of designs, No. 28, which appear to have emanated from a practical engineer; the works are well detailed, and although extravagance in all cases should be avoided in public works, still there is a line to be drawn, so as to avoid delusive cheapness.

These remarks apply also to designs No. 7 ("Practical"), which certainly claim originality. They were described and illustrated in our *Journal* for October 1854. Beyond their claim to originality, they have received during the past seven years high approval from various public bodies; which we think should have entitled the competitor (Mr. W. Austin) to a prize, or at the least to a recognition. Objections might possibly exist that the designs and arrangements (No. 7) are on too large a scale; this might be easily obviated by reducing the scale, keeping the contour section and general arrangement still in view; but we much fear that this curtailment would be unwise, for that which is worth doing is worth doing well; or, as the *Times* in a recent article has it,—"To do the work before us as well as we can, and when it is done, to be content with the *gain* rather than to count the *cost*."

There are many serious objections to the arrangements in the majority of the plans, including the selected prizes, which will doubtless, if put in practice, prove serious difficulties. We allude to the want of proper access to the pipes, for repair or removal of obstructions. We object, too, to the low fall given to the house drains discharging into the sewers, which latter, when fully charged, would choke back the house drains, and flood the cellars and basements of the houses,—the very evil which subways should prevent if properly constructed. Another objection is the proposed discharge of gases and foul vapours from the sewers, through towers or shafts into the air; which would be blown down again into the upper floors and garrets.

To prevent the possibility of such results, works imperatively necessary for the health and improvement of the vast metropolis should be carried out in such a manner as to reflect the highest credit on our abilities and exertions, by a selection of the best methods and the best materials which can be procured; the combination of which, under judicious arrangements. must effect the desired object.

ROYAL INSTITUTE OF BRITISH ARCHITECTS.

The session will commence on the 2nd inst.; and the honorary secretaries have addressed a circular to the members, inviting them to contribute papers or information in another shape to the general meetings. They say:

"If, as is highly probable, you may have recently made some particular subject your especial study, or if, as is not less likely, you have been engaged upon the design and superintendence of some works involving novelties in architectural composition or construction, you would be conferring a benefit upon the profession at large by the communication to the Institute of the results of your study in the one case, or your experience in the other.

"In these days, when new styles of art, new building materials and appliances, and modifications of old ones, are being constantly brought into use, the records of individual experiment are of growing importance; and we trust that you may take occasion to communicate to the Institute such conclusions as you may have arrived at with respect to their value, either by theoretical investigation or actual practice.

"We find occasionally that architects have withheld valuable papers from an apprehension of the necessity of preparing elaborate diagrams. Such apprehensions need not be entertained, as we have found that papers are generally best illustrated by sketches, and the working drawings from which important buildings may have been executed."

At the opening meeting of the session, a paper by Mr. Wyatt Papworth will be read, "On the Introduction of Deal, and of Painting (woodwork) into this Country."

ARCHITECTURAL ASSOCIATION.

On the 16th ult. the first business meeting of the session was held at Lyon's Inn Hall. Mr. Wigley, President, who was in the chair, said that since the last meeting a fortunate event had happened to their treasury, and which had brought it nearly to par. After correspondence with the Architectural Exhibition, with reference to the advance of funds that was made by the Association, on the occasion of the first Architectural Exhibition, in 1849, altogether originated by the Association, which advanced something like 15*l.* for the purpose, that sum had been refunded by the Architectural Exhibition to their treasury. This gave the Association the double satisfaction of having a public acknowledgment of their having originated that useful public institution, and enabling them to face their creditors.

Mr. S. C. Capes read a paper "On the Public Libraries, Art Schools, Museums, and Buildings in London, with the advantages they offer in Architectural Education." Mr. Penfold madesome observation at the close of it, wherein he referred thankfully to the lectures of Professor Donaldson at the London University, and showed their value, as did the chairman also.

Mr. Herring, Hon. Sec., said it was a well-known fact that many of those engaged in architecture had not proper time, although they might have the means, for study, and he would propose that the meeting should express its feeling to the architectural profession at large, as to the desirableness of letting their pupils have the benefit of the Saturday afternoon. Ultimately, a resolution was passed expressing as the opinion of the Architectural Association that the privilege of the Saturday afternoon holiday should be accorded to the pupils and assistants of architects in London and the United Kingdom, and recommending the subject to earnest consideration.

NOTES OF THE MONTH.

Sculptors and others are beginning to turn their attention in earnest to designs for the proposed memorial of the '51 Exhibition. In this case the committee, seeking to afford every latitude, have made no stipulation as to scale, and will receive either models or drawings.

On 2nd ult. the election of a district surveyor for St. George-in-the-East and Aldgate, in the room of Mr. Henry Flower, resigned, took place in the Council-chamber, Guildhall, at the usual weekly meeting of the Metropolitan Board of Works. There were eleven candidates. The choice of the Board fell upon Mr. John Billing.

Mr. John Ayris, of Westminster, has been appointed by the corporation of South Shields to act as their borough surveyor.

At a meeting of the Islington Vestry on the 16th ult., the committee presented their report on the designs for the Vestry-hall submitted in competition, and recommended twelve designs for the consideration of the vestry. The following is a list of the numbers and mottos:

8. L'Espérance.	52. Dum spiro spero.
32 & 33. Islington.	57. Whyttington.
35. Utilitas.	66. Faith.
46. Con Amore.	69. Nemo.
47. (A device.)	71. A. B. C.
50. Utility.	72. Bravo.

After some discussion, the recommendation of the committee was adopted, and the further consideration of the matter was deferred for a short time.

The temporary pedestal in the court-yard of Burlington House, Piccadilly, for Mr. Foley's excellent equestrian statue of Lord Hardinge, is now ready. The statue is cast, and will shortly be put up.

The Town Council of Sunderland, having requested Mr. Crozier, the borough engineer, to prepare estimates for public drinking-fountains, he has reported that they may be provided for five pounds each.

In constructing the railway from Paris to Vincennes it was ascertained that a portion of the line would pass under the workmen's city of Reuilly, and fears were entertained lest it should be found necessary to remove the structure. The engineer —M. Bassonpierre-Sewerin—however, suggested an excellent mode of overcoming the difficulty. The tunnel was constructed in successive circles, or sections, beginning with those intended to support the angles and bearing portions of the building, and then connecting them by digging out the soil and constructing the tunnel in the ordinary way. After tracing the axis of the tunnel, the doors and windows were stayed and walls shored up, and the earth removed from beneath the walls at different points to allow of passing beams, about a foot square, under the angles of the structure, which was by these means supported. Two cuttings were then opened—3 metres broad, 8½ metres deep—in which the piers were built, and subsequently united by an arch. When the vaulting was completed it was made to carry the foundations of the workmen's dwelling by filling up the space between the latter and the arch with solid constructions. The remaining constructions were effected in the usual manner, and every portion of the building appears as solid and substantial now as it did before the passage of the railway beneath it.

There are at present two lines of magnetic telegraph in operation in South Australia, of an aggregate length of about forty miles, the line from Adelaide to the Port and sea coast (eleven miles), being opened on February 18, 1856, and the north line to Gawler Town, including a branch to the Dry Creek Stockade (twenty-nine miles), was commenced in the middle of January last, and opened on the 14th of April. A small station has been erected at Gawler Town. During the ten and a-half months that the Port line was in operation last year, 14,738 messages were transmitted, and in the first three months of the present year, 7253. The sum of 25,000*l.* was voted by the late Legislature, for the erection of the South Australian portion of a line to connect Adelaide and Melbourne, and contracts have been entered into for carrying out the work. Ten miles of submarine cable are to be laid under Lake Alexandrina and the Goolwa channel, to connect Goolwa and Pelican Point of Lake Albert Peninsula. Lines are in course of erection between Melbourne and Sydney.

THE council of the Architectural Institute of Scotland have made application to Sir Benjamin Hall to authorise an exhibition in Edinburgh of the prize competition designs for the War and Foreign Offices at Westminster. As the exhibition would prove of importance to the advancement of art in Scotland, it may be hoped that the commissioners will find it within their power to gratify the public of Scotland in this way.

AT a recent meeting of the Board of Guardians, fifty-six tenders for the survey and valuation of the parish of Kingston-on Thames, were received, varying in amount from 190*l.* to 1000*l.* The board decided on accepting the joint tender of Mr. J. Wornham Penfold, of Charlotte-row, Mansion-house, and Mr. E. Kermock, of Kingston.

MESSRS. COTTERELL and SPACKMAN are preparing a design for the re-erection of Bellott's Hospital, Bath, on a scale which will be likely to meet the wishes of the public, and to carry out the designs of the founder. One feature of the plan will be the introduction of a thermal bath for the use of the inmates.

MR. W. B. ADAMS, whose numerous useful inventions are well known, proposes to improve the windows of buildings by introducing two thicknesses of glass into one frame, or by joining the compartments of frames or sashes, or two sashes, to produce the same result, viz., a cellular space between the glasses, containing air, which will materially prevent radiation, and increase the warmth of apartments. The glass is to be fixed in the frames, either in the ordinary modes, or by means of elastic or plastic caulking.

M. ZANTH, architect to the King of Wurtemburg, and designer of the magnificent Moorish château, the "Wilhelma," near Stuttgardt, died recently. He was associated with M. Hittorff in his fine works on the buildings of Sicily, and was a corresponding member of the Institute of British Architects.

COMPETITIONS.

The municipal authorities of Bourdeaux have invited artists of all countries to submit designs for a Fountain of monumental character to be erected in that city. The choice of material is left open, and may be of several kinds; the cost is not to exceed 8000*l.* A premium of 240*l.* will be awarded, if a design of sufficient merit to justify it be presented. In addition, the sum of 160*l.* will be placed at the disposal of the jury, and be appropriated as they may decide. In the event of the execution of the selected design being confided to the author of it, he is to receive, independently of the selected design, an honorarium equal to the twentieth of the whole outlay. The designs are to be sent in by the 20th instant.

The Local Board of Health for the Minster District, Isle of Sheppey, are desirous of supplying the inhabitants of Sheerness with an abundance of spring water in their respective houses; and invite the attention of engineers to the subject. A premium of 100*l.* for the Plan, Specifications, and Estimates of requisite works is offered. Plans to be sent in by the 1st of January next. For particulars apply to Mr. Chas. Atkins, 20, Albion-place, Mile-town; or to Mr. James Beal, Sheerness.

Drawings or models of designs are invited for the erection of a Memorial of the Great Exhibition of 1851. Premium 100 guineas. The time for sending in designs is extended to February 2, 1858. A scale of 2 inches to the foot is suggested, but not insisted on.

COMPETITIONS AWARDED.

The design for St. Paul's School, Nottingham, having the motto, "I take this for my Mark," the author of which is Mr. C. H. Edwards, architect, 4, St. James's-terrace, Camden-town, has been adopted.

The design of Mr. J. Hamilton, architect, West Nile-street, Glasgow, has been awarded the premium for the New Bank-house for the Ulster Banking Company.

The Board of Guardians of the Hemsworth Union, near Barnley, have accepted the design of Mr. Weightman, architect, of Sheffield, for the new Workhouse.

NEW PATENTS.

PROVISIONAL PROTECTIONS GRANTED UNDER THE PATENT LAWS AMENDMENT ACT.

Dated June 12.

1648. J. C. Dieulafait, Essex-street, Strand—Improved method of manufacturing garments, whereby one garment may be changed in form to that of several others

Dated June 15.

1670. W. Smith, Salisbury-street. Adelphi—Improvements in chromotypographical printing presses. (Communication from A. E. Rochette, Paris)

Dated June 16.

1678. W. Smith, Salisbury-street, Adelphi—Improvements in steam generators. (Communication from J. M. Prost)

Dated July 11.

1938. H. Lamy, Essex-street, Strand—An engine or apparatus for obtaining motive power by an improved method of applying steam, gas, or heated air

Dated July 24.

2030. T. Williams, Aberdaron, Carnarvonshire—Improvement in the construction of ships or vessels, whereby their draught may be regulated

Dated July 25.

2032. W. Johnson, Stockport—Improvements in looms for weaving

Dated August 12.

2152. R. Wagstaff, Mottram-in-Longdendale, Cheshire—Improvements in locomotive engines to be employed on common roads or ways, applicable to agicultural and other similar purposes

Dated August 25.

2243. J. Gedge, Wellington-street South—Improvements in envelopes for letters and other documents. (Communication from F. Thénard, Paris)

Dated August 27.

2270. J. H. C. Löbnitz and J. McLintock Henderson, Renfrew—Improvements in steam engines

Dated August 28.

2276. J. Muckart, Montrose, Forfarshire—Improvements in effecting the combustion of fuel, and in the consumption or prevention of smoke, applicable to boiler furnaces

Dated September 4.

2318. A. Turner, Leicester—Improvements in the manufacture of elastic fabrics

Dated September 7.

2334. B. Parker, Hammersmith—A new elastic composition for coating, cementing, bedding, and otherwise protecting bodies, also applicable to the construction or formation of articles to which it may be suitable

2336. U. Scott, Camden-town—Improvements in boots and shoes, applicable in part to shoes for horses

Dated September 8.

2338. G. J. Mackelcan, Falcon-street, Falcon-square—Improvements in floating docks

2342. J. Marland, Fernlee Vale, Saddleworth, Yorkshire—Improvement in the manufacture of cop tubes

2344. W. Geach, Falmouth—Improvements in machinery for propelling vessels

Dated September 9.

2346. S. Hoga, Charlotte-street, Fitzroy-square—Improvements in apparatus for generating electricity, and for transmitting electric currents from place to place

2348. A. Hédiard, and S. Levieux, Paris—Improved boiler for generating steam

2350. E. Lavender, Aston-street, Limehouse—Improvement in distilling products from coal

2352. J. B. Bacon, Brunswick-square—Improvements in machinery for manufacturing horse-shoe nails. (Communication)

Dated September 10.

2353. H. Lawford, Berners-street—Improvement in the manufacture of dining tables with expanding and contracting tops, applicable also to other expanding and contracting planes

2354. J. Leslie, Glasgow—Improvements in carding or preparing textile materials. (Communication from A. Sentis and Sons)

2356. M. J. A. Mille and F. Canal, Paris—Improvements in producing gas

2358. J. Fenton, Low Moor, W. Thomson, jun., Wakefield, and T. Snowdon, Middlesboro'-on-Tees—Improvements in the permanent way of railways

2360. W. Clark, Chancery-lane—Improvements in Jacquard apparatus, and in the pattern surfaces of such apparatus. (Communication),

2362. J. Harrison, Red Lion-square—Improvements in apparatus for producing cold by the evaporation of volatile liquids in vacuo

2364. G. Brüninghaus, Dortmund, Prussia—Improvements in the treatment of iron ore (crude iron) for the production of iron and steel

Dated September 11.

2366. T. Silver, Philadelphia, United States—A machinery or apparatus for regulating or governing the paying out or delivery and the laying down of submarine or oceanic telegraph cable, parts of which are also applicable for taking and recording soundings, and for other purposes

2368. W. P. McCallum, Birmingham—Improvements in machinery used for stamping or raising metals

2370. S. Colbeck and W. H. Colbeck, Batley, Yorkshire—Improvements in looms

Dated September 12.

2372. N. Fisher, Milton, Northamptonshire—Improvements in machinery, combining operations in preparing land for agricultural purposes

2374. C. Watson, Alfred-place, Bedford-square—Improved apparatus for curing certain bodily complaints

2376. J. Edwards, Aldermanbury—Improvements in railways to facilitate locomotive engines ascending inclines

2378. J. Leeming, Bradford—Improvements in looms for weaving

2379. W. Gossage, Widnes, Lancashire—Improvements in the manufacture of soda and potash

Dated September 14.

2380. T. Waterhouse, Sheffield—Improvements in machinery or apparatus for applying steam and atmospheric air to actuating and governing forge and other hammers

2381. T. Marsh, Sheffield—Improved piston. (Communication)

2382. W. Jenkins, Miles Platting, near Manchester—Improvements in the furnaces or fire-boxes for locomotive boilers to adapt them for the consumption of coal and the smoke arising therefrom

2383. A. Gray, Glasgow—Improvements in the picking motion of power looms

2384. D. T. Lee, Birmingham—Improved washing machine

2385. J. Sleddon, and J. Marsland, Oldham—Improvements in preventing incrustation in steam boilers

Dated September 15.

2386. A. Gray, Glasgow—Improvements in lubricating mechanism

2387. R. Shiers, jun., Oldham—Improvements in the manufacture of velvets

2388. J. Ashby, Croydon—Machinery for cleaning wheat and other grain or seed from smut and other injurious matters

2389. J. Walmsley and T. Howard, Accrington—Improvements in machinery or apparatus for warping, sizing, or dressing and winding on yarns or threads

2390. T. Grahame, Leamington—Improvements in grinding corn, and in generating gas on inland waters

2391. G. J. Bensen, Christian-street, St. George's-in-the-East—Improvement in drying sugar

2393. A. J. A. Dumoulin, Paris—Improvements in heating apparatus

2394. T. Robson, Critchill-place, Hoxton—Improvements in washing machines

Dated September 16.

2395. T. S. Adshead, Staleybridge, Cheshire, and J. Platt, Oldham—Improvements in machinery for carding cotton and other fibrous materials

2396. P. B. Godet, Paris—A new mode of illustrating literary productions

2397. R. Wicks, Phœnix-street, Somers-town—Improvements in furnaces

2398. G. Davies, Serle-street, Lincoln's-inn—Improvements in the manufacture of cloth or woven fabrics composed of a mixture of wool and a vegetable filamentous material not hitherto used for such a purpose. (Communication from G. Ahman and A. de Villeneuve)

2399. A. Seward and C. Seward, Lancaster—Improved boiler for heating and keeping up circulation in water

2400. C. W. Lancaster, New Bond-street—Improvement in breech-loading guns, and in projectiles for the same. (Communication)

2401. A. R. le M. de Normandy, Judd-street, Brunswick-square, and E. T. Simpson, Wakefield—Improvements in the manufacture of soap

2402. J. H. Winder, Sheffield—Improvements in rotary steam engines and pumps

2403. W. Middleton, jun., and T. T. Chellingworth, Birmingham—Improvements in adjusting the sliding parts of chandeliers and gas pendants

2404. R. Brown, Glasgow—Improvements in moulding or shaping metals and other materials

2405. R. Garrard, Loman-street, Gravel-lane, Southwark—Improvements in the manufacture of japanned straw hats
2406. P. A. le Comte de Fontainemoreau, London—Improved railway break. (Communication)
2407. E. Alcan, Fore-street—Improved process for refining paraffine. (Communication)

Dated September 17.

2408. J. E. F. Luedeke, Birmingham—Improved motive-power engine
2409. E. Hayes, Stoney Stratford—Improvements in winding apparatus for hauling ploughs and other agricultural implements
2411. I. L. Pulvermacher, Paris—Improvements in apparatuses for creating electric currents, chiefly for medical purposes
2412. G. F. Hack, Hackney—Improved cigar tube or holder for smoking cigars or tobacco
2413. H. Greaves, New Palace-yard—Improvements in constructing the permanent ways of railways

Dated September 18.

2414. W. Smith, Salisbury-street, Fleet-street—A novel machine or apparatus for engraving the metallic surfaces of printing rollers or cylinders. (Communication from P. E. Gaiffe, Paris)
2415. B. Burleigh, Great George-street, Westminster—Improvements in the mode of laying submarine telegraphs
2416. J. Webb, Bristol—Improved chaff-cutter
2418. R. W. Savage, St. James's-square—Improved spring and appliances for carriages and vehicles, which can also be adapted to use on shipboard, or otherwise to maintain the equilibrium of articles placed on a platform provided with the said improved spring and appliances
2419. D. Imhof, Oxford-street—Improvements in machinery adapted to the exhausting or forcing of air gases or vapour, and in the application of such machinery to various useful purposes
2420. C. Delevante, Kimbolton-place, Brompton—Improvements in bouquet holders
2421. S. Whitehead, Bury, Lancashire—Improvements in trowsers as part of male attire
2422. S. Faulkner, Manchester—Improvements in machinery or apparatus for carding cotton and other fibrous substances
2423. R. Watson, Galashiels, Selkirkshire—Improvements in weaving
2424. R. Watson, Galashiels, Selkirkshire—Improvements in the manufacture of heddles or healds for weaving
2425. T. Wilson, Chiswick—Improved boot and shoe cleaning apparatus
2426. D. Lichtenstadt, Castle-street—Improvements in the manufacture of pulp of which paper and other fabrics are composed
2427. Sir J. C. Anderson, Fermoy, Ireland—Improvements in locomotives and other carriages
2429. H. S. Snell, Chancery-lane—Improvements in apparatus for retarding omnibuses and other carriages
2430. T. Webster, Paris—Improvements in the permanent way of railways. (Communication)
2431. J. W. Burton and G. Pye, Ipswich—Improvements in the construction of rollers used for pressing fabrics and fibrous and other materials
2432. H. Bessemer, Queen-street-place, New Cannon-street—Improvements in the manufacture of cast steel
2433. A. and A. Rigg, Chester—Improvements in preparing, sawing, planing, grooving, tongueing, moulding, mortising, and tenoning wood, part of which is applicable to preparing other vegetable substances

Dated September 19.

2434. W. Naylor, Bradford, Yorkshire—Improvements in power-looms for weaving worsted, cotton, silk, woollen, and other fibrous substances
2435. M. R. Leverson, St. Helen's-place—Improvements in the preparation of food for cattle. (Communication from F. P. Auburtin, Paris)
2436. F. Cavalerie, South-street, Finsbury—Improvements in motive-power engines
2437. W. H. James, Old Kent-road—Improvements in steam vessels, parts of which improvements are applicable to sailing and other vessels
2438. R. A. Brooman, Fleet-street—A method of decomposing soapy wash waters used in the washing and scouring of wools and cloths, of separating therefrom fatty matters held therein, and of treating such fatty matters. (Communication from F. Picard)
2439. W. H. Peake, Liverpool—Improvements in the construction of beams, girders, and bridges
2440. W. T. Eley, Broad-street, Golden-square—Improvements in percussion caps
2441. H. Ormson, Stanley-bridge, Chelsea—Improvement in the manufacture of cast tubular boilers
2442. J. Minnitt, Nottingham—Improvement in extracting grease from animal refuse resulting from the manufacture of glue and from fell-mongers' processes

Dated September 21.

2443. P. F. Joly, Paris—Improvements in apparatus for generating and superheating steam
2444. R. Gray, Sheffield—Improved band or cord to be employed for distending or expanding skirts or similar wearing apparel
2445. G. Schaub, Birmingham—New or improved manufacture of rollers or cylinders, with patterns or designs thereon, for printing fabrics and other materials
2446. L. F. Picot, Toulon, France—Improvements in salinometers or instruments for indicating the saturation of water in marine boilers
2447. E. L. Owen, Wolverhampton—New or improved method of propelling vessels
2449. J. Absterdan, Massachusetts, United States—A certain new and useful improvement in electric telegraphic tables
2450. J. Paterson, Wood-street, Cheapside—Improvement in clasps, buckles, and other like fastenings

Dated September 22.

2451. D. Forrester, Mortimore-road, Kingsland—An improved fastening for securing watches, &c., worn on the person, whereby the same are rendered safe from robbery, to be called "Forrester's Patent Watch and Property Protector."
2452. G. J. Worssam, Oakley-crescent, City-road—An ink self-supplying pen-holder
2453. M. Theiler, North-terrace, Westminster-road—A direct printing telegraph without relays and local battery (Communication from F. Theiler, Einsiedeln, Switzerland)
2454. M. Henry, Fleet-street—Improvements in the mode of transmitting motion, especially applicable to apparatus employed in navigation. (Communication from R. Tissot)
2455. J. Ford, Stepney—Improved apparatus for marking or scoring at whist and other games, which may be adapted for otherwise assisting the memory of the players
2456. R. Lawson, Manchester—Improvements in apparatus for regulating the admission of air to furnaces
2457. H. Hughes, Wellington-street—Improvements in machinery for cutting, embossing, and stamping
2458. G. Rennie, Holland-street, Blackfriars—Improvements in vessels for war and revenue purposes
2459. A. V. Newton, Chancery-lane—Improvements in obtaining photographic pictures. (Communication from D. A. Woodward, Baltimore, United States)
2460. W. E. Newton, Chancery-lane—Improved machinery for forging metals. (Communication)
2461. W. S. Clark and B. Moore, High Holborn—Improvements in machines for cutting splints for friction matches. (Communication)
2462. A. Count de Bylandt, Michael's-grove, Brompton—Improvements in propelling ships or other navigable vessels

Dated September 23.

2463. F. C. Bakewell, Haverstock-terrace, Hampstead—Improvements in the preparation for use of caustic alkalies. (Communication from G. Thompson, North America)
2464. P. Oury, Hatton-garden—Improved apparatus for impressing or marking figures or designs upon silk, cotton, or other suitable substances employed for lining caps, hats, and other similar articles
2465. P. A. le comte de Fontainemoreau, London—Improved method of marking paper for postal purposes. (Communication)
2466. A. Murray and W. Pollard, Bradford, near Manchester—Improvements in the manufacture of textile fabrics
2467. J. De la Haye and M. Bloom, Salford—Improvements in laying down submarine telegraphs
2468. W. Power, Rotherhithe—Improvements in steam-engine boiler furnaces, and other furnaces for smoke prevention

Dated September 24.

2469. W. B. Johnson, Manchester—Improvements in raising and lowering trucks, carriages, engines, or other such railway appendages from one level to another
2470. T. Singleton, Over Darwen, Lancashire—Improvements in looms
2471. A. V. A. Laugère, Orleans—Improvements in windmills
2472. T. Saunders, Pump-row, Old-street-road—Improved tumbler key and lever tumbler lock
2473. A. B. Patterson, Baltimore, United States—Improved mode of laying submarine cables

Dated September 25.

2474. J. Barber, Manchester—Improvements in machinery or apparatus for manufacturing rollers or cylinders used for printing and embossing woven fabrics, paper, leather, and other materials
2475. J. Kelshaw and J. Wilkinson, Elland, Yorkshire—Improvements in self-acting couplings for railway carriages and engines
2476. L. Newton, Oldham—Improvements in the mode of placing tubes on the spindles used in spinning machinery
2477. J. Fortescue, Charles-street, Middlesex-hospital—Improvements in the construction of domestic or other fireplaces for the purpose of consuming smoke and saving fuel
2478. J. Gregory, Bitton, Gloucestershire, and W. Craymer, Bristol—Feathering and adjusting screw propellers to be used in propelling vessels
2479. A. V. Newton, Chancery-lane—Improvements in rock-drilling machinery. (Communication)
2480. J. Jackson, St. Suerin-sur-l'Isle, France—Improvements in the manufacture of tyres for railway and other wheels
2481. J. Chubb, St. Paul's Churchyard—Improvements in the construction of iron safes and doors for strong rooms
2482. B. Robinson, Gilbert-street, Grosvenor-square—Improvements in the bodies and jackets of ladies' dresses

Dated September 26.

2483. P. Balboni, King William-street, Strand—A marine, submarine, and aerostatic propeller, being a new mechanism for propelling steam-vessels on and in the water, applicable also to aerostatic purposes, combining speed and safety in steam-boats, and giving the power of directing balloons
2484. J. Lewis, Salford—Improvements in machinery or apparatus for making bricks, tiles, and other similar articles, and also in the machinery for preparing clay for the same manufacture
2485. R. Watson, Galashiels, Selkirkshire—Improvements in weaving
2486. M. Henry, Fleet-street—Improvements in the manufacture of artificial wine, vinegar, and brandy, part of which improvements is applicable in the manufacture of brandy generally. (Communication)
2487. G. Speight, Woodbridge-street, Clerkenwell—Improved head plaits, foundations for wigs, bracelets, and other plaited ornaments for personal wear
2488. T. Crick and J. T. Crick, Leicester—Improvements in the manufacture of boots, shoes, and slippers

Dated September 28.

2489. J. Broad, Drury-lane—The construction of a lamp with two wicks and two burners to produce one flame or two flames, according to its regulation, by generation of gas from all and every sort of oils or spirits, naphthas, resinous and tarry substances, and also for petroleum or earth oils
2490. R. Kay, Rochdale—Improvements in machinery or apparatus for printing calico and other textile fabrics
2491. G. Roby, Wigan—Improvements in machinery or apparatus for raising water and employing the same as a motive power
2492. W. Bestwick, Salford—Improved material suitable for skirt springs and other similar purposes
2493. W. Bowler, Bristol—Improvements in the manufacture of hats and other coverings for the head
2494. R. Quin, Rodney-street, Pentonville—Improvements in the construction of cases suitable for containing photographic and other pictures
2495. E. M. Blount, Paris—Improvements in distilling

Dated September 29.

2496. E. H. Smith, New York—Improvements in sewing machines
2497. E. A. Lejeune, South-street, Finsbury—Improved crupper. (Partly a communication from J. J. Brunessaux, Paris)
2499. W. Bayliss, Wolverhampton—Improvements in the manufacture of chain cable
2500. S. Smith, Manchester—Improvements in coffins. (Communication)
2501. R. A. Brooman, Fleet-street—Improvements in raising and lowering weights and bodies in mines and other like places, in ventilating mines and other like places, and in extracting water therefrom. (Communication)
2503. J. C. Pearce, Bowling, near Bradford—Improvements in apparatus used in hot-pressing, and in the means of manufacturing parts of such apparatus
2504. J. Welch, Southall, Middlesex—Improvements on carriages and portable railways, to facilitate their movement on common roads and other surfaces
2505. S. Clarke, Albany-street—Improvements in apparatus for burning night lights or mortars
2506. W. E. Newton, Chancery-lane—Improved apparatus for igniting gas or other lamps. (Communication)
2507. W. E. Newton, Chancery-lane—Improved apparatus for measuring gas. (Communication)

Dated September 30.

2509. J. H. Johnson, Lincoln's-inn-fields—Improved hand-saw. (Communication from J. Gorham, Bairdstown, Georgia, United States)
2510. A. Bouret, Paris—Improvements in Pecqueur's loom for manufacturing fishing and other nets
2511. G. J. Wainwright and C. T. Bradbury, Dukinfield, Chester—The machinery or apparatus for making or manufacturing tubes or partial tubes used in spinning and doubling machinery, and for holding the same ready for use, part of which machinery is applicable to making pens, pen-holders, and similar purposes
2512. J. Paisley, Hele Works, Devonshire, and G. Bertram, Edinburgh—Improvements in the manufacture of paper

2513. E. Thompson and W. J. Nicholson, York—Improvement in railway switches
2515. J. Firth, Crossland Moor, near Huddersfield—Improvement in metallic pistons

Dated October 1.

2519. J. Ward, Liverpool—Improvements in pumps applicable for mines, ships, and other purposes
2520. J. Long and J. Long, Little Tower-street—Improved method of and apparatus for ascertaining and registering the depth of water and the pressure of steam
2521. E. Leigh, Manchester—Improvements in machinery or apparatus used in spinning and preparing cotton and other fibrous substances, parts of which are also applicable to machinery or apparatus generally
2522. J. G. Jennings, Holland-street, Blackfriars—Improvements in the manufacture of articles used for forming flues and air and water passages in buildings
2523. J. M. Napier, Vine-street, York-road—Improvements in printing machines

Dated October 2.

2525. L. De Cristoforis, Lower Thames-street—Regulating the ascent and descent of the railway locomotives on inclined planes, which is to be called the De Cristoforis ascending and descending locomotive apparatus
2526. S. Davis, Brilley, Herefordshire—Improvements in apparatus for heating the feed-water of steam-boilers
2527. A. Illingworth and H. Illingworth, Bradford—Improvements in machinery or apparatus for combing wool and other fibrous substances
2528. H. J. C. Shakespear, East India Company's Service—Improvement in the structure of carriages for military and other purposes
2529. J. S. Willway, Bristol—Improved apparatus to act as a gas valve
2530. G. W. Shibles, Thomas Town, Maine, United States—Improvements in arranging and reefing the sails of ships
2531. P. Kerr, Paisley—Improvements in preparing or finishing threads or yarns
2532. J. England, Beverley—Improvements in washing-machines
2533. A. Macpherson, Carstairs, Lanarkshire—Improvements in the manufacture of fences
2534. J. H. Johnson, Lincoln's-inn-fields—Improvements in the construction of iron bridges. (Communication from F. C. Lowthorp, Trenton, Mercer, New Jersey, United States)

Dated October 3.

2535. R. Green, Crawshaw Booth, Rawtenstall, Lancashire—Improvements in raising or forcing liquids
2537. W. Riley and T. Riley, Greetland, near Halifax—Improved means, machinery, or apparatus for "saving" or covering the lists of textile fabrics previous to the dyeing of such fabrics
2538. J. A. Molineaux and J. Nichols, Brighton—Improvements in pistons for steam-engine and other cylinders
2539. G. Chowler, Dippertown, Lewdown, Exeter—Improvements in the arrangement and construction of fog, wreck, and other buoys
2540. A. Seyferth, Paris—The employment of sulphuret of carbon for motive purposes, and engines and apparatuses for applying and regenerating the same
2541. W. E. Newton, Chancery-lane—Improvements in machinery for making mould candles. (Communication)
2542. W. Pursall, Birmingham—Improvements in the manufacture of eyelets
2543. J. Stobbs and G. R. Hall, North Shields—Improvements in pumps for raising water and other liquids

Dated October 5.

2544. G. Duncan and W. J. Jellicorse, Birmingham—Improved smoke-consuming furnace
2545. J. Rubery, Birmingham—Improvements in the manufacture of certain parts of umbrella and parasol furniture
2546. C. Reeves, Birmingham—Improved sword
2547. W. Richardson, Ranelagh-grove, Pimlico, and G. Richardson, Copenhagen-street West, Islington—Partly or wholly stopping wheels of carriages of every description when in motion, and such break or breaks to be applied by the motive power
2548. R. Atkinson, Newcastle-on-Tyne—Improvements in garments as part of male attire
2549. G. Davies, Serle-street, Lincoln's-inn—Improvements in the combustion of coal without smoke, which improvements are also applicable to the combustion of other kinds of fuel. (Communication from J. L. Tardieu, Limoges, France)
2550. M. Henry, Fleet-street—Improvements in apparatus or machines for raking and scraping or cleaning roads, streets, ways, and places. (Communication from M. Marmet)
2551. L. Beckers, New York—Improvements in apparatuses for exhibiting daguerreotype, photographic, and other stereoscopic views and pictures. (Communication)
2553. J. P. Harvey, Spalding, Lincolnshire—Improved machinery for crushing land or clods
2554. A. V. C. Regnauld, South-street, Finsbury—A universal preservative medicine

Dated October 6.

2556. J. T. Pitman, Gracechurch-street—Improvements in apparatus for making candles and other analogous manufactures. (Communication)
2557. R. H. Hughes, Hatton-garden—Improvements in hydraulic connections of gas chandeliers, lanterns, or pendants
2559. E. Vigers, Bayswater—Improvements in the construction of wrought-iron beams and girders
2560. R. A. Brooman, Fleet-street—Improvements in apparatuses for taking photographic pictures. (Communication)
2561. C. W. Finzel, Bristol—Improvements in cleansing animal charcoal, and in removing iron and other impurities therefrom
2562. J. Stoneham, Audenshaw, near Manchester, and J. P. Lees, Ashton-under-Lyne—Improvements in uniting or connecting piping
2563. G. T. Robinson, Leamington Priors, Warwickshire—A machine for obliterating postage stamps on letters, at the same time stamping the post marks and registering the number of letters so stamped
2564. W. Knapton, Albion Foundry, York—Improvements in gasometers or gasholders and in the application thereof to railway and other carriages, and ships, for lighting the same with gas
2565. A. Applegarth, Dartford, Kent—Improvements in printing machines
2566. J. Warburton, Low Mills, Addingham, near Otley, Yorkshir—Improvements in combing wool and other fibres
2567. E. Stevens, Cambridge-road—Improvements in machinery for making bread and pastry and other similar articles
2568. R. Romaine, Beverley—Improvements in machinery for digging or cultivating land, part of which improvements is applicable to agricultural steam-engines generally
2569. W. Gossage, Widnes, Lancashire—Improvements in the manufacture of sulphuric acid

Dated October 8.

2570. A. Boyd, Lees Brook, near Oldham—Improvements in machinery for spinning and doubling
2571. T. Forsyth, Manchester—Improvements in the construction of metallic pistons
2573. J. Allen, Commercial-road, and J. Young, Shadwell—Improvements in preventing oscillation in carriages upon railways
2574. T. Grubb, Dublin—Improved photographic lens
2575. C. Barlow, Chancery-lane—Improvements in buoyant or life-preserving garments. (Communication)
2576. W. MacNaught, Rochdale, and W. MacNaught, Manchester—Improvements in steam-engines
2577. W. G. Craig, Gorton, Lancashire—Improvements in the manufacture of railway carriage and other wheels formed of cast-metal, or having cast-metal naves or bosses
2578. D. Reuver, Brussels—Improvements in propelling and steering ships and other floating bodies
2579. J. Cocker, Liverpool—Improvements in the manufacture of wire
2580. W. R. Todd, jun., Hull—Improvements in manufacturing or preparing washing blue
2581. J. Cocker, Liverpool—Improved apparatus for heating or annealing wire, wire iron or rods, or sheets of iron, or other metals
2582. E. Foster, Connecticut, United States—Improved life-preserving berths for navigable vessels
2583. T. Massey, Birchin-lane, and T. Savage, Soley-terrace, Pentonville—Improvement in apparatus for ascertaining and recording the speed of ships
2584. J. Wadsworth, Haselgrove, near Stockport—Improvements in the production and management of artificial light and heat, and in certain parts of apparatus applicable thereto

Dated October 9.

2585. G. Scott, Philadelphia, United States—Improvements in steam generators
2586. S. Walmsley, Heaton Norris—Improvements in the construction of footsteps for upright shafts and spindles
2587. F. H. Allman, Mornington-place, Regent's-park—Improvements in the construction of valves and taps
2588. R. Davies, Pilgrim-street, Newcastle-on-Tyne—Improvements in washing machines
2589. J. Harland, Shield-street, Newcastle-on-Tyne—Improvements in purifying and cleansing clay, and in the manufacture of bricks, tiles, and similar articles therefrom
2590. A. M. Poisat, Paris—A machine for preparing wood to be reduced into pulp for the manufacture of paper, card, and pasteboard. (Communication)
2592. H. Brown and W. Brown, Albert-street, Newington Butts—An improved whip socket
2593. W. E. Newton, Chancery-lane—Improvements in stirrups or stirrup irons. (A communication)

Dated October 10.

2594. C. Barnard and J. Bishop, Norwich—Improved washing machine
2595. F. A. Calvert, Manchester—Improvements in machinery for ginning cotton and for burring and cleaning cotton, wool, and other fibrous materials
2596. G. Miller, Salford—Improvements in apparatus for heating and ventilating
2599. A. Barlow, Leeds—A Jacquard apparatus dispensing with the use of cards, and the usual mode of designing for figured weaving
2600. W. H. Myers, Whitechapel-road—Improved means for signals on railways, being a system of signals for railway trains in motion or otherwise, comprising communications between guards and engine-drivers, station-masters, and others, the same apparatus being applicable as fog, danger, and accident signals, from station-masters or their servants, including point and signal men, to guards and engine-drivers; the same apparatus being also a communication for passengers by means of glass or metallic pendant signals
2601. R. Porter and J. Porter, Blackburn—Improvements in machinery for the manufacture of bricks
2602. R. Ussher, Rath-boro, Killanne, Wexford—A machine for imparting motive power to thrashing machines, and such like agricultural implements
2603. H. Edwards, Dalston—Improved vessel or feeder for administering food and medicines
2604. F. M. Butler, New York—Improvements in ventilators or wind guards for chimneys and other purposes

Dated October 12.

2605. F. Prestage, Westbury, Wilts—Improvements in the furnaces of locomotive and other steam boilers
2606. J. Gray, and J. W. Gray, Rathgar, Dublin—Improved means of causing signals to be made on railways, and of otherwise preventing certain classes of accidents on same
2607. G. Beard, Pall-Mall—Improvements in mechanism for producing impressions on paper or other surfaces
2608. V. Wanostrocht, St. Swithin's-lane—Improvements in converting muskets and other fire-arms into rifled fire-arms. (Communication from MM. Minié and Delvigne)
2609. W. Calvert, Residentiary Houses, St. Paul's—Improvements in obtaining motive power by the action of the wind

Dated October 13.

2611. W. E. Newton, Chancery-lane—Improved apparatus for roasting or torrefying coffee or other substances. (Communication from J. M. Gauthier, Paris)
2613. M. Henry, Fleet-street—Improvements in apparatus for playing loto. (Communication from P. E. Lemercier and J. F. Bouneau)
1617. J. H. Simpson, Petersham, Surrey—Improved machinery or apparatus for making bands or ropes of straw, hay, or other fibrous substances
1619. V. Wanostrocht, St. Swithin's-lane—Improvements in obtaining fatty and oily matters by distillation. (Communication)
2621. W. Sharman, Sheffield—Improved metallic compound, applicable to the manufacture of various useful and ornamental articles

Dated October 14.

2623. E. Keighley, Bradford—Improvements in the preparation and use of dye liquids
2925. J. F. Swinburn, Birmingham—Improvements in fire-arms. (Communication from T. Bailey, New Orleans)
2627. E. Owen, Blackheath—Improvements in the preparation and manufacture of manures
2629. J. Middleton, Hyde, Cheshire, and W. Rylance, Whitefield, near Manchester—The application of a certain metal or material to the manufacture of shuttles, bobbins, and tubes
2631. J. Parker, Southampton—Improved method of fitting and working Venetian and other similar blinds used as ventilators or screens or both
2633. G. Rhodes, Ship-street Barracks, Dublin—A parabolical or bell-shaped or other shaped camp or field tent, without any centre support or pole

PATENTS APPLIED FOR WITH COMPLETE SPECIFICATION.

2410. J. S. Barden, A. Watkins, R. H. Hinkley, and D. F. Child, United States of America—Improvement in engines for hydraulic or various other useful purposes. (Communication)—September 17
2508. R. Bodmer, Thavies-inn, Holborn—Improvements in machinery or apparatus for winding, unwinding, reeling, cleansing, measuring, sorting, weighing, twisting, and doubling silk and other fibrous substances. (Communication from F. Buser, Bâle, Switzerland)—September 29
2558. J. Parker, Maine, United States—Improvements in machinery for grinding card cylinders of carding engines—October 6

ON THE THEORY OF PILE-DRIVING.*

By MICHAEL SCOTT, of London, and ANDREW JOHN ROBERTSON, of Blyth.

THE subject of pile driving has been investigated by Dr. Whewell on principles first laid down by the present Astronomer Royal; but unfortunately the mathematical expressions which contain the result are so complicated, that, although the distance a pile will be driven may be ascertained, provided the data be correct, by the substitution of numerical values in the different equations, still the process is tedious and the result unsatisfactory. For the object of such investigations is not to determine to a fraction of an inch the distance a pile may be driven, more especially as the resistance offered by the ground, which forms the most important element in the calculation, can never be correctly ascertained;—but the object is to elicit those simple and general truths upon which the system depends. By supposing the pile to be only just stirred by the blow, Dr. Whewell has simplified the equations to such an extent as to deduce from them the following corollaries, which are arrived at by approximation; this approximation however holds good only when the quantities are so exceedingly small that the first two terms of a series which does not converge may be assumed to express the value of the whole series. The deductions are,—

1st. A slight increase in the hardness of the pile or in the weight of the ram will increase considerably the distance driven.

2nd. The resistance being great, the lighter the pile the faster it will be driven.

3rd. The distance driven varies as the cube of the weight of the ram.

Although these results cannot be depended upon as exact under all circumstances, they still give a tolerably correct indication, and are in accordance with those which may be arrived at by general reasoning. The complication in the original expressions arises from taking into consideration in the general question the weight and inertia of the pile. The weight of the pile however bears so small a proportion to the resistance of the ground that it may be safely neglected: for a 25 feet pile, 1 foot square, weighs about $\frac{1}{2}$-ton; and if the fall of a ram weighing 1 ton be 10 feet, and the distance driven by the blow be 2 inches, then the resistance offered by the ground, supposing the ram and pile to be perfectly hard, will be to the weight of the ram as 120 inches to 2 inches; that is, it will be 60 tons, of which $\frac{1}{2}$-ton is the $\frac{1}{120}$th part, and may therefore safely be neglected. But the inertia of the pile having to be compared with that of the ram is of more importance, the proportion in the case above supposed being as 1 to 2. Although therefore the inertia of the pile be a matter of too much importance to be neglected, it may nevertheless be considered separately, to the great simplification of the question involving the compressibility of the pile and ram.

If a body at rest be impinged upon by a body in motion, the two will, if inelastic, move on together, the momentum of the whole mass after impact being the same as that of the impinging body before impact; if they be elastic, the momentum of the two bodies together is still the same, but the distribution is different. The two extremes of these conditions of things may be illustrated by a small hammer striking a pile or anvil, and a sledge hammer striking a nail; in the first case, the hammer buries itself in the head of the pile, or rebounds from the anvil, without producing any further effect; in the second, the existence of the nail scarcely affects the motion or the blow of the sledge hammer. These two cases show at once the great advantage of mass in the striking body as compared with the mass of the body driven. In pile driving the proportions between an ordinarily heavy hammer and a nail can never be approximated to; but we may conclude with safety that within the limits imposed by practical considerations of convenience, and provided the material of the pile will stand the blow, the heavier the ram the more effective it will be.

Thus far the influence of mass has been considered only in overcoming the inertia of the pile; the same reasoning applies to show that the heavier the ram, and consequently the greater its momentum, the greater is its power to overcome the resistance of the ground. So long as piling engines were worked by hand, any increase of weight of the ram beyond $\frac{1}{2}$-ton or $\frac{3}{4}$-ton was seldom or never thought of; and, the space for the application of the power of men being very limited, the motion was necessarily very slow. The introduction of steam has removed this difficulty, and in Nasmyth's steam pile-engine the weight of the ram was increased to $1\frac{1}{2}$ ton.

It remains to examine the effect of the height of fall of the ram, of which no mention has yet been made. The writers believe there has hitherto been a prevailing opinion that a rapid succession of blows from a moderately heavy ram with a short fall is more advantageous than with a high fall and proportionately diminished number of blows; for it is alleged the pile never gets leave to come to rest. This opinion however they consider to be erroneous.

Let H be the height of fall, W the weight of the ram, R the resistance of the ground, and S the space through which the pile is driven; then, neglecting the inertia of the pile, and supposing the ram and pile to be perfectly hard,

$$S = \frac{WH}{R} \quad \ldots \quad \ldots \quad \ldots \quad (1)$$

But the ram and especially the pile are not perfectly hard; they are compressible and elastic, although imperfectly so. Let therefore A and B be the hardness of the ram and of the pile; then the space through which a nail is driven, that is, a body whose inertia may be neglected, is

$$S = \frac{WH}{R} - \left(\frac{1}{A} + \frac{1}{B}\right)\frac{R}{2} \quad \ldots \quad \ldots \quad (2)$$

as given in Whewell's work before mentioned, to which reference is made for the steps of the present investigation. The last term in this equation is therefore the defect arising from imperfect hardness, and is less as the hardness is greater, or as the joint compressibility of the ram and pile is less.

This equation leads to a result of great practical importance. For every position of the pile there is a certain value of the resistance R; and for this value of R there is some value of H, the height of fall, which will make the second side of the equation (2) equal to zero. There is therefore a certain fall which will not drive the pile at all, however great the number of blows, the only effect produced being to soften the head of the pile by continual hammering, and consequently to make matters worse. This is not a theoretical case only: in driving the piles for the foundations of the piers of the High Level Bridge at Newcastle it frequently happened that Nasmyth's steam pile-driver hammered on the head of a pile for a considerable time without producing any other effect than softening the head of the pile, and making it necessary to cut it off several times. It must be observed that this effect, or rather absence of effect, is due not to the compressibility of the pile only, but to the total amount of yielding from whatever cause arising. If the soil yields the same result follows; and yielding of the soil is worse than any ordinary compressibility in the pile, because it is far greater in amount. This accounts for the difficulty of driving in sand, and for the rebound of the pile that has been often observed.

But although it may seldom happen that absolutely no effect is produced, a diminution of effect must always take place; and the important point to be noticed is that, for a given degree of hardness and given resistance, the *proportion* of loss is diminished by increasing the height of the fall. For supposing the fall required to compensate for the defect arising from imperfect hardness to be 2 feet, and the actual fall of the ram 4 feet, the loss is then one-half; but if the fall be 8 feet the loss is only one-fourth. Now the power required to raise the ram 8 feet is the same as to raise it twice to a height of 4 feet in the same time; but the useful effect in the first instance is represented by $8-2=6$, and in the second by $2(4-2)=4$; or, for the same expenditure of power, the useful effect is half as much again with the higher fall.

Again we have from the equation (2), when S the space through which the pile is driven equals zero, $\frac{WH}{R} = \left(\frac{1}{A} + \frac{1}{B}\right)\frac{R}{2}$

Whence

$$H = \frac{1}{2}\left(\frac{1}{A} + \frac{1}{B}\right)\frac{R^2}{W} \quad \ldots \quad \ldots \quad (3)$$

or the height of fall which represents the defect arising from imperfect hardness varies as the square of the resistance and inversely as the weight of the ram. Hence it appears that if the fall be kept constantly the same, as in the steam-hammer piling machines, although at first the pile may be driven with facility, a point may be rapidly attained when the resistance and yielding of the pile will render the blow useless. For suppose at a given point the fall required to compensate the defective hardness be

* Paper read before the Institution of Mechanical Engineers.

1 foot, then when the resistance is doubled the fall must be 4 feet, whereas the stroke of Nasmyth's ram is only 3 feet. On the other hand, when the ram is raised to the same point throughout the driving of a pile, the deeper the pile is in the ground, and consequently the greater the resistance, the greater too is the power of the ram.

It appears also from the equation (3), that the heavier the ram the less is the height of fall lost; and since it was found before that, in regard to the effect when the inertia of the pile is taken into consideration, the heavier the ram is the better the effect, therefore on both accounts it is desirable to have as heavy a ram as possible.

It has been observed that the fall of Nasmyth's ram is equal to 3 feet; and as the writers believe that there is some misconception about the fall to which the stroke of this ram is supposed to be equivalent, it may be well to examine the matter,—assuming, as they believe is the case, that the stroke of the ram, measured from the lowest point to the top of the opening which admits the atmosphere above the piston, is 2 feet 8 inches, and that the remaining length of cylinder above the opening, which is the space allowed for the compression of the air, is 4 inches. The weight of the cylinder and case together is $1\frac{1}{2}$ ton; when therefore the air in the top of the cylinder is compressed to such an extent that its excess of pressure above the atmosphere acting over the area of the cylinder is capable of balancing $1\frac{1}{2}$ ton, the case will rise: if it does not rise, the upward motion of the ram has been destroyed before that pressure was attained;—in reality however it does rise, but only about $\frac{1}{4}$-inch, showing that the pressure has been just attained. In the fall of the ram, the recoil of the cushion of compressed air acts upon the piston attached to the ram until the piston has passed the opening communicating with the external atmosphere; and the force of the recoil, together with the force of gravity acting during the same period, accordingly impart the same velocity to the piston as it had when passing the opening in its ascent. The question therefore resolves itself into ascertaining this velocity and the height of fall to which it is equivalent. The velocity is readily determined by calculating the distance required to be moved through by the piston after it has begun to compress the air in the top of the cylinder, in order to produce the degree of compression necessary for balancing the weight of the cylinder and case; remembering that the motion of the piston must cease at that point, otherwise the case would be lifted. This distance is found to be $3\frac{1}{4}$ inches, and the velocity produced by the recoil of the air in expanding after its compression and by gravity, is the velocity which has been destroyed by the resistance of the air to compression and by gravity, and is that which would be acquired by falling through a height of 4 inches; which is therefore the extra height of fall due to the cushion of compressed air. The 4 inches being added to the actual fall (2 ft. 8 in.) gives 3 feet for the total fall of the ram in Nasmyth's pile driver, as before stated.

AN IMPROVED STEAM PILE-DRIVING MACHINE.*

By Michael Scott, of London, and Andrew J. Robertson, of Blyth.

(*With Engravings, Plate* XXXI.)

A new steam pile-driver was designed for the purpose of constructing a wharf or quay on the river Blyth, above the entrance to the proposed new docks near the mouth of the river. A row of piles, placed at intervals of 8 feet from centre to centre, and consisting of whole balks of Memel timber, were to be driven into the ground to a depth of 14 ft. 6 in. below the surface, with a batter of 1 inch to a foot; and 15 feet in the rear of this front row, a second row of piles 8 feet long were to be driven wholly into the ground, with a batter of 4 inches to a foot, one of the latter piles being placed behind every alternate face pile with a tie-bolt to connect the two. In addition to these two rows of piles it was subsequently ordered that the spaces between the face piles should be filled with sheet piling 12 inches wide by 6 inches thick, driven from 10 to 11 feet below the surface. With the exception of a portion of the line where there is a bed of very hard gravel, the ground is sand, a soil which presents great difficulties in pile driving; and the surface of the ground varies from a little under to between 2 and 3 feet above low water of ordinary spring tides, which rise at Blyth about 13 feet.

* Paper read before the Institution of Mechanical Engineers.

For accomplishing the above work, the new machine was constructed as shown in figs. 1 and 2, in accordance with the principles laid down in the previous paper. Fig. 1 is a side elevation of the machine, and fig. 2 an end elevation. It is designed to drive two face piles and one land tie pile whilst in one position, and consists of two ordinary leading frames A A, braced together at the proper distance apart for the two piles to be driven; these frames turn on hinges B, for the purpose of adjusting them exactly to the required angle of the piles, and are supported at the back by ties C. The timber frame D, to which the hinges and ties are attached is independent of the lower platform E, upon which it rests, and is capable of being moved backwards or forwards upon it, so as to bring the leaders A, into the exact position for the piles; but when in work the frame D is held down to the lower platform E by bolts. The movement of the frame D, upon the platform E, is accomplished by means of wheels F, on each side; under the wheels are placed tapered iron wedges G, so that a small turn of the wheels is sufficient to raise the frame D, slightly from the platform E, thereby removing the friction which would prevent motion, and at the same time effecting the small movement necessary for adjustment. The wedges G, are then driven out from under the wheels by the blow of a hammer.

The lower framework of timber H, is strongly braced together by diagonal ties, and runs upon a railway laid upon the ground; it is made sufficiently high to keep the platform E, always above high water. The machine is moved along the rails by means of chains attached ahead and astern to screw moorings sunk in the ground; the chains pass round pulleys I, fixed to the lower frame, up to the crabs, and wind upon the end drums K; they are stopped or locked on the platform and unwound from the drums when the machine has been moved the required distance.

The leading frame L, at the back of the machine for driving the land tie pile is fixed at the required angle, but is not adjustable, any little inaccuracy in its position being unimportant.

On the platform E, is placed a portable steam-engine M, with two crabs N, N, each working a ram O, in the usual way. The crabs are furnished with clutches for throwing them in and out of gear, and with breaks. The clutches P, P, shown enlarged in fig. 3, are connected together so that when one drum is in gear the other is out of gear; the means of disconnecting is by the weighted lever Q, which is loose upon the spindle and acts by catching in the notches R. The method of working is as follows: one drum having been put into gear by the weight on the hand-gear lever Q, the ram is being wound up; during this time the lever Q with its weight is turned over to the other side, as shown dotted; the tendency of the weight is then to throw the clutch of the working drum out of gear, but the friction produced by the strain of winding the ram prevents disengagement; when however the strain is relieved by the release of the ram, the weight throws the working drum out of gear, thereby preventing the further ascent of the monkey or claw S, which lays hold of the ram, and throws the other drum into gear, which in its turn lifts the other ram. The monkey S, of the first ram now descends to lay hold of the ram again, the break T being put on to check its velocity; and the handle Q is reversed, to be in readiness again to disconnect the clutch of the working drum when the second ram has reached the top. In this way the operation is continuous, the engine is neither stopped nor reversed, and no time is lost.

The clutches and breaks as at first made did not work satisfactorily; the breaks T were originally in one piece with the clutches P, but were afterwards attached to the drums N; and the bearing surfaces of the clutches were originally perpendicular to the face of the clutch, but the friction between the surfaces in contact was then so great that the lever Q could not readily disconnect them when the strain was relieved, and they were therefore made slightly bevilled, to the extent of about 1 in 5, as shown in fig. 3, to cause them to separate more easily; after these alterations the machine worked satisfactorily.

The weight of the ram O, is $1\frac{1}{2}$ ton, and including the weight of the monkey and friction the strain on the chain and machinery is considerably greater. From the high velocity at which the crabs are driven, this strain would be felt as a sudden tug on beginning to raise the ram, which neither chain nor framework could be expected to bear without injury; and hence arose the necessity of providing something in the form of a buffer to mitigate the intensity of the strain. The arrangement adopted is shown in fig. 4; it consists of a cylinder U, furnished with a piston on the upper side of which is a strong volute spring requiring

$1\frac{1}{2}$ ton to compress it; the travel of the piston is $4\frac{1}{2}$ inches, and the chain is wound up for this length before the ram rises, the strain gradually increasing up to $1\frac{1}{2}$ ton. During the ascent of the ram the spring remains compressed; but on arriving at the top of the machine the ram is suddenly disengaged, and the whole weight being removed, the rebound of so powerful a spring would probably drive the piston through the bottom of the cylinder; this is prevented by admitting air into the cylinder through a small orifice at the bottom, and thus providing a cushion for the piston, the orifice being so minute that it takes the whole time of the ascent of the ram to fill the cylinder, and the air cannot escape in a moment. The formation of a vacuum below the piston and the compression of the air above assist the spring in its action.

The piles are floated to the place in rafts; and the rams being made fast at the top of the machine by a pin passed through the leaders A, the working chains are detached and hooked to a pair of dogs fastened on a pile, which is then raised and pitched to its place by the engine. The operation is performed with astonishing quickness, but this depends in a great measure upon the facility obtained by the peculiar kind of hook V, shown enlarged in fig. 6, for attaching the chain to the monkey; with facility for immediate detachment the hook combines the advantages of great security, strength, and provision against accidental detachment by the upward blow.

In driving sheet piles below the level of the gauge piles by other steam pile-driving machines, such as Nasmyth's, it is necessary to use a dolly or intermediate piece of timber, by which a great part of the effect is necessarily lost; but in the new machine the use of a dolly is unnecessary, for by reversing the position of the monkey lever and making it project outwards instead of in-inwards, so as to clear the frame, the ram will descend to the ground. Figs. 4 and 5 show another method of accomplishing the same object, by means of a long rod W, furnished with a guide X, serving to connect the monkey with the ram, however far below the platform the ram may be; this arrangement, however, is not recommended.

The new pile driver above described was designed to obviate the difficulties that would have attended the adoption of any of the methods previously in use. To drive the piles by the ordinary hand-engine would have been a work of considerable time; for not only is a hand-engine very slow in its operation, but it would have been only at low water of spring tides that the work could be done. Nor would any of the methods hitherto employed for applying steam power meet the exigencies of the present case. For in the first place the ordinary travelling steam-engine could not be applied to work the crabs of hand-engines, on account of the rise of the tide; nor could it be placed beyond the influence of the tide, because the beach being flat the space between the new wharf and the shore, which is covered at high water, is considerable; nor could it have been used with a piling engine on a barge, for, not to mention the swell in the river, the ground is in some parts sometimes and in other parts always bare at low water. Nor were the elaborate machines that have been constructed by Nasmyth and Morrison, acting on the principle of the steam hammer, more applicable in the present case. It would have been necessary either to make a strong frame to carry their great weight, in which case rails laid upon the sand would not have been sufficient; or else to drive a large number of extra piles by hand to form a gantrey. Moreover, these machines are expensive, and being applicable only to the purpose of driving piles must be idle when that work is done.

From these considerations it was resolved to attempt the present arrangement, which has proved entirely successful. The machine costs only about a fourth of those referred to above, and is only about a fourth of the weight; it will do as much work per day in many cases, and will do it better and more cheaply. The whole work of pitching and driving the piles and moving the machine is effected in the new pile driver by a four-horse-power engine, whilst in the others there are two complete separate engines of greater power; and although the latter machines will do more work per minute while they are in motion, in consequence of their greater power, in many cases they will not perform more per day, on account principally of the difficulty of moving them; moreover the great weight of these machines requires that a good foundation and a strong superstructure be provided to carry them before they can be moved forwards. This was proved in a recent case where Nasmyth's machine was employed, by the fact that, although it could drive one pile in twenty minutes, yet the average per day was only ten piles driven, an amount of work which the new machine will do easily. With respect to the quality of the work executed, the comparison is again in favour of the new machine; the piles are driven with rare precision, the profile of the work being almost perfect; the heads of the piles are not bruised, and when the rings are removed there is hardly any appearance of abrasion. With regard to cost of working, the steam is kept up all day in the other machines, although the engine is only at work about three hours, and there is a great loss from condensation and leakage in the steam pipes; and as the power and dimensions of both engines and boilers are also much greater than in the new machine, there must necessarily be a larger expenditure of fuel. Although however the other machines were inapplicable in the case for which the new machine was designed, there are circumstances in which they would be more effective than the new engine; such as when a great number of piles were to be driven in a limited area.

One of the disadvantages of contracts for harbour works is the large amount of money sunk in plant, every different kind of work requiring different machinery and tools. The new piling machine however is not a piling machine only, as in the case of the other machines, but may be used also as a steam crab; or if taken to pieces, there is a portable engine complete in itself and applicable to other purposes, a pair of crabs, and the leaders and rams which would go to form two hand piling engines, the only special expense being the lower framework and the fitting together of the various parts.

Only one machine has been made at present, the cost of which was about 450*l.* complete, with the portable steam-engine and the three rams. The cost per foot run of pile driving by the machine has not yet been ascertained.

FRENCH SYSTEM OF EDUCATING AND TRAINING OFFICERS FOR THE SCIENTIFIC CORPS.

By W. Yolland, Lieut.-Col. R.E., and W. C. Lake, M.A., Fellow of Baliol College, Oxford;

Commissioners appointed by the Secretary at War to consider the best mode of re-organising the System of Training Officers for the Scientific Corps.

The principles of continental military education are distinct in each separate country, and are strongly marked by differences of national character. In France, highly rewarded competition is the mainspring of the whole system; in Prussia, the chief object aimed at appears to be the attainment of a good average of general and professional education from all officers whatever; in Austria, vigorous competition is the principle of the Staff School, with high education for a small portion of the officers, and a most liberal encouragement of non-commissioned officers; finally, in Sardinia there is, again, considerable competition. Everywhere there is an organisation for education so systematic, and so large an expenditure for the purpose, as to show both the value which is attached, in a military point of view, to the teaching and training of officers and the position it occupies in the general education of the country.

In French military education, the feature which principally attracts attention is the remarkable character of the Polytechnic School, and the teaching it gives to the officers of the special corps. But this great school, the principal scientific institution in existence connected with any army, may more properly be reserved, together with its School of Application, as the highest points of French military education; and we shall previously state the marked principles on which the whole of this education is based, and which are carried out in all the other military schools of the country.

The characteristic points of the French system are as follows: (1), the proportion, founded apparently upon principle, which officers educated in military schools are made to bear to those promoted for service from the ranks; (2), the mature age at which military education begins; (3), the system of thorough competition on which it is founded; and (4), the extensive State assistance afforded to successful candidates for entrance into military schools, whenever their circumstances require it.

1. In the French army one-third of the officers in the line, two-thirds of those in the Scientific Corps, and the whole of the staff, receive a careful professional education; the remainder are appointed from the ranks, by the choice of the Emperor, on the recommendation of their superio officers. We were assured,

however, that the latter class of officers do not usually rise above the rank of captain; and the inference would seem to be that for the inferior commands, courage and conduct are considered sufficient qualifications, while scientific study and professional knowledge are thought requisite for the higher.

2. The next point worthy of notice is the manner in which France has gradually but completely thrown aside the idea of juvenile military education, adopting in its place the plan of giving professional teaching and training to young men, just as they are emerging into manhood, and when their general education may be considered to be almost completed. In this practice France in some respects differs from any other country, although Prussia resembles her in giving no specific military education at a very early age. The experiment of thus making a good general education the basis of a special military one seems to have been first tried on the foundation of the Polytechnic School in 1793, and the idea is in great measure due to the practical genius of Fourcroy and Carnot. On the very first establishment of this school young men were allowed to enter it at the average age of eighteen, with the prospect of joining the army after two or three years; and it was soon found that they brought to their special studies a freshness and energy far greater than boys who had been taught, and perhaps sated with, military subjects from the age of twelve or thirteen. Gradually the system adopted at the Polytechnic was extended to the other army schools, and although the Lycées under the first Empire were coloured with what may be called military fashions,—which, indeed, to some extent affect all French education,—juvenile military schools were in course of time discontinued or diminished; and after 1814 the principle of juvenile military education may be said to have been entirely abandoned. The plan adopted instead says, in effect, "Give your young men a sound education, in the best schools of the country, till the age of seventeen or eighteen; at that age, let them compete for entrance into a military college, where they will be instructed for two, three, or four years, according to the requirements of the service they are to enter; once entered into the school, the State will assist them in their education, and will thus enable them to commence a career."

3. With this alteration in respect of age was combined the establishment of the principle of competition for admission into military schools; and the extent to which this practise is encouraged will be amply illustrated by the account of every military school.

4. Every candidate who can succeed in the open and competitive entrance examination to St. Cyr and the Polytechnic School is entitled, according to his means, to a partial or entire support from the State. At the present time, not less than one-third of the students in each of these schools receive such maintenance. It is, however, manifest that such a regulation combined with other points in the social system of France, while it developes talent, must exercise a democratic influence on the army.

Such are the principles adopted by France in encouraging the education of that portion of its officers from whom alone it requires educational qualifications: and these principles are carried out at St. Cyr, for the line; at the Staff School, for which St. Cyr is the principal feeder; and at the Polytechnic, and its School of Application at Metz.

School of St. Cyr.—The preliminary studies which best fit a pupil for the competitive entrance examination to St. Cyr are almost entirely mathematical. This is one of the points in which the peculiar genius of France colours its military education somewhat differently from that of other countries. We shall remark elsewhere, in speaking of the Polytechnic, though quite recognising the superiority of mathematics over any other single element in military teaching, that to encourage this to an almost exclusive extent (as is done in France) militates against the principle of a complete *liberal* education; and in England a liberal education is justly considered of greater consequence than a special intellectual training in any single subject, however important. The above remark applies, however, as regards St. Cyr, solely to its entrance examination, and the preliminary studies it encourages. The instruction given at the school itself seems to us well considered and judicious. The young men enter, on an average, between the ages of seventeen and eighteen; they spend two years at the school; and on leaving, twenty-two of the best scholars usually obtain places in the Staff School, and the rest choose their regiments according to their places on the examination list. The nature of the studies may be judged of from the following Table:

First year's Lectures—	Second year's Lectures—
27 in desriptive geometry	10 in topography
35 in physical science	27 in fortification
20 in military literature	15 in artillery
35 in military history	10 in military legislation
27 in geography and military statistics	12 in „ administration
30 in German	27 in „ art and history
	20 in German
Total 174	Total 121

It will be observed that military literature, military history, military geography and statistics, constitute nearly half the total number of lectures in each year; and, indeed, in every good military school on the continent we have found these subjects insisted upon, as the best means of interesting a young officer in the study of his profession. The other subjects taught are also essential parts of the instruction of an educated officer; and it must be remembered that these *lectures* (which for the whole year may appear few in number) occupy much more time than English *lessons*; notes upon them bring always written out, and the whole work gone over with the *répétiteur*, an assistant to the professor. We must add that practical exercises form great part of the military training given at St. Cyr, greater, for instance. than in the chief Austrian academy at Wiener Neustadt, the school to which it bears the closest resemblance. There is apparently more study at Wiener Neustadt, and an equal prospect of ultimate appointments is held out to its pupils.

Competition is encouraged in the whole school course, by the effect which the credits given at the numerous examinations have upon the student's position in the final examination, when the total result of his efforts may gain for him the coveted prize of admission to the school for the staff corps. It should be remembered that the social position of a large proportion of pupils both at St. Cyr and the Polytechnic is such as to make the prizes given at each objects of much greater ambition than would probably be the case in England.

Staff School.—Entrance into the School of Application for the staff corps may be considered the reward of proficiency at St. Cyr, the twenty-two best pupils of which, together with three from the Polytechnic, constitute the ordinary yearly admission to this school. Strictly speaking, indeed, the twenty-seven best pupils from St. Cyr compete for the entrance to the staff school with an equal number of sub-lieutenants, who may obtain permission from their commanding officer to appear as candidates. But we were informed that few, if any, now present themselves. The course of teaching lasts for two years, no fewer than eighteen professors being employed, and the principal studies being topography, military art, and fortification. The pupils are carefully ranged in the order of merit at their different examinations, and enter the staff corps according to the places they finally obtain. Immediately on leaving the school they are made lieutenants, and are then sent to the infantry to do duty for two years, and at the expiration of this time are attached for an equal period to the cavalry. They *may* finally be sent, but are not necessarily so, for a year to the artillery or engineers.

It is obvious that both these schools carry out the main principle of French military education—open competition, upon which it more thoroughly relies than any other country we have visited. This principle, as well as that of the later commencement of military education, was apparently first brought to influence the army on the establishment of the Polytechnic School. In the continuous wars which ensued, promotion and reward must indeed have been given upon other considerations than those of success in military studies; but during the long period of comparative peace it seems to have been established that the best ground for advancement, at least in the earliest stage of an officer's course, was proof of talent and attainments in the profession which he had selected.

Polytechnic School.—It will not excite surprise that this spirit should be found most active at its very birthplace—in the most competitive school in the world, the Polytechnic itself. Indeed, from first to last, every detail of the teaching given there is devised for this end. The general results, it cannot be doubted, have been remarkably successful; and though they have not been solely military (for the school is partly a civil one), they have placed the special arms in France in a higher relative position, in point of mathematical instruction, than is probably the case in any other continental army. The principles of the school are both instructive educationally, and are calulated (even where not directly applicable to our own state) to throw light on interesting questions of military education. The whole system brings out in its strongest light the French practice with regard to competition, and the French estimate of the value of high scientific attainments in a military point of view.

The Polytechnic is a great preparatory school, possessing a monopoly of admission into twelve of the chief public services of France, among which are those of the artillery and engineers, many of the others being of a civil character. There is a public, and always a very severe competition for admission; every detail of the education is skilfully devised to encourage emulation during the pupil's course; and there is a final competition for a choice among the 140 or 150 appointments which the school yearly offers.

In mentioning these facts we have probably said enough to show the advantages of such a school, both in the amount of ability it can collect, and in the stimulus it supplies to exertion. The talent encouraged is almost solely mathematical, that peculiar talent of France, which is of all others the best fitted for the preparatory teaching of the special corps of the army. And thus it would appear at first sight *that in point of theoretical instruction* the officers of the French artillery and engineers must excel those of all other European armies; and it is certainly our opinion that this is the case. But having praised this school so highly, we are entitled with equal frankness to state some drawbacks which may perhaps detract from the efficiency of its military pupils.

1. All the highest prizes are civil ones, and this is certainly a drawback, even if compensated for by other advantages. It was not so much felt in the days of the first empire, when all the talent of France streamed into the army. But since that time it has usually been found, that with a few striking exceptions (chiefly distinguished pupils of the higher ranks), the thirty or forty first pupils choose the civil services.

2. The system of education, excellent as it is in its stimulating power, has one or two marked defects. Such is the attempt to give exactly the same teaching, lesson by lesson, during a course of two years, to a class of 160 pupils, with no reference to their varieties of ability or powers of application. This practice has a tendency either to make many of the pupils superficial, or to exhaust them. Now it must be remembered that the majority of these pupils enter the army; and hence, probably, the numerous complaints on both points from the military authorities at Metz, who possess the best opportunity of testing the effects of the Polytechnic. Another defect is that already referred to, the exclusively mathematical spirit encouraged, which may be said entirely to overshoot its mark, and to prevent (what seems to us most desirable for a scientific soldier) the education from being truly liberal. Nor can we avoid remarking, that education has its moral as well as its merely intellectual side; and we were not nearly so much impressed by the moral and manly as by the intellectual effects of the Polytechnic teaching. It is the more necessary to state this, because in describing the system pursued at the school we have naturally been led to dwell chiefly on its intellectual results.

In spite of these drawbacks the Polytechnic School appeared to us a most instructive study for purposes of military education. Many points in its system of teaching are admirable; and above everything else it seemed to evidence the extraordinary spirit imparted to education by the competition created by its valuable prizes. It does in this respect for the army and the services of the public works in France, what the universities do chiefly for the bar and the clerical profession in England. It gives every possible encouragement to early application and talent, while by the pecuniary aid of the State it places this talent in a position to do itself justice.

School of Application at Metz.—This school is the completion of the Polytechnic course of training for most of its military pupils. They are sub-lieutenants on admission, and they pursue during two years a course which is partly practical, but in which theory still holds a prominent place, and is carried to a greater extent than we conceive to be necessary or desirable for *all* officers, even for those of the special arms. A brief summary would give but an inadequate idea of these studies, and we must refer to another portion of our report for information respecting the School of Metz, and the translation of its principal programmes.* The studies of artillery and engineer officers are conducted entirely in common for the first and for two-thirds of the second year, but during the remaining third they diverge widely. Yet even at Metz the instruction of officers for the special arms is not held to be completed. They join their regiments upon leaving, and are employed in practical exercises with troops till they obtain the rank of second captain in their respective arms; then the training of artillery officers apart from their men is, in a certain sense, resumed—they are sent to the arsenals, foundries, and manufactories of arms.

* See *Journal*, *ante* p. 225.

THE BEST SITE FOR A HARBOUR OF REFUGE ON THE EAST COAST OF ENGLAND.

By E. K. Calver, R.N., Master and Surveyor.

In obedience to directions from the Admiralty, to state my views with respect to the selection of a site for a refuge harbour on the eastern coast of England, which would be best adapted to materially lessen the loss of life and property on that seaboard which we have annually to deplore, I shall endeavour, as briefly as possible, to show the necessity which exists for a harbour of refuge; what that necessity arises from; and the site which should be selected for securing the object in view.

Firstly. The comparative necessity for a harbour of refuge upon any section of coast may be determined by the number of wrecks occurring upon it, compared with those upon the adjoining shores, for wherever the greatest number of these disasters takes place, it is but fair to assume that to be the most dangerous portion of the seaboard, and that it possesses features against which neither the efficiency of the vessels navigating it nor the experience of their commanders will ensure protection.

Now I believe it to be a fact of easy proof from existing records, that throughout the whole of the eastern coast of England, from the Thames to the Firth of Forth inclusive, by far the greatest number of wrecks occur north of Flamborough Head, and especially within that embayed portion of the coast, or what may be termed the north-eastern bight, contained between Robin Hood Bay to the southward, and North Sunderland point to the northward, an indentation 78 miles wide and 13 miles deep. These limits embrace all the principal ports on the north-east coast of England.

Not having the proper documents by me, I cannot give the exact number of wrecks upon the various sections of the eastern coast, but there is no doubt the great preponderance is as I have stated, and as a careful attention to the features of the coast would have led one to predict. A few special instances of wholesale wreckage may, however, be mentioned, to prove the necessity for a refuge harbour within the limits specified.

It may here be noticed, as a point to be remembered in considering the question, that an easterly gale, or one veering from S.E. to E. by N. or E.N.E., is that which causes the greatest destruction of shipping on the north-eastern coast, and which was the case in all the following examples:—

"On the 12th October 1824 a gale commenced from the E.S.E., which afterwards got round to E.N.E.; the result was, that 113 sail of vessels were wrecked or driven on shore between Scarbro' and the Tyne; of this number 37 went ashore in Tees' Bay."—Brooks, Redcar, pamphlet of 1832.

"In 1852, within a radius of 70 miles from the Tyne, a quarter of the wrecks of the whole kingdom took place, and in a single easterly gale in October 69 lives were lost in a few hours within 20 miles of the Tyne."

"It appears from the Admiralty Wreck-chart of 1853, that, during 1852, 125 took place within 30 miles of the Tyne."

"In the beginning of January 1854, in an easterly gale, 110 wrecks took place in three days within 30 miles of the Tyne; 36 of them were at the mouth of that river. A large number of lives and a quarter million of property were destroyed."

"Out of 1141 wrecks and casualties in 1856, 576, or upwards of one-half, took place upon the eastern coast."

"On the 5th of January 1857, within a radius of 50 miles from the Tyne, 94 ships were driven ashore or foundered, and 167 lives were destroyed in a few hours, as well as a large amount of property."—Petition of Tyne Commissioners.

"January 3rd 1857. Fresh gale from S.E. until nearly sunset, when it became more moderate, inclining towards the N.E.; by midnight the gale increased, and from four to six o'clock on the following morning (the barometer rising) it was all but a hurricane; the sea was tremendous, and probably without precedent upon this coast. At tide-time in the forenoon vessels were seen approaching; six of them were driven upon Middleton beach; five sunk in the West harbour; five went ashore between Carrhouse and Seaton Carew; three foundered, with all hands, off the bay; one went ashore on the North Sands, and one on the rocks a little to the westward of the new pier. These casualties (21) took place that day within the limits of the port. On the night of the 6th (the gale not having ceased), a foreign brig was totally wrecked between the two harbours......In the gale 80 casualties took place between the Fern Islands and Flamborough Head; 45 of them foundered or were total wrecks; and 130 lives were estimated as lost, one-fourth of them being within the limits of the port, a length of seven miles."—Report of Haven-master to Hartlepool Commissioners.

The sad catalogue is an ample one, and might be extensively quoted; but there is no need in this place to multiply examples. The cases mentioned, embracing an appalling loss of life, and the consequent amount of anguish, misery, and destitution, are sufficient to enlist the deepest sympathies of the country; and as there is no valid reason to suppose that these distressing losses will, under existing circumstances, be less frequent than they have hitherto been, the magnitude of the evil, and the means for preventing it, becomes an imperial rather than a local question.

Secondly. The cause of these losses, and the necessity for a harbour of refuge somewhere between Robin Hood Bay and North Sunderland, arise from the following circumstances:

It is necessary to premise this axiom in navigation. A vessel's liability to be driven ashore by an on-shore gale depends principally on the configuration of the coast abreast; for instance, if she be opposite a salient sea-board, or one which recedes from a given line on either hand, there is no risk whatever, as the land may be cleared either way with a flowing sheet. Abreast a straight or direct line of coast there is danger of being stranded, and it requires promptitude at the beginning of a gale, and a well-found and powerful vessel, to gain and maintain an offing under such circumstances. But if a gale finds a vessel within the line joining the horns of a bay, then the danger of being stranded becomes imminent, and in the majority of cases is nearly certain, depending more or less upon the strength of the gale, the nature of the sea caused by it, the quality of the vessel, her amount of offing, and whether there be a harbour under her lee which will admit her. From the foregoing remarks, it will be understood, that in a bay, or that portion of a coast recessed within the general line, a risk is incurred, which only obtains in a minor degree upon a direct shore, and which has no existence whatever upon one forming a salient line.

To apply this to the present case. The coast between Robin Hood Bay and North Sunderland Point forms a bight, as already noticed 78 miles across, and 13 miles deep, and as this is the only bay (properly so called) on the eastern coast of England, it is consequently the most dangerous portion of the whole coast. Once caught in this bight in a heavy on-shore gale, or one from E. by N. (which is the direct embaying wind), without the vessel be of light draft, and the state of the tide admits of her entering one of the bar harbours under her lee, there is no escape. Being within the horns of the bay, she cannot clear the land on either tack, and though the catastrophe may possibly be delayed a little by dint of carrying on a press of sail, first upon one tack and then upon the other, her constantly increasing leewardly drift insures her fate, and she is ultimately stranded, generally to her own destruction, and frequently to the loss of the crew.

It is clear that the same risk cannot be incurred upon other portions of the coast, for the reason that a vessel must necessarily be opposite a salient sea-board, and that she will generally have a harbour available for shelter on the one hand or the other. Take, for example, the several stages along the eastern coast of England; a vessel abreast the Fern Islands, with an offing of five miles, will have the land on either hand bearing respectively N.W. by N. and S. ½ E., or, in other words, she will be 2½ points of bearing in advance of a direct line, with the Firth of Forth available for refuge to the northward, and the Humber to the southward. From five miles in the offing abreast Whitby, the bearings will be N. ½ W. and S. ½ E., and the vessel will be, consequently, on the direct line. Five miles off Flamborough Head the bearings will be N. ¾ W. to the Ferns, S. ¾ E. to the Would, on the coast of Norfolk, and S. by W. ½ W. to the Humber; the latter, a noble refuge harbour, being under her lee for the whole distance from Flamborough Head to Cromer. Off Lynn Deeps, the deeps are available; and so on for the coasts of Norfolk and Suffolk continuously to the Thames; the whole forms a constantly receding, or salient line, affording shelter at the several stages, either by roadstead, harbour, or channel. How different is the case on the north-eastern coast. A vessel five miles off Hartlepool Heugh, near the head of the bight, has the land bearing respectively N. ½ E. and rather outside S.S.E.; she is, in fact, recessed 2½ points within the direct line, and with no possibility of escape, unless under the exceptions already mentioned.

The necessity for a refuge harbour somewhere within the north-eastern bight is further increased by the existing harbours being fitted for affording shelter only in a very limited degree; they are all bar harbours, and entry into them (at most times attended with difficulty) is rendered extremely critical at the time when it is most needed. The following ruling low-water depths over their several bars will show their inferiority: Warkworth, 1 foot; Blyth, 1 foot; Tyne, 6 feet; Wear, 4 feet; Seaham, 1 foot; Hartlepool, 3 feet; Tees, 8 feet. It will be apparent that, except near the time of high water, and then only for handy vessels of moderate draft, they are absolutely unfitted to afford shelter in cases of extremity. Imperfect as they are, however, vessels attempt them under nearly all circumstances, and even when the ebb is running, and the danger arising from a deficiency of depth is greatly increased by a bursting sea. Much loss has occurred under my own observation from these causes, and it is a question in my mind, whether the harbours are not a temptation to risk, and the cause of the loss of more vessels in the attempt to enter them than they save from actual stress of weather. Possessing none of the proper features of a refuge harbour, depth and width of entrance, ample internal space, and complete availability, they can only be termed dangerous decoys.

The necessity for a refuge harbour in the north-eastern bight is still further increased by the vast number of ships constantly crossing it. The whole of the coal ports are within its limits, and it becomes the focus of wreck partly because it is the focus of trade. Vessels bound to these ports are drawn into difficulties from the necessity which exists for their hanging abreast the several bars, to be ready to enter immediately the tide suits, instead of maintaining the amount of offing which the character of the coast and a simple consideration to the vessels' safety would require. Some interesting facts connected with the amount of trade are noticed in the Petition and Memorial from the Tyne Commissioners. It is stated that "in the five ports of the Tyne, Wear, and Tees, according to a parliamentary return, upwards of 8,100,000 tons enter or proceed outwards; being one-sixth of the trading tonnage of the kingdom, and more than that of the Thames. These ports have 102,000 vessels annually entering and leaving their harbours, which makes about 283 vessels daily on the seaboard of these rivers, and sometimes 1000 vessels are off the coast detained by contrary winds. With those employed in the coal ports the nature of the trade sends them to sea in the stormy season rather than in the fine—in winter rather than in summer. When once at sea and the necessity arises for a return, there is no return; and hence it is that upon this most dangerous of all coasts you have one-seventh of the wrecks of the kingdom to deplore."

The foregoing are a few of the principal considerations which show the necessity for the erection of a refuge harbour on the north-eastern coast, and it now remains for me to indicate—

Thirdly. The site which should be selected for securing all the objects in view.

It is clear that it should be as near the head of the bight as practicable, that is, in the neighbourhood of Hartlepool, for this special reason—that a vessel embayed would be able to reach it from any portion of the bight, which she could not do if it were placed anywhere else. A distance of 10 fathoms opposite each port from the line of embayment would represent nearly the position a vessel would be in if waiting tide to enter the port. The direct embaying wind, as already remarked, is E. by N., and the course for a vessel near Blyth to a refuge harbour at Hartlepool would be south, or three points free; from abreast the Tyne (after Souter Point has been rounded), S. ¼ W., or 3¼ points free; from abreast Sunderland, S. ¼ W., or 3¼ points free; from near Seaham, S., or 3 points free; and from the whole of the northern coast of Yorkshire between Whitby and Hartlepool, N.W. ½ N., or 4½ points free;—whereas a refuge harbour placed in the vicinity of the Tyne, for instance, would be comparatively useless to vessels embayed in the same depth of water to the southward of it, as they would have to make good a N. ½ E. or "upon a wind" course to reach it; a feat they could not possibly accomplish, even in moderate weather. It is necessary, in short, to bear in mind as a material point, that while the greater the distance of a port in a bight from the line of embayment, the greater is its disadvantage in a nautical point of view, as the same fact of deeper embayment renders it more fitted as a site for a harbour of refuge. Hartlepool and its vicinity being at the head of the bight, necessarily embrace the site which should be chosen.

There are three positions in the vicinity of Hartlepool for a work of the sort, from which a selection may be made, viz., Redcar rocks, the mouth of the Tees, and Hartlepool Bay. I shall give the leading features of each site, as materials to assist in forming an opinion as to their respective merits.

1. Redcar or Salt Scar rocks, opposite the village of Redcar, are two main ledges of alum shale, drying from 5 to 7½ feet at low water springs, and projecting in a general E. by S. direction for 1250 yards beyond low-water mark; their dry portions, and the ledges in connection with them, embrace a space of 172 acres; 15 acres near the centre of this area are occupied by a mass of partially dry ledges named the High Stone; 122 acres, partly sandy and partly foul, have a less depth than 18 feet at low water, and the remaining space of 35 acres is only fitted for berthage in a very qualified sense. It is true that the late lamented Captain Hewett, in his evidence before the Select Committee on Harbours of Refuge, in April 1836, remarked, respecting a site for a refuge harbour: "Redcar is the only place that nature seems to have provided for the purpose;" but it is right to remember, that Captain Hewett had made no detailed survey of the rocks, and that he appeared to be entirely unacquainted with the mass of foul ground they enclosed. If it were absolutely necessary to form a harbour of the sort near Redcar, the wiser plan would seem to be, instead of building upon the Salt Scars, and so enclosing a nest of rocks, to place the works upon the sandy foreshore, on one side of them, where the enclosed space would be all clear, and where the stability of the works would not be endangered from being placed on sloping ledges, with a bursting sea acting upon the toes of the slopes.

2. The mouth of the Tees, from being the outlet of a river, is not adapted for a refuge harbour, for these reasons:

The sea breaks upon the north-east coast of England, in onshore gales, in 5 fathoms at the least; and a refuge harbour, to be taken with safety, should not have a less depth at its entrance. On the bar of the Tees, as already mentioned, there is a depth of 8 feet. Admitting that by the aid of artificial means, this might be increased to 12 feet, yet this is a depth altogether too small for the purpose, remembering that a refuge harbour to be worthy of the name must not only be safe of access, but must always be available for entry whatever the state of the tide may be.

Again, a fair following sea, or one in which a ship running before it is comparatively safe, being under easy control, does not exist in a strong tide-way, especially when the tide-way is the outset from a river. This stream, when directly opposed by the wind, causes a high, hollow, uncertain and breaking sea, in which a ship quickly becomes unmanageable, broaches to, and is lost. From the combined effect therefore of a dangerous sea, and a deficiency of depth during the greater part of the ebb, and a want of depth for a considerable portion of the flood, the outlet of a river however situated would be useless for refuge purposes during at least eight hours out of the twelve.

Again the channel of approach to a refuge harbour should not only be wide and deep, and be entirely free from a strong tidal outset, but its features should also be permanent. Now it is a characteristic of all rivers issuing from between sands, that their outlets are constantly fluctuating; and though artificial works might correct this evil for a time, yet the original features in a modified degree would eventually form outside them, when the process of change would be continually repeated as before.

There are other objections to converting the outlet of the Tees to the purposes of a refuge harbour, but the foregoing are the principal ones, and it will be apparent that they apply with full force against adopting the Tyne or any other river for a work of that description.

3. Hartlepool Bay, the last of the three sites at the head of the north-eastern bight, is happily one possessing substantial merits, and one to which few real objections can be made. The following are some of its manifest advantages:—

It has a clear seaward approach, with a gradually decreasing depth in front, and its position is already marked by a good light upon a projecting headland.

It is not only at the head of a dangerous bight, and thus conveniently placed, as we have seen, for the preservation of life, but it is also to leeward of the principal coal ports in those gales which are the heaviest and of most frequent occurrence, namely, those between north and north-east; and it would, consequently, be admirably adapted for the shelter of vessels caught under such circumstances short of their port.

It has excellent holding-ground, and the surface of the bottom is uniform. The soil is of stiff clay, of considerable thickness, covered by a surface deposit of sand; it has been bored into to the depth of 20 yards, and it is supposed to be even thicker in the outer portion of the bay.

It is of a circular form, being partially enclosed, if I may use the term, by the Heugh, a headland of soft magnesian limestone, to the northward, and by the Long Scar, a ledge of soft red sandstone, to the southward. It possesses, therefore, features which if aided by properly projected works would afford a large protected space at a comparatively small outlay.

The tidal streams in the bay are weak, being at the rate of little more than a knot per hour in springs, and not half that amount in the inner part of the bay; while a judiciously planned covering-work would not decrease that rate (keeping in view the maintenance of depth), neither would it increase the rate—an important consideration, as I have already stated.

The strand in the circuit of the bay is sandy and even, and well suited for beaching vessels upon in cases of extremity, with safety to themselves and their crews. It is even now, in its natural and unprotected state, a favourite place among seamen for this purpose.

It embraces within its limits the two flourishing and rising ports of Old and West Hartlepool; and while its protection and conversion into a refuge harbour would be a direct and inestimable advantage to them, their various docks would supply an inner harbour, into which vessels disabled could enter and be repaired; from whence pilots could go out to sea in all weathers; and where assistance could be immediately given, by steam-boats or otherwise, in all cases of distress.

Lastly, a collateral and a not unimportant advantage attending the establishment of a refuge harbour at Hartlepool would be, that being fitted for vessels of heavy draft, it would be invaluable in case of war for the protection of the coal ports, as well as the whole of the north-eastern trade; while its position, nearly midway between the Humber and the Firth of Forth, would render it equally valuable for the defence of the kingdom.

RAILROAD DEVELOPMENTS.*

By John M. Richardson, United States.

The maximum gradient of any road is determined by the following considerations, viz.: the character and amount of the traffic it is required to accommodate, the topography of the country through which it passes, and the funds at the disposal of the company. "What a road ought to be," is determined by the first of the above considerations, but the second and third, frequently, if not always, interfere and determine that it must be what it should not be.† Owing to the great irregularity of the surface of the earth, the ingenuity of the superintending engineer is often severely taxed in endeavouring to keep within the limits of the required grade, and very frequently much valuable time is lost. I propose to present in this paper, some considerations which should influence an engineer when seeking to locate a road between two points, the direct line connecting them being too short. This is a case of frequent occurrence in hilly and mountainous districts, and one which often causes much difficulty. Imagine a case. Suppose it is required to connect two points A and B, whose difference of level is 660 feet, their horizontal distance apart 10 miles, and the maximum grade 40 feet per mile. It is evident that the straight line connecting A and B is too short and steep, for it rises 66 feet per mile. Hence the line cannot be straight, but must be curved or mixed. Regard A as the

* From the 'Journal of the Franklin Institute.'

† For an excellent *resumé* of the principles which should determine the construction of a road, see chapters i. and v. of Prof. Gillespie's work, 'A Manual of Road-making.' This work cannot be too highly commended: it is admirably suited for an introductory text-book to the professional student; and although it does not go so fully into the matter as such a reader may desire, it is the better calculated to answer the purpose intended by the author, whose aim was to diffuse practical information in a popula form adapted to the capacity of the general class of readers and students.

lowest of the points; a little consideration will show that in order to get the shortest line fulfilling the required conditions, it must continue to ascend according to the given grade. Now, $660 \div 40 = 16{\cdot}5$; that is, the horizontal length of the required road is 16·5 miles. If from the nature of the surface between A and B any part of the road connecting them be necessarily level, the entire horizontal length will be 16·5 miles + the level part. If the road anywhere descends below the regular grade line in passing from A to B, the entire horizontal length will be 16·5 + a length equal to that necessary to overcome a height twice that of the descent. If the road anywhere ascends above the regular grade line in passing from A to B, the entire horizontal length will be generally equal to at least 16·5 miles + a length equal to that necessary to overcome a height twice as great as the ascent. Thus, if in passing from A to B, the line anywhere descends 100 feet below the grade line, it will have to ascend the same, and this ascent and descent of an extra 100 feet will be equivalent to adding at least 200 feet to the original difference of level; making it 860 feet, and increasing thereby the horizontal length of road by at least 5 miles. Cases may arise in which it will be impossible to avoid making occasionally such descents and ascents in passing from A to B, but such a location should be given to the road (if it is possible to find one not attended by too great cost) that the ascent from A to B may be gradual and constant.*

If d denote the sum of the unavoidable descents below the grade line in passing from A to B, a the sum of the unavoidable ascents above the grade line, l the length of level part; the entire horizontal length of road connecting A and B will be, generally at least,

$$16{\cdot}5 + 0{\cdot}05\,(a + d) + l \text{ miles};$$

and the length of the road itself,

$$l + \left[\left(\frac{330 + a + d}{2640}\right)^2 + 0{\cdot}0025\,(330 + a + d)^2\right]^{\frac{1}{2}} \text{ miles.}$$

If $a = d = l = o$, the length of the shortest line will be, 16·500473 miles.

Now, though this is the *shortest* line fulfilling the required condition, it may assume *several different positions*; it may lie entirely on one side of the vertical plane, passing through A and B; or, partly on one side and partly on the other; or it may assume several different positions on the same side.* Some of these positions or locations will now be traced, and others indicated.

Problem.—Having given the difference of level of two points A and B, and their horizontal distance apart, it is required to connect them by a line rising uniformly from A to B according to an assumed grade—that is, by a line making a constant angle with the horizon. Let the horizontal plane of reference pass through A, and B′ be the projection of B on that plane; h = the height of B above A, and $2c$ = their horizontal distance apart.

Since the required line is to make a constant angle with the horizon, it must be a helix, and if a denote the constant angle, the length of helix is

$$s = h \cos a \quad . \quad . \quad . \quad . \quad . \quad (1)$$

The horizontal projection of s, or horizontal length of line connecting A and B, is

$$s = s \cos a = h \cot a \quad . \quad . \quad . \quad . \quad (2)$$

The *length* of a helix as well as the length of its horizontal projection, is unaffected by the nature of the surface upon which it is located, but the *position* of the helix in space, and the form as well as position of the curve into which it is projected, depend entirely upon the nature of this surface.

For the sake of simplicity assume that the helix is located on a right cylinder with circular base, whose projection on the plane of reference passes through A and B′, and that the helix shall not pierce the vertical plane of A and B. The projection of the helix, which will be the horizontal length of the required line, and which is known from difference of level of A and B, and the assumed grade, will be the arc of a circle passing through A and B. Tho problem will be solved when the radius of this arc and the angle subtended by it are determined. (See fig. 2.)

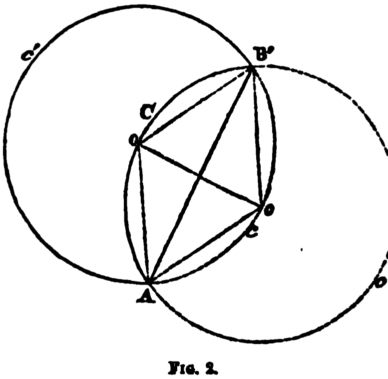

Fig. 2.

Let A C B′ be the projection of the helix: $\rho = \text{O A}$ the required radius, 2φ the angle subtended by A C B′. The equations of condition are,

$$\rho\, 2\varphi = s = h \cot a \quad . \quad . \quad . \quad . \quad (3)$$

$$\rho \sin \varphi = c \quad . \quad . \quad . \quad . \quad . \quad (4)$$

Expanding $\sin\varphi$ in terms of ϕ,

$$\sin\phi = \varphi - 2^{-1}.3^{-1}.\varphi^3 + 2^{-1}.3^{-1}.4^{-1}.5^{-1}.\varphi^5 - 2^{-1}.3^{-1}.4^{-1}.5^{-1}.6^{-1}.7^{-1}.\varphi^7 + \&c.$$

Substituting in (4),

$$\rho\,(\phi - 2^{-1}.3^{-1}.\varphi^3 + 2^{-1}.3^{-1}.4^{-1}.5^{-1}.\varphi^5 - 2^{-1}.3^{-1}.4^{-1}.5^{-1}.6^{-1}.7^{-} \quad \varphi^7 + \&c.) = c \quad . \quad . \quad . \quad (5)$$

Eliminating ρ between (3) an (5), and taking only these terms of the development of $\sin\phi$,

$$\phi^4 - 20\,\phi^2 = 240\,c\,h^{-1} \tan a - 20 \quad . \quad . \quad (6)$$

Solving (6),

$$\varphi = \pm\left[10 \pm (240\,c\,h^{-1} \tan a - 20)^{\frac{1}{2}}\right]^{\frac{1}{2}} \quad . \quad . \quad (7)$$

Substituting in (4) and reducing,

$$\rho = d \cos\left[10 \pm (240\,c\,h^{-1} \tan a - 20)^{\frac{1}{2}}\right]^{\frac{1}{2}} \quad . \quad . \quad (8)$$

From (7), it is evident that φ will have at least two real values, numerically equal, but affected with contrary signs, when

$$\tan \overline{\overline{>}}\ 6^{-1}\,(2c)^{-1}\,h \quad . \quad . \quad . \quad . \quad (9)$$

* See Prof. Gillespie's work already referred to, page 233. It seems to be hardly necessary to add anything to the preceding remarks, but lest any one should experience the least difficulty in comprehending how it is that a descent below or an ascent above the grade line can add practically to the difference of level between the two points, a height equal to twice the ascent or descent, an example will be given. Referring to the example already suggested in the body of this paper,—if in passing from A to B, 300 feet of their difference of level being overcome by a line rising uniformly from A to B, accordingly to the required grade, it being found necessary, owing to the great irregularity of the surface (a valley intervening, for instance,) to descend 100 feet, a corresponding ascent will have to be made before the original difference of level (360 feet) between B and that point of the road where the descent began can be restored. And this descent and ascent of an extra 100 feet will require a length of road equal to an ascent or descent of 200 feet; and the total length of road will be the same as if 200 feet had been added to the difference of level of A and B, and the road had risen continuously according to the assumed grade from A to B. Again, if after having overcome 300 feet of the difference of level between A and B, it be found necessary—a mountain intervening which it is judged best not to pierce by a tunnel—to ascend above the regular grade line to a height equal to 100 feet, the difference of level between B and the point where this ascent terminates will be less by 100 feet than the difference of level between B and the point where the ascent above the grade line began. Hence only 260 feet remain to be overcome; and if no corresponding descent be necessary, and if the horizontal distance from B to the point where the ascent began be not increased, the total length of road from A to B may not be increased at all. But if, as will generally be the case under such circumstances, a corresponding descent of 100 feet be necessary before the surface of the ground is such that the road can ascend continuously from A to B, the total increase in length of road connecting A and B will be equal to that necessary to overcome a height of 200 feet, as already determined. It will be well to illustrate this last position by fig. 1. Let A C b' be the projection of the regular grade line as located on the surface of a right cylinder with circular base, and whose base passes through A and b', C is 300 feet above A, and suppose that after having arrived at C, the superintending engineer concludes that it is best not to pierce the mountain intervening between C and B by a tunnel, but to deflect the road to the right rising above C 100 feet to D. It will generally be necessary to descend at least 100 feet to some point, as E, before the surface of the ground is such that the road can ascend continuously to B. This ascent and descent of 100 feet will add five miles to the length of road connecting A and B, and it will in general be preferable to pierce the mountain and build the road along the line A C b', rather than along the line A C D E F b'; but if the initial expense of constructing the road along the route C D E F b', the yearly expense of keeping it in repair, and the wear and tear of the engines and cars over the same, be less than the aggregate of the corresponding items of expense along the line C b', the engineer will be justifiable in making the deflection, otherwise he will not. Further, if the difference of level between the highest point of road and A be greater than the difference of level between A and B, then the length of road connecting A and B will be increased by an amount equal to at least that much necessary to overcome a height twice as great as the difference of level between B and the highest point of road.

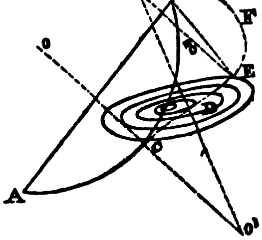

Fig. 1.

* The line is evidently a helix, and it may be located upon a cylinder, a cone, a sphere, an ellipsoid, a paraboloid, and a hyperboloid—or it may be traced upon several tangent surfaces—and in no two cases will the projections be the same, although they will all be of the same length.

If a' be the angle made by the straight line connecting A and B with A B′, $\tan a' = (2c)^{-1} h$, and (9) becomes

$$\tan a \overline{\overline{>}} 6^{-1} \tan a' \quad . \quad . \quad . \quad . \quad (10)$$

If in addition to the condition expressed by (10), there is this other one, viz.:

$$10 \overline{\overline{>}} (240\, c\, h^{-1} \tan a - 20)^{\frac{1}{2}}, \text{ or reducing,}$$

$$\tan a \overline{\overline{<}} \tan a'. \quad . \quad . \quad . \quad . \quad (11)$$

ϕ will have four values, of which, however, only two will differ numerically.

It is evident from the nature of the problem and the conditions assumed, that $\tan a$ can never exceed $\tan a'$; also that the two values of ϕ which differ numerically must be supplements to each other, *i.e.*, so related that their sines will be equal; for if they are not, ρ will have two different values, numerically considered; and therefore s, the projection of the helix, will be equal in length to arcs of two different circles subtended by a common chord,—which is impossible. (See Davies' 'Legendre,' Book v. 17.)

Again, since the relation expressed by (11) must always hold, that expressed by (10) must also, in order for ϕ to be real. The assumed condition which determines (10) is, that the helix shall not pierce the vertical plane passing through A and B.

If $\phi < 45°$, the helix will be projected into an arc less than a semicircle; if $\phi = 45°$ the projection of the helix will be a semicircle; and if $\phi > 45°$, the arc of projection will be greater than a semicircle. Having found ρ and ϕ, the arcs can be traced, and the difficulties to be encountered in constructing the road along either of them ascertained. Several other routes may also be obtained. A B′ may be divided into two, three, four, or more parts, equal or unequal, and the helix located on as many tangent cylinders. The projection of the helix in all such cases will be a curve of contrary flexure. (See fig. 3.)

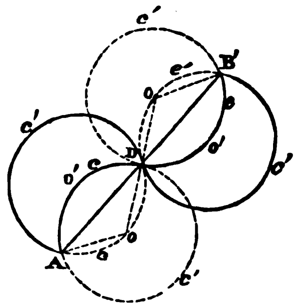

Fig. 3.

It is seen that ϕ and ρ can only be approximately determined, the nearness of the approximation depending upon the number of terms of the development of $\sin \phi$ that is taken. If 4, 5, 6, &c. be employed, equations of the sixth, eighth, tenth, &c. degrees will be obtained; but as they contain only even powers of ϕ, they may be reduced to equations of the third, fourth, fifth, &c. degrees, by introducing an auxiliary unknown quantity. Instead, however, of attempting to solve these equations, it will be better perhaps to proceed thus:—having found an approximate value of ϕ from (7), (8) will give an approximate value of $\rho - \rho = r'$— Substituting in (3) there will result

$$\phi = 2^{-1}\, r^{-1}\, h \cot a = \phi' \quad . \quad . \quad . \quad (12)$$

This in (4) gives

$$\rho = c \cos \phi' = r'' \quad . \quad . \quad . \quad . \quad . \quad (13$$

This in (3) gives

$$\phi = 2^{-1}\, r''^{-1}\, h \cot a = \phi'' \quad . \quad . \quad . \quad (14$$

This in (4) gives

$$\rho = c \cos \phi'' = r''' \quad . \quad . \quad . \quad . \quad . \quad (15)$$

&c. &c. &c.

The approximation should be continued in this manner, until ρ is correctly obtained to four decimal places. If in any case $\tan a < 6^{-1} \tan a'$, the helix cannot be located on a right cylinder with circular base, and must then be traced on some other surface or surfaces. (See article 'Helices,' &c., already referred to.) Since (7) gives only an approximate value for ϕ, the two values of ϕ will not be exact supplements of each, but will only approximate towards that relation, and will approach nearer and nearer to the state of having their sines equal to each other the farther the approximation is carried. The same remark holds when, instead of employing (7) to find ϕ, 4, 5, 6, &c. terms of the development of $\sin \phi$ are used.

When equations of higher degrees than these are employed to determine ϕ; the real and positive values obtained must either be supplements of each other, or so related that their sines are equal.

$$\operatorname{Sin}\phi = \sin(\pi - \phi) = \sin(\pi + \phi) = \sin(2\pi - \phi) = \sin(2\pi + \phi) = \sin(m\pi \mp \phi) \ . \ (16)$$

m must be a positive even number. The values equated are the numerical ones, no attention being paid to the algebraic signs.

If four terms of the development of $\sin \phi$ be employed, the resulting equation in ϕ will be

$$\phi^6 - 42\,\phi^4 + 840\,\phi^2 = 5040 - 10080\, c\, h^{-1} \tan a \quad . \quad . \quad . \quad (17)$$

Putting $x = \phi^2$, (14) becomes

$$x^3 - 42x^2 + 840x = 5040 - 10080\, c\, h^{-1} \tan a \quad . \quad . \quad . \quad (18)$$

If five terms be employed, the resulting equation will be

$$\phi^8 - 72\phi^6 + 3024\phi^4 - 60480\,\phi^2 = 725760\, c h^{-1} \tan a - 362880 \ . \ (19)$$

(19) may be put under the form

$$x^4 - 72x^3 + 3024x^2 - 60480x = 725760\, c\, h^{-1} \tan a - 362880 \ . \ (20)$$

Having found an approximate value for x from (19) or (20), there will result $\phi = \mp \sqrt{x}$. This in (4) will give an approximate value for ρ. Then apply the method of approximation already described.*

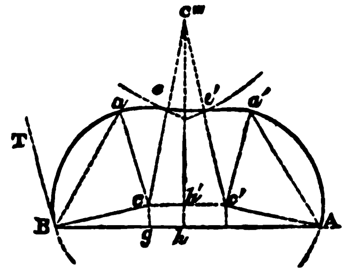

Fig. 4.

The helix may be located on several tangent cylinders, so that its projection may be a curve of contra-flexure, lying entirely on one side of A B′. Several examples are given. (See figs. 4, 5, 6.)

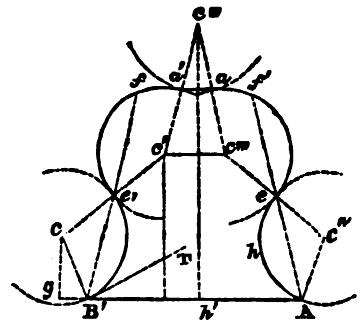

Fig. 5.

Figs. 4 and 6 represent the helix as located on three tangent cylinders. In fig. 5 it is located on four.

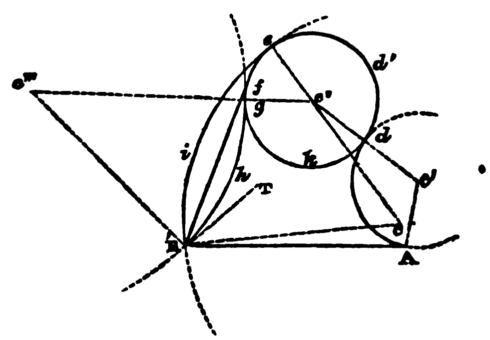

Fig. 6.

Fig. 6 exhibits six routes for passing from A to B: they are not all of the same length in the diagram—A*dd′ei*B′; A*dd′ef*B′; A*dd′efgh*B′; A*dkgh*B′; A*dkgf*B′; A*dkgfei*B′. Now although

* Let $h = 660$ feet; $2c = 52{,}800$ feet; $\tan a = 1 + 132$, which cor-

in practice none of these may ever arise, especially none of the last three, yet it is easy to conceive of the circumstances under which it may be necessary to adopt any one of them.

In fig. 4, $ed = ee' = e'd' = 3^{-1}dB' = 3^{-1}Ad' =$ one-ninth of the entire horizontal development $cd = c'd' = c''e$. $B'd$ is an assumed chord taken sufficiently long to prevent too great curvature in the arc $B'd$. Having determined $\rho = cd = r$, and $\phi = B'cd = B$, the horizontal development can be traced. In order to trace it, the angle which the curve at its initial point makes with AB' must be found. Drawing $B'T$ tangent to the curve at B', it makes with AB' an angle,

$$AB'T = AB'c + cB'T = AB'c + 90° \quad . \quad . \quad (21)$$

Draw eg perpendicular to AB', and ch' parallel to the same; thence

$$c'h = hg = 2ce \sin(6^{-1}\phi) = 2r \sin(6^{-1}\varphi);$$
$$B'g = 2^{-1}c - 2r \sin(6^{-1}\varphi);$$
$$\cos AB'c = 2^{-1}cr^{-1} - 2\sin(6^{-1}\varphi), \text{ or,}$$
$$AB'c = \cos^{-1}\left[2^{-1}cr^{-1} - 2\sin(6^{-1}\phi)\right] \quad . \quad . \quad (22)$$

In fig. 5, $df = dd' = df' = 3^{-1}ehB'$,
and since $B'e = ef = f'e' = e'A$, there results

$$AB'T = Bcg = fc'd = 3^{-1}B'ce = 3^{-1}\phi \quad . \quad . \quad (23)$$

If, in fig. 6, the development $Add'efghB'$ be taken, the angle $AB'T$ can be determined thus: In the plane figure $AB'c'''c''c'$ all of the sides are known, together with the angles $B'c'''c''$, $c'''c''c'$, and $c''c'A$. Hence, $AB'c'''$ can be found, and subtracting 90° from it, the remainder will be equal to $AB'T$. That is,

$$AB'T = AB'c''' - 90° \quad . \quad . \quad . \quad (24)$$

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responds to a grade of 40 feet per mile.

$$\tan a' = 660 \div 52{,}800 = 1 \div 80 = \cdot0125.$$

Hence $\tan a > 6^{-1} \tan a$.

Substituting in (7),

$$\phi = 1\cdot654 \text{ or } 4\cdot164.$$

To express φ in seconds,

$$\phi = 648{,}000 \times 1\cdot654 \div 3\cdot14159 = 341130\cdot4';$$

and reducing to degrees, minutes, and seconds,

$$\phi = 94° \; 45' \; 30\cdot4''.$$

This value in (4) will give the first approximate value of ρ. Substituting it in (3), the second approximate value of ϕ will be obtained; and so on, placing in (15) for c, h, and $\tan a$, their values; there results,

$$x^3 - 42x + 840x = 21{,}840 \div 11.$$

By inspection $x > 2$ and < 3. Assume $x = 2\cdot6$, there results

$$x = 2\cdot4944 \; ; \text{ and } \phi = \sqrt{x} = 1\cdot57$$

for the first approximate value of φ, which can be employed as before.

The higher the degree of the equation employed the more nearly correct is the value obtained for ϕ.

It is evident that ρ is always greater than c.

Hence, instead of solving (7), (15), or (18), an approximate value for ρ greater than c may be assumed, and the method of approximation then applied to find φ and ρ correctly to four or five decimal places. It will be best however to solve one of the highest equations involving φ.

A word of explanation here with regard to fractional and negative exponents. It is possible that this paper may fall into the hands of some whose limited mathematical knowledge will not enable them to comprehend the analytical solution of the problem, but who may be desirous to apply the results of the investigation. For the benefit of such, the following equivalent expressions are given:

$$a^{\frac{2}{3}} = \sqrt[3]{a^2} : (a^2 - b^2)^{\frac{1}{2}} = \sqrt{a^2 - b^2} : 6^{\frac{1}{2}} = \sqrt{6} : (63-48)^{\frac{2}{5}} = \sqrt[5]{(63-48)^2}$$

And generally,

$$a^{\frac{m}{n}}(r^2 - s^3)^{\frac{p}{q}} = \sqrt[n]{a^m} \times \sqrt[q]{(r^2 - s^3)}\,\frac{p}{q}.$$

That is, any quantity raised to a power denoted by a fractional exponent is equal to that root of the quantity whose index is the denominator raised to a power the exponent of which is the numerator.

$$2\cdot7^{-1} = 2 \div 7 : 3\cdot4^{-3} = 3 \div 4^3 : 7\cdot9^{-\frac{1}{3}} = 7 \div 9^{\frac{1}{3}} = 7 \div \sqrt[3]{9} :$$
$$(6a + 7^{-1}b)^{-\frac{2}{3}} = 1 \div (6a + b \div 7)^{\frac{2}{3}} = 1 \div \sqrt[3]{(6a + b \div 7)^2}.$$

And generally,

$$a^{-m}\, b^{-n}\, c^{-s}\, d\, e = d\, e \div a^m\, b^n\, c^s.$$

That is, if there be several factors, some of which have negative exponents, the expression is equivalent to a fraction whose numerator is the continued product of the factors having positive exponents, and denominator the continued product of the factors having negative exponents, the signs of the negative exponents being changed.

The angle made by the tangent to eiB' at B' is also readily found,—likewise the angle made by fB' with AB'. In all cases except the first ρ may be assumed so as to regulate the curvature of the arcs: ϕ and the chord will then be known.

Figs. 4, 5, and 6 have been introduced merely to show into what a variety of forms the helix may be projected.

The practical conclusion drawn from this investigation is as follows: when it is required to connect two points whose horizontal distance apart and difference of level are given, by a line making a constant angle with the horizon, the straight line connecting the points being too steep, the shortest line fulfilling the condition may assume many different positions, several of which should be examined in detail, and that one selected which presents the fewest or least formidable obstacles to the construction of the road. Much might be added here with regard to the importance of running numerous "trial lines," when the nature of the surface is such as to present any difficulty in the practical solution of the problem. I forbear, however, to say more than I have already said on this subject. Any additional remarks may seem to be rather out of place in this paper, which is devoted to the solution of a special problem in practical engineering.

FIR, DEAL, AND HOUSE PAINTING.

AN ATTEMPT TO DETERMINE WHEN THESE WERE INTRODUCED INTO ENGLAND, WITH REMARKS ON THE PROCESSES OF THE LATTER.*

By WYATT PAPWORTH, Architect.

IT has been generally supposed that the timber seen in old buildings is almost without exception oak; but it will be found on investigation that many other kinds of wood were used, a knowledge of which, tested as they have been in trying positions, would be highly serviceable to the architect and to the builder. From records quoted in Mr. Turner's 'Domestic Architecture of England,'† it appears that in 1253, temp. Henry III., the bailiffs of Southampton were commanded to buy 200 Norway boards of fir to be used at Winchester for wainscot; that in 1255, 1000 Norway boards were purchased for wainscoting certain rooms in Windsor Castle, and that a house of deal was to be made, running on six wheels, and roofed with lead. The word used, *sapo* or *sappo*, has been translated "deal;" this latter is stated to be derived from the Dutch, *deelen*, or German, *dielen*, "firwood," which would perhaps be the better translation of the word *sapo* (Fr. *sapin*). Turner gives his opinion that "the wood ordinarily used was fir, possibly because it was cheaper and more easily worked than oak;" and that "Norway planks were largely imported into this country from an early period of the thirteenth century, and perhaps, although it is not quite so clear, at a still earlier time." His authority for these remarks appears to me very slight; but he has in his favour the fact that treaties "for the benefit of trade" were made by Henry III. with one or two of the kings of Norway; the use of the timber however would appear (from these records) to have been confined to the royal works. Deal boards bought for doors and windows are mentioned between 1272 and 1307. One of the halls appropriated for the royal seat at the coronation of Edward II. (1307) was ordered to be covered with boards "de sapo." The wardrobe accounts of Edward IV. (1480) mention "cofyns of fyrre" for the carriage of the king's books to Eltham.

The above extracts show that fir timber was imported at that early period; and omitting the last record, we must now pass over an interval of about 200 years to the next date, for the first statement I have been able to find of the actual importation of timber, which is as late as 1517, temp. Henry VIII., when the Dutch in particular were accused of bringing over iron, timber, and leather, ready manufactured. During that monarch's reign the scarcity of timber began to be experienced, and several statutes were passed for fixing the price of barrels: requiring the importation of clap-boards for their manufacture; and for the preservation of the forests of England, but excluding the counties where iron-works had been carried on from very ancient times. Queen Elizabeth (1558-1603) having reduced the forests still further, passed subsequent acts for their preservation. Mr. Clayton, in his work on the ancient timber edifices of the western part of England, states that the timber buildings of England of this

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* Paper read before the Royal Institute of British Architects.

† The omission in this work of information as to the exact kind of wood used in the different buildings is the more to be regretted as the author of the second volume states that he had visited every place he described.

period (that of the sixteenth century) were invariably constructed of oak, of extreme durability; and Harrison (1573), the often quoted writer in the reign of Elizabeth, says: "The walls of our houses on the inner side be either hanged with tapestrie, arras worke, or painted cloths—or else they are seeled with oke of our owne, or wainscot brought hither out of the East countries;" and in another place,—"in times past men were contented to dwell in houses buylded of sallow, willow, plum-tree, hard beame, and elme, so that the use of oke was in a manner dedicated unto churches, religious houses, princes' palaces, noblemen's lodgings, and navigation; but now all these are rejected, and nothing but oke anie whit reguarded." It will be observed that deal is not mentioned for building purposes. During the last years of Elizabeth's reign, cottages and farmers' houses were building in all directions, and in London the progress was likened to an inundation. Large quantities of timber were thus needed, as brick had not yet been adopted for general use.

Although without any historical record of the fact, it is to about this period (1558-1608), and to the above-named causes, that I should attribute the general introduction of foreign timber as an article of commerce; as in 1553 (1st of Mary) the English had discovered Archangel, and in 1560 commenced trading to Narva, then belonging to Sweden. The fitness of fir besides other woods for building, is set forth by an English writer in 1586, seventeen years before the death of Elizabeth:—"Firr timber is meet for divers workes, and greatly esteemed for its height and bignesse, whereof are made the ship masts and pillars for houses, for it is very strong and able to abide great force. It is used also in building, for great gates and door-posts: in fine, good for any building within, but not so well enduring without doores, and very soon set a-fire. The firre, the poplar, the ash, and the elme are meet for the inner parts of the house, but they serve not so well in the weather as the oke doth. The best to bear weight is the fir and the larch, which, howsoever you lay them, will neither bend nor break, and never faile till wormes consume them. Ash for thin borde; the best to clean, the firre, the poplar and the beech." In or about 1603, Sir Walter Raleigh presented to James I. some observations on trade and commerce, showing how the Dutch had engrossed the transport of the produce of other countries, and stating that "the exceeding groves of woods were in the East Kingdoms, but the huge piles of wainscot, clapbord, fir, deal, masts, and timber, is in the Low Countries, where none grow, wherewith they served themselves and other parts, and this kingdom, with these commodities." From other accounts it appears that for about seventy years a very considerable trade had been carried on with Russia (Archangel, it will be remembered, was discovered by the English in 1553), and that down to about the year 1590 a large number of ships sailed annually to that country; but in 1600 only four had been sent out, and in 1602 only two or three; whereas the Russian trade of the Dutch employed from thirty to forty ships each as large as two of the English, and all chiefly laden with English goods.. Though the above shows the extent of the trading, yet a pamphlet, published about fifty years later, in 1662, whilst describing the produce of Russia, mentions oak as the only timber exported. By the year 1638 Germany, Prussia, and Norway, all sent timber and deal boards. In 1662, Charles II. interdicted the importation from the Netherlands and Germany of deal boards, fir, timber, and other articles, upon any pretence whatever.

Besides a panel, to which I shall refer presently, the date of which is somewhat uncertain, the earliest instance of the actual use of deal I have been able to find, is in the description of Wimbledon Hall, erected in 1558 by Sir Thomas Cecil. This building became about 1640, the property of Queen Henrietta Maria, and was surveyed by order of the Parliament, in 1649. The accounts do not state whether any repairs were made in the sixty years between the date of its erection and the survey. If the deal therefore, which was introduced so largely in the floor boards and wainscoting was not in the original erection, we must infer that the house was put into repair or modernised near the middle of the seventeenth century, when it was prepared for the queen; I am in favour of the deal having been used in the original erection.

The account of Wimbledon Hall extends over fifty pages of the Archæologia, and describes how each room was paved, lighted, and ceiled; whether wainscoted, coloured, or plastered; what fixtures remained therein; concluding with the state and extent of the gardens and buildings, the park, and erections belonging to the estate. The use of deal for floor boards, wainscoting, wall linings, presses, &c., frequently occurs in the account, which time will not permit me to give at length. In the basement was a dry larder, having a press of deal wainscot. Among the exterior buildings a pheasant garden is described, severed from the park by a pale of deal boards, 10 feet high. The land of Richmond Palace is likewise described as part fenced with brick, and part with deal boards.

Another early instance may be obtained by inference, in Brandenburgh House, Hammersmith, erected about the beginning of Charles I.'s reign (say 1625), by Sir Nicholas Crisp, the materials of which were sold by auction in 1822, *the dry rot* having got into the timbers (Falkner's Hammersmith, edit. 1839). Sir Bulstrode Whitelocke, ambassador to Sweden in the time of Cromwell, on his return in 1654, brought a cargo of deal boards, which he mentions in his journal to have been used at Fawley Court for new flooring his hall, and for wainscoting it.

Respecting the asserted practice of "painting" during the thirteenth century, Turner says a few instances do occur of directions to paint the woodwork, but in a note he adds that the chapel built by Henry III. (1216-72) at Windsor, had a wooden roof formed and coloured to imitate one of stone at Lichfield, and that wooden and stone posts or piers and arches were painted a marble colour, as were those of the halls of Guildford and Ludgershall. In this century, the ordinary custom was to decorate in paint or colour the wainscoting with patterns or subjects taken from sacred or profane history. Green was the favourite colour, very frequently starred with gold, with borders of a different pattern, male and female heads, &c. This wainscoting being generally only 5 or 6 feet high, the wall or plaster above it was painted in fresco or in water, to represent some history, or a curtain. The Queen's chamber, at the Tower, was to have the walls whitewashed and pointed, and within those pointings painted flowers; the next year the same chamber was to be thoroughly whitened internally and newly painted with roses; also the King's own chamber was to be entirely whitewashed. But this was not confined to internal work, for in the following year the king directs that water-pipes should be put up to the great tower, so that the walls of the said tower, which has been newly whitewashed, might be in nowise injured by the dropping of rain water, nor be easily weakened. Even the chapel of St. Catherine in Nottingham Castle, was to be whitewashed on every side, and pointed lineally: directions are also given to whitewash within and without the King's chapel, the Queen's chapel and chamber, and the Queen's great wardrobe, all at Guildford, where the hall also was whitewashed. Whitewashing would appear to be then almost a royal luxury; though not wholly so, for evidence is found that during the thirteenth and fourteenth centuries the citizens of London not only whitewashed their walls, but were compelled by the magistrates to do the same to the thatch of the roofing, as a precaution against fire. White lead and oil, with fine and inferior varnishes, were also extensively employed in this period for the decorations. Turner, in support of external painting, says that the habitable buildings being of timber, it would require painting in some way to be preserved from the weather, for although park palings will stand for almost any length of time, yet carved woodwork, and even plain timber when mixed with plaster, require painting. He appears to have formed this opinion upon the present mode in Lancashire and Cheshire, of painting (colouring ?) the timbers black and the interstices white. Clayton says, "it would seem probable, from the appearance of the timbers in many of these buildings (the town-halls of the sixteenth century) that their surfaces were originally protected by a description of paint, of a rich brown colour; it is, however, extremely uncertain whether the practice of blackening them, as usually done in the present day, can be traced to ancient origin. The following extract from a record, dated 1574, will remove any doubt on the point: "The plastering and whitening the fore-front of my Mr. his house in Coleman-street, and the courte, with the blacking of the timber work, 42*s*. 6*d*."

The extensive employment of tapestry in the fourteenth and fifteenth centuries would appear to have allowed the whitewasher to rest, except for the ceilings, which were "white lined," as usual; a few walls, however, were white lined even in Elizabeth's reign; but then they were decorated with poesies and moral proverbs on fantastic labels, of which Luckingfield furnishes so profuse an example. At Hardwick Hall, 1570, the walls of the state room are divided at about half the height by a stringing, the upper part filled with landscapes, figures and animals relieved in plaster, and painted "all proper" on a white ground; the lower division hung with tapestry, and the oak panels of the wainscot of one of the rooms are all marked in gold with the Stafford knot, the cognisance of that family. The survey already mentioned of Wimbledon Hall in 1649, states that the oak wainscot was varnished green, with gold stars, crosses, &c.; or coloured with "livor color" and varnished; or varnished white, filleted with green; and it is interesting to notice that from the absence of all description to the contrary, the deal so much employed may be supposed to have been left plain. The "knotts" in the garden "are compassed about on three sides thereof with very handsome rails, piked with spired posts, in every corner and angle, all of wood, varnished with white, which very much adorns and set forth the garden." Oil painting is thus not noticed.

As an illustration of the use of deal in the reign of Elizabeth, and also of this mode of decoration, Mr. Reynolds Rowe, of Cambridge, has forwarded a panel of fir: it originally had a groundwork of vermilion, in the centre of which was a pattern laid on in gold of a good thickness. This panel had formerly belonged to Swansea Manor House, in Cambridgeshire, temp. Elizabeth, which still contains some of the same kind of work, probably under the coat of white paint of a later period.

In connection with this period reference may be made to a small octavo volume, by Stephen Primatt, published in 1667, the year following the Fire of London, and evidently intended as a guide to builders. Describing the finishing of the various classes of houses illustrated; he specifies that the walls of each floor are to be "plastered and sized;" the partitions to be "lath, plaster, and rendered and sized." Painter's work is described "for a fair stone colour laid in oil for windows, doors, rails and banisters for staircases, shop-windows and modillions is worth 12*d.* per yard, being coloured over thrice. For a timber colour in oil, over doors and windows, 9*d.* per yard. For a door painted on one side with a stone colour, 12*d.* a yard, and for a light of a window, 6*d.*; for a lead colour in oil, 9*d.* or 10*d.* a yard. Painter's work of ordinary lights of windows in oil, at 6*d.* per yard, or 3*d.* per light. For painting the best cerulean or blue colour in oil, 1*s.* 6*d.* per yard:" this is the only expensive colour mentioned, and seems to indicate the original paint for metal-work. "Whitewashing with size" is given as worth 2*d.* per yard.

In 1671 it was agreed that the wainscot in the Hall of the Carpenters' Company should "be handsomely painted, and the walls above the wainscot on the south side hung with painted cloth of some neat painting-work suitable to the front side." A French traveller in England in 1672, remarks that "the houses of Canterbury are well built and painted after the Dutch fashion. For many years after 1700, the following description from a work of the period will convey some idea of the extent of painting practised: "Out-door painting for door, shop-windows, window-frames, pediments, architraves, friezes, and cornices, and all other exposed timber-work ought at first setting up to be primed with Spanish brown, Spanish white, and red lead (about a fifth part) to make the other two colours dry, ground in linseed oil: then again with the same colour, only whiter; and, lastly, with fair white made of lead, and about a fifth part in quantity (not weight) of Spanish white." "Wainscot colour," "white colour," and "walnut colour" are enumerated; also "ordinary branched painting" and "plain japan, either black or white." On considering this recital of painter's work I have thought that these wainscot and walnut colours were used for the purpose of making woodwork resemble those woods. An interesting account has lately been published of a lady of rank, who in 1612 or 1613 appears to have entirely changed the fashion of the arrangements of houses in France, and to have been the first who painted rooms in any other colour than red or tawney. The next and last item in the description is "whiting and colouring on plasterer's work." Here I would request your attention to the continued use of "colour" (distemper) for interior work, down to such a late period (1700), a fact which I conceive at once accounts for the extensive use made of it in our churches. It is clear that from about 1700, oil paint became a disguiser of materials, and we know from his own description that the interior of St. Paul's Cathedral was painted under Sir Christopher Wren's direction. In a work of 1703, the contrivance of closets in most rooms, and painted wainscot are mentioned as two great improvements. Perhaps the first intimation of oil paint being used to a large extent *internally*, is in a "Compendium" of 1721. It states that the taking of the dimensions for painters' works within doors, is the same with that of joiners, by girtings about the mouldings and members of cornices, &c.; but the painter never requires work and half work as the joiners do, but reckons his work once, twice, or thrice primed or coloured over. Wood, in his history of Bath, says "that about 1727, if the walls of any of the rooms were covered with wainscot, it was with such as was mean and never painted;" as the new buildings advanced, the rooms were all wainscoted and painted in a costly and handsome manner.

Ware, in 1767, writes that "fir, as it is cheap and works easy, since the use of paint has become so frequent, has in a manner superseded all other kinds." In the descriptions of buildings given at the end of his work, he specifies that the walls are to be rendered and fronted for hangings, and paints all the wainscoted rooms a "common or stone colour" three times in oil. In 1775 a large mansion in the country is stated to have paper to the ground-floor rooms, whilst the walls of the bed-rooms, garrets, and basement were limewhited. And at the beginning of the present century, says a later writer, the houses of traders and middle-classes, particularly in the provinces, were chiefly adorned with simple wastings of rose pink, whitening, and size. A friend, now in his eighty-fifth year, remembers the lining to walls being left unpainted, and much of the woodwork even to the rooms connected with the Houses of Parliament were also of plain deal. The plastered walls of houses were coloured, the sashes painted white, the door-skirtings, and other parts generally black. Several present can no doubt recall many houses in the country still exhibiting this ancient style of ornamentation. Thus we may conclude that house painting, or, as it has been very descriptively termed, the "three coats and flat work," did not come into fashion until about the period of William and Mary, and Anne, up to which time either colouring by distemper or by whitewash had been in vogue for plasterwork, leaving inside woodwork more or less untouched.

In every branch of painting in oil applicable to buildings, the general process will be found very similar, with the exception of such variations as easily suggest themselves to the careful workman. The first essential is, that the wood, plaster, or cement should be perfectly dry. This is acknowledged by all, and yet when dispatch is the order of the day, it must be neglected. One writer goes to the extent of stating, that, "Perhaps in general cases, where persons are building on their own estates or for themselves, two or three *years* are not too long to suffer the stucco to remain unpainted; though now frequently in speculative works as many weeks are scarcely allowed." The wood-work having been prepared for fixing, has first to undergo the operation of "knotting," in order to prevent the turpentine in the knots of fir-wood from passing through the several coats of paint. One method for best work is to cut out the knot whilst the work is at the bench, to a slight depth, and to fill up the hole with a stiff putty made of white lead, japan, and turpentine. There are many ways of "killing" the knots. The best and surest is to cover them with gold or silver leaf. Sometimes a lump of fresh-slaked lime is laid on for about twenty-four hours, then scraped off, a coating of size knotting applied, and if not then sufficiently killed, they are coated with red and white lead in linseed oil, and rubbed down when quite dry. The general method is to cover the parts with the "size knotting," *i. e.* a preparation of red lead, white lead, and whiting, made into a thin paste with size. The most common mode is to paint them with red ochre, which is worth nothing. The next process is that of *priming*, which consists in giving a coat of white lead with red lead, and a little drier in linseed oil. This is the first coat, and upon which the look of the paint on completion depends. This first, or priming, coat is put on before "stopping" the work, should that process be required. It consists of filling up with putty any cracks, or other imperfections on the surface of the wood. If the putty used in the process of stopping be introduced before the first coat of colour is laid on, it becomes loose when dry. A good painter, after the application of this first coat, removes by pumicing all irregularities from the surface, especially those rendered apparent by the knots and fibres of the wood. A smooth surface being thus obtained, a second coat is given, consisting of white lead and oil: about one-fourth part of turpentine is sometimes added for quick work. If four coats are to be put on, this second one has sometimes a proportion of red lead, amounting to a flesh colour; but if only three, it is generally made to assume the tint of the finishing coat. It should have a good body and be laid even. This coat, when thoroughly dry and hard, is in best work rubbed down with fine sand-paper, and carefully examined to ascertain whether any further stopping be required; and then the third coat, or "ground colour" applied, of a somewhat darker tint than wanted when finished, having sufficient oil for easy working, but not too fluid: thus, two-thirds oil and one-third turpentine are employed; or sometimes in equal proportions of oil and turpentine. The *flatting* coat follows, the object of which is to prevent the gloss or glaze of the oil, and to obtain a flat, dead appearance. The advantage is not confined to the look of the paint, for it hides all defects in the wood or other material that is painted. White lead is mixed with turpentine, to which a little copal varnish is sometimes added; and when the tint is put in, it is always made lighter than the ground colour, or it would when finished appear in a series of shades and stripes. Flatting must be executed quickly, and the brush generally, if not always, carried up the wall and not across it. It must be understood that a flatting coat is not considered as a coat of paint; being wholly of turpentine, it is by exposure to the air evaporated, leaving a thin coat of pigment which is only required for effect, not for use. Some painters, particularly where the work is required to dry rapidly, use a large proportion of turpentine in the several coats; thus the ground coat has two-thirds oil and one-third turpentine. If four coats are to be laid on, the third has a little more turpentine than usual, which in the second is about a quarter, and so on. I would suggest for particular attention, that *turpentine* on the whole is chiefly useful for the purpose of saving oil and labour. It should never be employed where really lasting work is required. The necessity of having the substance perfectly dry before it is painted has already been noticed, and it is equally important that each coat of paint should be quite hard before another is applied, more especially where the work is exposed to the sun. When the material is quite dry, the first coat is readily absorbed by the wood or plaster.

Plaster to be painted requires some additional care in the workmanship itself; unless it be quite good the lime works out in minute bubbles and destroys the effect of the paint, which can only be corrected by rubbing down and repainting; even then with no great certainty of success. Some persons advocate the use of a priming or of a second coat, made of strong double size, stained with some colour to mark where the brush goes. The second coat then consists of white lead in all oil, used as stiff as possible: the third coat is made of single size with a little white lead ground in water to mark the course of the brush: and the fourth coat of white lead in two-thirds oil and one-third turpentine, with a little blue black to take off the rawness of the white. Such work as this is now generally repudiated: those in its favour state that it is of equal benefit with a coat of paint for inside, but confess that it is not so for outside work. Its objectors state that such "sheepskin" coats prevent the paint from sinking into the wood or plaster, causing the paint to peel off and chip. I fear that it is much practised in inferior work. When inside work has to be finished of any colour, it becomes necessary to provide for it at the third or second operation, according to the number of coats; particularly if the work is to be finished flat or (as it is termed) dead white, grey, &c. All new *outside work* should be primed a flesh colour, mixed in all linseed oil. The second coat may be of the same mixture if four-coat work is to be done; and in this coat all defects are to be made good. If three coats only are to be applied this one should be laid on with care. The third and fourth coats, whichever may be determined upon, are generally white, stone colour, lead colour, chocolate, olive, and invisible green, all in linseed oil. When white lead is employed alone, it has been recommended to dilute it with half drying or boiled oil and half linseed oil, as the boiled oil affects the colour of the white lead a little, but in all other colours boiled oil may be considered the best for the purpose of preservation.

When it is required to cover a painted material or "to repaint," the surface must be prepared to receive the coats of paint: it is sometimes first washed, or if the work be very greasy, turpentine is used, after which the paint is rubbed down with pumice-stone and water, or with some potash in it, until an even suface is obtained, removing any knobs or imperfections in the previous coatings. In repainting, the first coat is called "second" colouring, the old work being considered equal to a primed state. It is composed of white lead, turpentine, and oil, with the pigment required for the colour that may be wanted. Some painters use two-thirds turpentine and one-third oil; others, three-fourths turpentine and one-fourth oil; and even all turpentine, drier, and a very little red lead; but this last must be worked very quick, crossed once, and laid with the grain of the wood, as it is not much better than a flatting coat. For third colouring or finish, the white lead is thinned with half turpentine and half linseed oil, drier, and a very little blue black to take off the rawness of the white, and also to make it cover better. For the best rooms the flatting coat is required, as before described. Two coats of new paint are frequently sufficient for ordinary work where painted previously. Light-coloured work, as margins, rails, and so on, is generally painted before the darker work, as mouldings, &c. Carved work especially requires care to prevent the work being clogged up.

When the face of old work presents a very bad and uneven appearance from blisters or other causes, the inequalities are filled up with a cement. Modern specifications often require that the woodwork should have four or more coats, until the paint "bears out." This is certainly necessary, when it may be anticipated that little oil will be used, or where the priming and early coats may not have been properly attended to. The result is a deadness in one part, the glaze continuing in another. It often happens, too, that the sun and air has quickly dispersed the greater part of the most valuable quality of the paint, *i.e.*, its oil, and the work presents the same flatness. Care is also required when constantly painting in chocolate or black: if these are made too thin with boiled oil, blisters occur, which cause the paint to peel off and leave the wood almost bare.

Painting plaster work demands a few observations. White lead and linseed oil, with some litharge as drier, are mixed to the consistency of thin cream and applied: the oil is entirely absorbed into the plaster in a few hours. This coat will perhaps be sufficiently dry in a day or two; when another, a little thicker, is given, the oil of which is also wholly or only partially absorbed, according to the nature of the plaster. In a few days a third coat can be applied, made rather thick, and (according to the absorption of the oil from the second coat) one-fourth or less of turpentine is added, and likewise the pigments approaching to the tint required. Should the plaster be thoroughly saturated, the flatting or finishing coat is applied as before described. When very durable work is required, a fourth coat is put on, thinned with equal proportions of turpentine and oil, and then the flatting coat. If the plaster be not flatted, the last coat is made of two parts turpentine and one of oil. By thus painting plaster is rendered incapable of absorption, and its surface becomes hardened by the oil to a depth of about ⅛-inch, rendering it less brittle, and enabling the surface to be washed. To effect absorption quickly, painters sometimes give the plaster two or three coats of boiling linseed oil, which are soon absorbed, and then give it the other coats of paint.

The substance generally constituting nine-tenths of the body of paint is carbonate of lead, commonly called white lead, the quality of which is therefore of the greatest importance to the durability of the work. White lead is said to improve by being kept for several years before use. Besides the three qualities manufactured, six or more chief modes of adulteration have been recorded: 1, by carbonate of lime, as chalk, whiting, &c.; 2, sulphate of lime, as gypsum, selenite, plaster of paris; 3, carbonate of baryta; 4, sulphate of baryta; 5, pipe and other clays; and 6, starch, flour, &c. Fine whiting ground in oil is very difficult of detection: it not only renders the paint a much less compact body, but causes it to be more easily acted upon by the atmosphere; thus blanching and destroying it by repeated washings. These adulterations will in some measure account for the great difference that exists in the prices of painters' work. The other metallic white paint now used is zinc white, well known for its intense whiteness, its resistance to sulphurous and other deteriorating causes, and its harmless qualities to the painter and the inmates of the house under decoration. It is requisite that the oil used should be as white as possible, all the brushes and pots well cleaned with spirits if they have been used before for white lead, and driers or colours with a lead basis should not be mixed with it. Zinc white possesses less body than white lead, and great care is requisite that the colour when ground in oil is of sufficient consistency to be laid on a flat surface without showing through; for in that state any oil in excess will form a slight glutinous coating on the surface, retaining every particle of dust brought in contact with it, until it has evaporated. In general this white will not dry so quickly as the older colour, but this defect is remedied by the application of proper drying oils. With these precautions a few trials will enable any painter who chooses to work zinc white to overcome the difficulties which appear at first to condemn the invention. It is asserted that in consequence of the great durability of the colour of this paint, a house painted with it may be washed for a succession of three, four, and even five years; and that after each successive washing the surface will be found as clear and as bright as when fresh painted.

"Clearcole" has already been referred to in conjunction with coats of oil paint. It is a cheap mode of painting, when used alone, for servants' rooms, kitchens, and such like places where dispatch is necessary, or when it is necessary to paint often. The old work should be well cleaned and dried; and then a mixture of white lead, ground up in water and mixed with size, laid on: this will dry directly. For finishing the white lead is mixed in half linseed oil and half turpentine, and used as stiff as possible: blue-black or some colour and a little drier are requisite.

The use of distemper is older than that of oil and varnish. Whitewashing is a kind of distemper, especially when size is used with it. The extracts from the records in the former part of this paper have no doubt reference to this kind of painting; and the word "colour" would be more applicable as a translation than "paint," which is generally used. Common distemper colour for walls is Spanish white, or whiting, broken into water, to which is added strong size whilst warm, and then allowed to cool, when it should appear a thin jelly; two coats are generally necessary: when applied to old work it should be first washed by a brush with water. This process in old publications is called "painting in water colours." Papered rooms coloured in this manner, especially if flock papers were used, look very well, as the pattern can be seen through the coats of colour. A convenience in the use of this preparation is that the rooms may be completed and dry in one day, with very little dirt or inconvenience. It is not generally known that walls which have been distempered cannot afterwards be limewhited, in consequence of lime when laid on whiting becoming yellow. Oil colours however can be applied afterwards, and then white lead is used. Apartments that are to be varnished are prepared in two ways. The first is by applying the intended distemper colour, and then covering it with as many coats of coloured or uncoloured varnish as may be required. It may be useful to observe that distemper causes the wood to swell, and that if the material be not quite dry previous to the application of the varnish, the latter penetrates into the size, but is prevented from reaching the wood by the moisture retained in it, which opposes any union with the resins forming the base of the varnish. The varnish then gives to the distemper the hardness of cement, which, not yielding to the shrinking of the wood, scales off in drying. The second method is to grind and mix up the colour with varnish, which produces a better result, especially if the coating be applied when the woodwork is dry, and if it be very clear, so as to dispose the wood to imbibe it, The successive coats then become incorporated with the first. Generally but little colour is added to the last coat of varnish, and in some cases it may be applied colourless. It then forms glazing, and its brilliancy is greater, the colour also is stronger. The use of size produces a considerable saving in varnish, and the splendour given to this last stratum conceals the imperfections of an unequal coating of the colour. For new plaster-work a coat of size is requisite; a solution of glue in water, not too strong, is applied warm, that it may penetrate the plaster, which should be already quite dry. Additional effect may also be obtained by a careful pumicing after the first coat.

It is generally asserted that varnish is more liable to injury by dirt than oil painting, and that the means of repairing it cannot be the same, because the dirt adheres more strongly to the resinous parts of the varnish than to the oil surface. Soap and water applied carefully with a sponge, and the use of clean warm woollen cloths to dry the work, are efficacious means of cleaning both surfaces. The steps of wooden staircases which have been painted, grained, and varnished, wear better than those which have been only painted; the gloss is only very slightly injured by the operation of cleaning, and neither dust nor dirt adheres so easily. A coat of varnish can be again put on at any time.

The processes of graining and marbling can be traced back at least as far as the time of James VI. of Scotland (1567-1603), in whose reign a room of Hopetoun Tower was painted in imitation of marble. Before that period, imitations as I have already mentioned were done in stone colour, marble colour, wainscot colour, &c. In 1676 marbling was executed, as well as imitations of olive and walnut woods; and in 1688 tortoise-shell was copied on battens and mouldings. The friend above referred to tells me that the doors of the chapel in Conduit-street, Bond-street, attracted much attention from the novelty of their being grained to imitate wainscot—done perhaps about the year 1810, when a new front was given to the building. From some letters in my possession I find that mahogany was imitated in 1815, and maple wood in 1817. The imitating *marbles* and most kind of woods has nothing very peculiar in its mode of execution, being similar to actual painting, the result depending more on *natural taste* than on *mechanical skill*. The process of graining is in the first instance the same as for ordinary painted work, but it requires more care in obliterating the marks of the brush. The last coat, instead of being flatted, is composed of equal portions of oil and spirits of turpentine, and is brought up to the colour characteristic of the wood to be imitated. The shades and grain are given by thin glazings of Vandyke brown, burnt sienna, or umber, ground in water, and mixed with small beer, which is a sufficiently glutinous vehicle; but imitation wainscot requires a thicker one, in order to receive the impression of the combs by which the grain is imitated. Thus oak graining is executed with colour in turpentine mixed with a little turpentine varnish; the work being covered with it, the combing is done without delay, as it dries very quickly. The lights are then taken out with a camel's-hair brush or a rag moistened with turpentine, and rubbed clean. In cheap work the operation ends here, and the surface is covered with copal varnish to protect it; but good work is "over grained," that is, a glaze of colour in beer, as dark as may be requisite, is laid over the combed work, in shades thrown across the work. Sometimes the whole panel is laid in with this glaze, and the lights taken out with a sponge, a brush is then used to lighten the edges; when quite dry, the work is over-grained with the same colour laid on thin and softened off. For graining wainscot in oil, bees'-wax is used instead of varnish to the colour, mixed in equal quantities of turpentine and oil; one, two, or three coats of a good oil varnish, such as copal, are applied when the work is quite dry.

Time only allows me to mention the use of staining and varnishing, and to refer slightly to the process of polishing wood by varnish and wax. Varnish and polish both form a glazing, and give a lustre to the wood they cover, as well as heighten the colours of the wood; but from their want of consistence they yield to any shrinking and swelling, rising in scales or cracking when much knocked about, which damages can only be repaired by application to a proper workman. Waxing, on the contrary, resists percussion, but it does not possess in the same degree as varnish the property of giving lustre to the bodies on which it is applied; any accidents however happening to its polish are easily repaired by rubbing. As another method of covering a surface, a board now exhibited has been prepared to show how deal may be employed without the use of oil painting. The surface having been prepared, it was at once grained, the natural colour of the wood forming the ground of the imitation wood; the whole was then varnished as usual. In coarse deal the knots might be worked into the pattern; but in wood selected for the purpose the small knots could hardly be said to disfigure the work. Another advantage to be considered of material importance is, that as there is no oil painting required the material would be drying up to the last minute of finishing the house, when the graining and varnishing would be done in a few days.

The proper time to paint is a subject worth consideration. For interior work it is not so important as it is for exterior; though for the former some part of the warm—not hot—season should be selected, not only to get rid of the smell more quickly, but because moderate heat improves the look of the work, while cold air chills the oil. For external work the proper season is undoubtedly the autumn, when the days are sufficiently hot to dry the work properly, and the weather sufficiently settled to allow of its being carried on continuously. If a house is done up for the summer, the paint then executed in the spring is chilled by the cold and ruined by the unsettled weather. Or should the painting be performed later, say in the month of June or July, the hot sun dries up the oil, the really effective preservative property of the paint, before it can be absorbed. Such work is consequently worthless at the end of less than two years; whereas, were it done at a later period the result would be a better appearance, lasting for perhaps double that time. Aspect should also be considered when external painting is required to be performed.

Mr. C. H. Smith said, that in recommending the use of varnish, it was necessary to state what kind should be used. Any resinous substance in combination with an oil would produce a varnish; but the difference between a resin and a gum, which might resemble each other in outside appearance, should be clearly understood. A resin proper would mix with oil, but not with water; whilst a gum proper would mix with water and not with oil. After mixing a resin with any volatile oil, such as alcohol, spirits of wine, or oil of turpentine, and applying it to any substance, the oil would rapidly evaporate, and leave the resin in a powdery state, which could easily be sponged off. But if used with a less volatile oil, the varnish would produce a totally different effect, and for woodwork copal varnish in oil should alone be employed. This would give a very hard surface, as might be seen on the panels of carriages. He might mention a house built about 1813, at Brighton, by the late Mr. Bonomi, for Mr. Prince Hoare, in which the joiners' work was varnished, and it was in a very good condition many years afterwards, the varnish having acquired a very dark rich colour. With regard to cleaning paint, a solution of wood ashes was frequently employed formerly for washing either linen or paint. This mixture, if too strong, had a tendency to decompose the paint, and careless use of pearlash and soda would wash off all the paint, though if used gently it would effect the object required. With regard to paint, the only valuable quality of white lead was its extreme density. In the course of his early experiments he had tried to make a pigment from sulphate of lime, using the finest plaster of paris; and although this made a beautiful pigment, there was no body in it. This material was applicable to water-colour painting, if mixed with a very little gum, to prevent its brushing off. It had advantages over the white generally used for water colours, and made of lead or zinc; and if the slightest film of it were used, it would be almost transparent when laid on, but when dry intensely white. In experimenting upon magnesian limestone he had found that magnesia was also applicable as a water colour. He did not know of any sulphate or mixture of sulphur that would have any effect upon it. It was totally unaffected by the vapour from sewers or drains, and therefore superior to white lead for distemper painting.

Mr. J. G. Crace said that the very best way of treating wood was simply to varnish it, and not to smother it over with paint. Eight or ten years ago he had been employed to paint a house in the Isle of Arran, for the present Duke of Hamilton, and he had found the wood-work, of red pine, so free from knots and so well executed, that he suggested that it should be at once varnished; which was done with great success, and the work looked now as well as when it was done. He believed paint had not been used as a preservative to wood before the time of William and Mary: before that time painting was a decorative process. The style of architecture and the use of wood seen in the buildings of that eign, altogether came, he thought, from Holland. Mr. Crace eferred to a document in his possession, a tender for painting he work at Greenwich Hospital, in 1696, by William Thompson. he price asked for painting outside work three times in oil was . per yard. There was also a price for painting sashes, iron rs, and inside work, and for painting "three times in good lin-ed oil and well primed." At that period he believed painting s chiefly executed in white; for in cleaning off the paint from l wood-work of that age, he almost invariably found that the iginal colour had been white. A blue tint was afterwards used, d, in the time of George III. various shades of stone colour and b. With regard to the operations of painting, he said the use size colour was to be guarded against, as its application in the st instance prevented the absorption of the oil paints by the od, and all the after processes only formed a skin laid on the dwork, rather than a coating to effect its preservation. When sun (as in a window shutter, for example) struck upon wood ed before painting, it was sure to crack and flake off. To clean int he strongly recommended that the raw alkalies should not used, as they would infallibly take off the flatting coat. The st mode of cleaning was by means of good soap, not too strong, ld on with a large brush, so as to make a lather; this should be ashed off clean with a sponge, and wiped dry with a leather. With regard to varnish, nothing but copal should be used, as no other would wear so well. It was the most expensive of all varnishes, and therefore could not be applied good in cheap work.

Mr. G. Godwin said that Mr. Wyatt Papworth's paper had brought many valuable facts together, and would no doubt lead many to understand why one person could do painter's work 30 per cent. cheaper than another, and yet get more money by it.

IMITATION MARBLE MANTELS.*

The Committee on Science and the Arts constituted by the Franklin Institute, to whom was referred for examination, the specimens of "Imitation Marble Mantels" manufactured by the Penrhyn Marble Company of Boston, Massachusetts—report:

That the patent is for the method of applying the colours by means of a peculiar bath, used in the place of the ordinary "size-bath," long familiar in the manufacture of marble paper. The bath now patented consists in a film of Dammara resin floated upon water, which may be broken up into any desired figures by means of a rod or spatula previously dipped into the desired colours. The bath thus prepared is said to be more manageable than the ordinary one. The article to be "marbleised" is, after being prepared with the ground colour, immersed in the bath, then withdrawn, dried or baked in an oven, and then coated with a proper varnish and again heated.

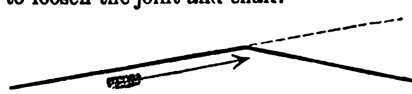
The articles examined by the Committee are of slate prepared in this way—and they present resources for ornamentation which are valuable from their comparative cheapness, and the great accuracy of the imitation of which they are capable. The slate is also stronger and less liable to injury than many of the composite marbles which are thus imitated. Compared with the "marbleised iron," these objects are better imitations of the stone, because the iron has to be covered with a glass to give it the stone surface, and the thickness of this transparent coating shows itself in certain cases; and they are more durable, because the different expansibility by heat of the iron and glass finally causes the latter to crack, and the iron then rapidly rusts. The new material is free from both these objections, but, on the other hand, the imitations of carved work cannot be done so cheaply as in the iron.

The Committee consider the beauty of the manufacture well deserving of the award of a premium.

ON JOINTS FOR RAILWAY BARS.*

By A. C. Jones, C.E.

In a recent discussion that took place in the Franklin Institute, I believe there was no mention made of the injury to the joints, resulting from the common method of making a curve to consist of a series of short chords by each length of rail being laid straight; or if sprung to a curve, its stiffness, aided by the running of the trains, soon brings it to a straight line. From a personal inspection of tracks, almost continuous from Massachusetts to Alabama, I found that scarcely any attention has been paid to this point; and yet at a glance of the diagram, it will be seen that there is a side thrust from the flange of each wheel, aiding the vertical pressure to loosen the joint and chair.



Persons having been on the platform of the old four-wheel locomotives, when running, may remember the unpleasant side twitch from this cause; the flanges hugging the straight rail by the centrifugal force, runs its length to the end of the next, there to be changed from its tangential course, and so on the next length until the curve is run. This is not now so perceptible with the truck, but still it is an element of destruction, and is one cause of trains leaving the track.

The proper mode is to curve the bars before laying them. The expense of curving the bars is not great, for during my connection with the New York and Erie Railroad, as many as five hundred (20 feet) heavy bars were curved each working day in midwinter, by two labourers operating on a curving bench, the rail being brought to it by assistants.

All persons travelling on railroads where chairs are in use have noticed the disagreeable rattling consequent to the play of the bars in the chairs. As early as 1834, it attracted my attention, and I suggested a plan for obviating it, but it was not until 1840, that I had an opportunity of proving it myself. I took a few chairs (Stephenson's iron keys) and recessed them about $\frac{1}{4}$-inch, leaving a chipping piece at each end; when the chairs were in place without the keys, the recesses were filled with metallic lead (hard from having been melted many times), and although

* From the 'Journal of the Franklin Institute.'

this was part of a track which was used both ways by a large traffic, yet during the five months it was under my notice there was no "spewing out" of the lead, and the noise was slight compared with the keyed chairs.

Many of the wrought iron chairs exhibited at the meeting, having been fitted nicely to the individual bar, left nothing to be desired for fit, but in providing for a long line of road it would be different. Now, instead of this attempt at perfection which will enhance the cost of the chairs, they are "set in" at the ends and middle of long chairs, and the spaces between the bar and chair filled in with fusible metal, you have as perfect a fit as it is possible to make and at a small cost. There are many alloys melting at a low temperature which, when set, are nearly as hard and tough as wrought iron. When the bars are wished to be held endwise by the chairs, a piece of iron inserted in the holes will be kept by the alloy in place.*

Allusion having been made to the difference between the wear and tear of the rails on an unyielding superstructure and one that is springy, it may not be out of place to record the following. The Portsmouth and Roanoke Railroad runs over a portion of the Dismal Swamp, which consists of a turf-like substance ten or twelve feet thick, overlying a semi-fluid material composed of fine sand, mud, decayed vegetable matter, and water. The weight of a person jumping up and down on its surface will produce a wave, which will cause another person many yards from the first also to rise and fall. This was the condition of the foundation for the roadway, and the superstructure was made of split rails (similar to the farm fence,) laid crosswise 2 feet in thickness, and about 2 feet of earth on top, and then the sills or ties as usual; on each side ditches were made, which always remained full of the dark-coloured water of the swamp. This piece of road gave great trouble to keep in order for eight or ten months, until the interstices of the split rails had become filled and all consolidated; and afterwards this was the smoothest and best part of the track.

On another part of this road, in 1835, before the truck cars were in use, I tried an experiment on a straight level part, by painting the surface of the flat bars, and then had the train run over them at a speed of 40 miles per hour; the paint midway between the ties was not touched, the wheels actually jumping from one tie nearly to the next one, and this was the case on both sides of the track as far as painted.

Believing that the chair and rail should be of the same metal, I propose a "clamp chair," which is easily made, and involves no extra labour to be done to the ends of the bars; it has vertical and side stiffness, combining most of the good qualities of the "side fish," under plate, and T form, without requiring the rail bar to be drilled or punched, nor rivets or bolts to secure it to the rail; it may be long enough to suit a single cross-tie, figs. 1 and 2, or for two ties with the joint of bars between, fig. 3. The chair by either method of fastening will be held firmly to the ties and bars, and yet it admits of being quickly removed when required.

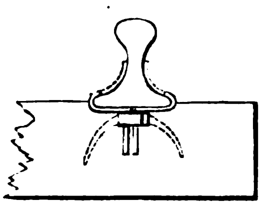


Fig. 1.

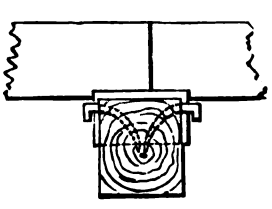


Fig. 2.

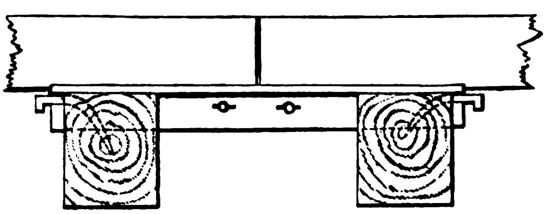


Fig. 3.

Angle-iron of a suitable length is bent on one edge so as to hook over the bottom web or base of the rail bar, and at each end a small piece is punched out, so that when two of these plates are placed with their straight flanges together, these square notches receive the head of a wedge-shaped staple, which clamps the two side plates on the base of the bar, and at the same time fastens all to the cross-tie.

The part of the chair hooking over the bar could be extended up to the stem, as shown by the dotted lines, fig. 1; but this would enhance the cost of making and fitting without commensurate benefit, as $\frac{3}{4}$ to 1 inch hook is ample for the purpose. The staple (fig. 4) is made of wrought-iron, the head suiting the notches in the chair; it has a hook on one side to facilitate its withdrawal from the tie after it has been driven in it; the "tines" are about 4 inches in length, and only differ from a square spike by the end being bevilled *diagonally*, like an engraver's tool; the only part requiring accuracy is the V form of the inside, this should be closer at the narrow part than the two thicknesses of the vertical flanges of the chair.

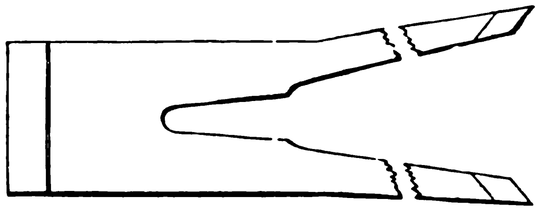


Fig. 4.

The wooden cross-tie having been prepared for the reception of the chair, the two plates are slipped along the rail until in position on the tie, and the staples (previously slightly bent in the direction of the point) are driven into the sides of the tie, and the diamond-shaped points will cause the tines to pass in curves downwards and endwise towards the heart of the tie, spreading more and more until home; the stiff jaw of the head grasps the two parts of the chair in the notch, drawing them close together, and the hooked edges on the wedge shaped base of the rail secures it to the chair. All are held firmly to the tie by the head of the staples in the notches of the chair.

The two parts of the chair when fitted to the bar should have a clearance between to suit variations in bars, to allow of compression and the springing of the parts. If thought proper, a thin slip of wood could be placed between the two flanges, below the staples.

It will be readily seen that the inside surfaces of the staples exert a great force to bring the two parts of the chair together; that the staple is prevented receding by the clinched form of its tines; and that the running of the trains cannot draw out the staple, as any force applied to the rail only acts on the *side* of the head in the notch of the chairs.

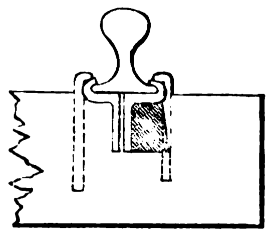


Fig. 5.

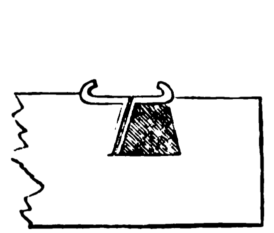


Fig. 6.

To withdraw the staples from the tie, a wedge-shaped tool is driven between the hooked head of the staple and the ends of the chair, and the staple drawn out; the plates forming the chair being pushed endwise, the two ends of the rail bars are set free.

In long chairs with the rail joint between the ties, two keyed bolts (fig. 3,) may be used along with the staples at the ends.

Another mode (fig. 5,) of securing the chair to the bars and ties is to take the lengths of angle iron, and instead of notching at the ends, make two notches in the hooked part; the jogs in the ties are made to suit a key made of hard wood passing outside of the vertical flanges of the chair. After this key is driven tightly in both cross-ties, the chair is held down by the usual hook-headed spikes in the notches, and the key prevented working out.

Staples and spikes may be dispensed with, by making the straight web of the chairs to hook under (fig. 6), forming a half "dovetail," and the key driven alongside as before; the key could be prevented working out by a single nail driven in its side.

* The proper place to secure the bar to the road-bed for expansion or end-thrust is at its middle, either by a chair or notch and spike.

ON AN IMPROVED ROTARY WATER METER.*

By William Gorman, of Glasgow.

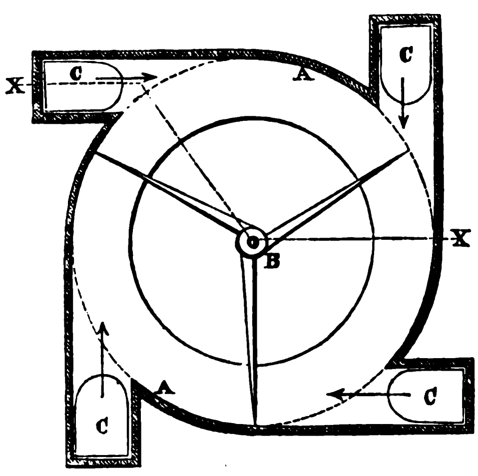
To produce a machine capable of measuring water under pressure, and otherwise suitable for general use, it is necessary that certain conditions inseparable from this ponderable and practically non-elastic fluid should be complied with.

Accuracy in measurement is very properly the first object to be attained, and the machine must be accurate not only when newly made, but must be permanently so, in order to be trustworthy. The meter must also deliver the water undiminished in pressure as far as possible, whatever force is necessary to pass the water through the meter being lost in the pressure of the discharge. Thus with a head of water 50 feet high, if it takes a head of 25 feet to work the meter, the water delivered can be supplied only 25 feet high; and such a meter should be considered only half as efficient as one that delivers the water to the full height from which it is supplied.

It is also necessary that machines moved by water should work as smoothly and uniformly as possible, and that the current of water in the supply pipes should in no case be suddenly checked, since this is not only detrimental to the machine itself, but affects all the water-works in the neighbourhood. It is further desirable that a meter should be capable of passing as bulky matter as possible; for however carefully the water may be filtered, a great deal of debris collects from the interior of the pipes, and workmen sometimes allow rope yarn to get into the pipes in making a joint. Meters have been found stopped by pieces of lead which had been left in the pipes when undergoing repairs.

Another very desirable object is that the measuring apparatus of the meter should at all times be propelled by the water, and that no springs or weights should be depended upon for continuing the action, as the least derangement of the works impedes their action, and the water is then allowed to pass without propelling the meter. When this takes place there is no chance of the meter starting again, as water will pass by the most free course; whereas when a meter is so constructed that no water can pass without acting on the machinery, the force of the water is always present, and no ordinary obstruction will prevent registration when water is being drawn off.

Fig. 1.



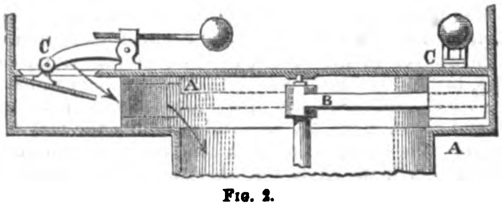


Fig. 2.

The meter forming the subject of the present paper is thought by the writer to include most of the above requirements. It is shown in the accompanying engravings—fig. 1 a sectional plan inverted, and fig. 2 a vertical section. The meter consists of a casing A, containing a vane-wheel B, driven round by the water, which is admitted at the circumference of the wheel in a direction tangential to the circle described by the vanes, and drawn off from the centre. The openings for the supply of the water are regulated by self-acting loaded valves C, which contract the orifices when the flow is small, opening at all times only to an extent proportioned to the quantity of water passing through, thus preventing the stream from becoming too feeble on account of its small velocity to move the vane wheel.

The vane wheel B, acts in the same manner as a light body, free to move, introduced into a pipe containing water. If the floating substance did not come into contact with the inside of the pipe, it would move just as fast and as far as the water in the pipe. The sectional area of the pipe being known, the quantity of water can be determined by the distance the floating substance has moved in the pipe. Similarly, in the present case, the quantity of water passing through the meter is measured by the velocity of revolution of the vane wheel B, the sectional area of the inlet or outlet pipe being known.

The meter above described is accurate in measurement under all circumstances which occur in practice, and as the measuring chamber and apparatus are not subject to wear, its accuracy must be permanent. Whatever pressure of water is supplied can also be nearly obtained after the water has been measured. The meter works smoothly and uniformly, and moves with equal power through every part of its revolution, as there are no dead points; and the water is delivered in a smooth uninterrupted stream. All the working parts are free from each other, none of them requiring to be in contact. The vane wheel may be kept as free from the case as is desirable, since the measurement does not depend on the size of the wheel, but on the capacity of the measuring chamber and the velocity of revolution of the wheel.

This meter was first experimented on when the Gorbals Gravitation Company offered a premium for a water meter to work under pressure; and although the machinery was very imperfect, the results obtained were amply sufficient to establish the accuracy of its action. The meter was tested under pressures ranging from upwards of 200 feet head to less than an inch, the flow of water being reduced to ¼-gallon per minute. The meter was correct at all important runs, and even when the smallest quantities were being drawn off the variation in measurement did not exceed 2½ per cent.

In the meter with which the experiments were made, the regulating valves were not properly placed in relation to the vane wheel, and consequently the registration was deficient when minute quantities of water were passing through the meter. This objection has been completely obviated in subsequent trials, and there is now no difficulty in regulating the flow of the water by means of the adjusting screws and weights of the regulating valves, so as to render the indications perfectly correct under all pressures.

With reference to durability it may be stated that these meters have been going regularly in Glasgow for upwards of four years; and they have never had to be returned except in one instance, where the case was too small, and consequently got choked with debris. Although the meter went for more than the time guaranteed, still as the case was too small it was exchanged.

It has been thought that the quick-going wheel in this meter would wear the soonest; but on the contrary, it has several times been found in practice that the teeth of the slow-moving wheels have been stripped in consequence of the spindle which carries the indication through the meter case to the outside getting jammed, when the fast-moving wheels which did the damage were not perceptibly worn.

* Paper read before the Institution of Mechanical Engineers.

THE BUILDERS' BENEVOLENT INSTITUTION.

On the 29th October, the tenth anniversary festival of this Institution, established in 1847, for giving relief and granting pensions to decayed members of the various branches of the building trade and their widows, and for affording temporary relief to workmen in case of accidents, was held at the London Tavern. About 220 gentlemen connected with the leading building firms of the metropolis sat down to dinner.

The Chairman announced, amidst applause, that Mr. Henry Dodd, of Hoxton, had made the munificent gift of between four and five acres of valuable land, in the neighbourhood of Windsor, for the purpose of building almshouses for the Institution.

MEMOIR OF LOUIS VON ZANTH, ARCHITECT.*

By Prof. Donaldson.

The death of a distinguished brother architect, and more particularly of one who has been a corresponding member of our body and a liberal contributor to our collection, demands some notice on our part. I feel it therefore to be a duty which devolves on me, as your secretary for foreign correspondence, to seize as early an opportunity as possible to pay that respect to the memory of our departed colleague Herr Zanth, who has by his works well merited a page in the history of our art.

I have reason to believe that he was born about 1798, at Breslau, in Silesia, and was consequently a Prussian subject. His father was an eminent medical man, and chief physician to Jerome Buonaparte, during the residence of that sovereign at Cassel. Louis was educated partly at Cassel and partly at Paris, and it is supposed was a pupil at the Lycée Napoléon. Having evinced a decided taste for drawing he was placed at Stuttgard, (where his widowed mother resided,) under the architect Fischer, professor of the Polytechnic School in that town. About 1819, Zanth went to Paris, and became the pupil of M. Hittorff; and although he had then made little progress in composition, he showed an evident bias for decorative detail and great purity of drawing. He followed his excellent master's advice, and took part in the competitions of the School of Architecture; but being of a reflective and deliberate turn of mind, which cannot at a given moment command the imagination, and hence under such a pressure becomes faltering and undecided, he was never able to improvise with sufficient rapidity, and could not accustom himself to the excitement, bustle, and clamour to which the impressionable youth of our neighbours yield when engaged in such exercises. This circumstance affected his conceptions, and though his *projets* were drawn out with the most elaborate care, he never could command a medal. But when left to himself and to the quiet of his own leisure and reflection, his designs were admirable, and evinced considerable originalty and careful treatment.

Zanth from the pupil became the assistant of his friend and master; and in 1823 both went to Sicily, with the view to investigate fully and thoroughly the antiquities of that island, which as yet have never been adequately illustrated, numerous and costly as are the works and learned as are the authors treating upon its ruins. During their stay, Messrs. Hittorff and Zanth were struck with the beauty of the numerous buildings erected since the Greek times, and which adorn the cities of Messina, Catania, Palermo, and other places, erected by the different conquerors of the island since it was in the possession of the Romans. They therefore took accurate drawings of the churches, palaces, monasteries, hospitals, public fountains, private houses, as also details of altars, tombs, pulpits, stalls, and other decorative embellishments in the churches, which are marked by a happy freedom of design, novelty, and effective combination. The work, which appeared in the joint names of the authors, was specially edited by M. Hittorff, in numbers, between the years 1826-35. The choice of subjects is extremely varied, containing examples of Moresque, Saracenic, and Byzantine, as those of Palermo and Mon Reale, and embracing every period of modern architecture without an exclusive adherence to any. The execution of the work is in outline, and may be cited for the judicious selection of the subjects, the purity of the drawings, and the exquisite character of the engravings.

At the same time appeared many numbers of their work on the ancient monuments. It is to be regretted that this valuable publication has been suspended, from the want of particulars to complete their previous studies, which a personal visit to Sicily can alone satisfactorily supply. It is to be hoped that the survivor may accomplish what still remains a desideratum—a work on Siculo-Grecian architecture, rendered complete by the light of modern researches, and the experience and learning which have of late years been brought to bear on works of this class; and for the elucidation of which no one has proved himself more competent than M. Hittorff.

Zanth was especially struck by the peculiar magnificence of Mon Reale, and the eastern aspect of the Capella Reale and of the palaces of La Zisa and La Cuba at Palermo, of which he subsequently made some splendid and elaborate coloured views to a large size; and in fact this style of art seems to have had much influence on his future artistic taste. In 1830 Zanth quitted Paris to seek a new sphere of employment, and returned to Stuttgard, where he constructed many charming town and country houses, perfectly adapted to the convenience of the occupants, elegant in their detail, picturesque in their masses. These erections, and some of his beautiful drawings, were brought under the notice of the king, who immediately appointed him as his architect, and commissioned him to make drawings for a theatre to be attached to the palace, but which, unfortunately, was never executed.

His royal patron was desirous to form for himself a kind of special personal retreat, or suburban villa, to which he might occasionally retire for the day, or a few hours, like those of the papal families in the neighbourhood of Rome, as the Villa Papa Giulio, or those at Frascati, and Tivoli, or as is found in various parts of Germany; or, *magna componere parvis*, like that at Chiswick, belonging to the Duke of Devonshire. It was to consist of a principal casino, hothouses, and conservatories; porticoes, kiosks, a belvedere, ball-room, theatre, and domestic offices, connected one with another by the general distribution of the garden, which was to be adorned with parterres, pieces of water, and fountains. The Wilhelma is situated at the extremity of the royal park of Rosenstein, at a league from Stuttgard, and near Cannstadt, famous for its mineral waters, and the gardens extend down to the Necker. The style selected by his sovereign was the Moresque. The plot of ground appropriated to the Wilhelma was a hanging level, rising from the Necker; and Zanth found great difficulty in combining its various parts with the grounds of Rosenstein, which had been laid out by an ignorant gardener, without any reference to the undulations of the surface. In order to make himself thoroughly acquainted with the most celebrated hothouses in England, he came to this country, and visited those of Chatsworth, and others, and also studied the application of iron to the various purposes of the forcing-houses, as also its fitness for the arcades, cupolas, kiosks, and columns of the porticoes.

On the occasion of this visit he exhibited his magnificent series of Sicilian drawings in these rooms, and was elected an honorary and corresponding member of our body. The studies of the Wilhelma were commenced about 1838; it was the favourite theme of his future existence, the one great object upon which he employed the remaining years of his life. His time, his health, his talents, and his means, were all devoted to it; it absorbed all his thoughts and aspirations; he seemed to live for it alone, with a chivalrous love for his art. I have said that the king selected the Moresque style for the architecture of his villa, a style which has not in our day been adopted for an architectural monument of any importance. With the exception of the edifice called the Mosque, in the Schwetzingen gardens near Manheim, no serious attempt has been made to reconcile the forms, combinations, and decorations suited for one climate, so as to be adapted for another essentially different. The volume of Owen Jones was the only authentic reference for such a style; but of course it is evident, with even this admirable illustration of Moorish work in the Alhambra, that much must be left to the imagination, the taste, and the discretion of the architect, to harmonise the fantastic poetry of the style, its brilliant decorations, and its piquant individuality, with the ordinary wants and conveniences of modern European life. Our friend did not fetter himself by a slavish adherence to precedent, nor neglect any means of success; and he employed stone of various colours from the adjoining quarries for the principal buildings, rich coloured brick for the offices, and cast-iron for the various details. The Wilhelma presents a conscientious mastery of difficulties, and the triumph of the architect was assured when the most renowned sovereigns of Europe, attended by their numerous brilliant suites, found themselves in the casino, the conservatories, gardens, and porticoes, brilliantly illumined, and reflecting the exquisite decorations, which, harmoniously distributed throughout, charmed the eye and satisfied the taste. And although the magician who had created the fairy scene was not there, his master spirit delighted the brilliant circle assembled in this truly royal villa.

Zanth has published ten chromolithographic illustrations of Wilhelma, drawn with the most elaborate patience, truly German; and they were executed by the most eminent lithographers in Berlin and Paris. He spared no expense to insure the most brilliant result, and one of the plates, the general view, required twenty stones. The French government, with a liberality that does honour to its love and patronage of art, subscribed for forty copies. It were to be wished that our own government felt more

* Paper read before the Royal Institute of British Architects.

alive to the expediency of encouraging in a like manner publications of this class. He presented a copy of this costly work to our library.

A wealthy landed proprietor in Hungary sent for him to make the plans for a large village, with houses and farms of different sizes, a church, and other public buildings, in connection with the restored castle of the lord. These designs are of the greatest interest, for he scrupulously studied to make them conform to the materials at command, brick and wood, which were alone procurable in the country; and he gave them a national character, elevated by elegant and appropriate combinations and proportions, without departing from simplicity and utility.

Zanth's health had of late years yielded to the unremitting toil with which he followed his art; and absolute rest being necessary, he last year visited Italy with M. Hittorff and family. His anxious friends had hoped that he might have enjoyed an elegant repose amidst such scenes without the fatigue of thought, and that the fire of his genius might have been rekindled by the renewed contemplation of the noble works of that classic soil. But the tone of his early energy was gone; the languid invalid looked without emotion at those monuments which he had once regarded with the liveliest enthusiasm, and his residence of some months at Rome was one of suffering and discomfort. While there he received instructions from his king to design a Protestant church, to be attached to the royal palace. This he completed, not without great effort, after the Basilica type, and on his return in June last presented it to the king, who approved of the conception, and the church was decided to be carried out as designed by him, and to be commenced early in 1858. He had also completed some time since the drawings for a Roman Catholic church, which it was recently intended to erect after the concordat entered into between the King of Wurtemburg and the Pope.

The death of this distinguished architect occurred on the 7th October last, and was attended by circumstances which may remind us of the hero cut off on the field of battle, or the chaplet-wreath bound round the head of the expiring victor in the Olympic games. The Emperors of Russia and of the French met as guests at the court of the King of Wurtemburg, and this prince, wishing to do all honour to the sovereigns, gave a splendid fête in the rural palace of the Wilhelma. The monarchs, surprised and delighted with the magnificence and taste of the fairy scene by which they were surrounded, and by a style of art recalling the fabled and gorgeous scenes of the Eastern caliphs rather than the court of a German king, eagerly inquired to whose skill and imagination their host was indebted for the exquisite and varied architecture around them. They learned that it was Herr Zanth, and that he lay at that moment on his bed of sickness. The Emperor of Russia, anxious to express his satisfaction to the artist, sent Prince Gortschakoff at once to the bedside of poor Zanth, to present him with the decoration of Commander of the Order of Stanislaus; and the prince himself attached to the breast of the sick artist the ribbon and cross of the order, accompanying the act with the gracious and touching expressions of admiration which the emperor had uttered. Zanth was on his deathbed, but this act of kind consideration soothed the last moments of one whose devotion to his art and amiable disposition had endeared him to all who knew him.

Zanth was an enthusiastic follower of architecture: his predilection was for classic art. He was unrivalled as a draughtsman for the minute accuracy of every part and the finish of every detail. His large perspective drawings were the most scrupulous possible renderings of the buildings they represented; and although they might want somewhat of aërial effect, yet they were always strikingly effective and grandly rendered. He was extremely susceptible in his feelings, and shrinking from observation. In disposition he was most generous, at all times ready to acknowledge talent in others, and most firm in his attachment as a friend.

"No man is a prophet in his own country;" and it is to be feared that the noble, upright, and highly-gifted architect of the Wilhelma, was not as fully appreciated by those immediately near him as he was by the sovereigns of other states, and by his professional brethren in other countries, who honoured him as an artist and esteemed him as a man. He had received the cross of St. Gregory the Great from the Pope; that of the Lion of Zahringen from the Great Duke of Baden; that of St. Louis from the Duchess Regent of Parma; and he was member of the academies of Berlin, Munich, Milan, &c.

These few notes consist of the impressions produced by an intimate friendship and intercourse of five-and-twenty years; but I am indebted for many particulars to our mutual friend M. Hittorff, who was to him as a brother, not merely in art, but in affection. Zanth was limited in his friendships; his modest and retiring nature made him instinctively avoid numerous attachments; but the few who knew him appreciated the rare moral and intellectual qualities, which made them share in the triumph of his successes, and lament him as one whose loss it is not easy to replace.

INSTITUTION OF ENGINEERS IN SCOTLAND.

The first meeting of the session of this newly formed scientific association was held on Oct. 28; Prof. Rankine, the president, in the chair. Mr. Hunt, the secretary, read the minutes of a meeting held in June, and announced the names of eight influential gentlemen proposed as members, to be balloted for at the next meeting.

The President then proceeded to deliver an inaugural speech, in the course of which he said, the institution traced its origin to the meeting of the Society of Mechanical Engineers held last year in Glasgow, it being considered by the promoters that a society of Engineers holding its meetings in Scotland—and in Glasgow as the best mechanical centre—would be successful, and highly advantageous. It combined mechanical and civil engineering, as both branches (unlike formerly) were now closely united since the extensive and increasing use of iron in building operations. The means of promoting the society's object, the advancement of engineering and practical mechanics, lay in experiments; and as few engineers had time for this at their disposal, the institution would prove useful, and enable them to record for the benefit of others whatever discoveries they might incidentally make in the pursuit of their business. The learned professor having commented upon the great importance of the advantage to be gained from the new institution, went on to say that the present period was a most favourable one for the development of science and the progress of such a society; for reckless speculation no longer existed, and engineers were disposed to conduct their operations with an economy that called forth all their skill—an economy that endeavoured to accomplish an end by means just sufficient to do so in the most scientific and serviceable manner, and no more. He then pointed out some of the more important subjects on which knowledge was required. One of the principal of these was that of materials. The interesting question arose: "Can iron produced in our own country be improved so as to remove the materials that deteriorate its strength?" That was an important matter on which the society would afford the means of throwing light by collecting the experiences of its members. There were other materials of importance—timber, for instance, the seasoning and preserving of which deserved attention. The hardening of stones, the manufacturing of artificial stones, the strength of bricks, and the laws on which the transverse strength of beams could be based, were also matters requiring investigation. Then there was the stiffening of suspension bridges, a subject that attracted great interest. That description of bridge was the strongest, but it was not well applicable to railway purposes, on account of the vibration, which would be so great on the transit of a train at high speed as to endanger the stability of the structure. In reference to this subject, Mr. Peter Barlow made experiments on models and found that very light girders in comparison to what had been generally supposed to be necessary, were quite sufficient to stiffen a suspension bridge: that, in fact, girders of a certain stiffness would sustain 25 times the weight that produced a deflection without the suspension chains. But these experiments were made only on models, and the result remained to be tried upon a large scale; and the matter was well worthy the attention of engineers. After some remarks of a technical character, the Professor alluded to the deviation from old rules adopted by Messrs. Brunel and Scott Russell in the building of the *Great Eastern*, and said that a change was required in the plan on which iron ships were now built. They were always built on the plan of wooden vessels, the builders never taking into account that they were dealing with a different material from that to which they had been so long accustomed. Having mentioned the steam-engine, the electro-magnetic engine (which he said was clean, manageable, and adapted for neat workmanship, although more expensive than the other), he touched upon the wide field for improvement in the railroad, and alluded to some other topics of interest to engineers. He referred to sanitary engineering, such as drainage, ventilation, water supply, ventilation of mines, and to the devising of some means to increase the illuminating power of gas, so as to diminish its cost. On the importance of accurate workmanship he need say nothing in a city like Glasgow, where there were so many skilful artizans. The reformation of the present sytem of measures, especially those of length, was a subject which the society should use their best efforts to secure. It would be for the institute to endeavour to promote a unity of opinion on this subject, which would be the only means of obtaining the necessary change at the hands of government. The last topic on which he would touch was legislation as it affected engineers. First of all, there were the patent laws, which required improvement. They had been partially amended, but both the laws and their administration needed further alteration. There was another class of legislation, then, to which an institution of engineers should turn their attention: laws concerning the public safety—laws to regulate the strength of boilers and the speed of railway trains. There were no laws enacted in reference to either of these matters; but if such laws were provided they should not be calculated to check enterprise or restrict or inconvenience inventors or manufacturers more than was necessary; and in order that the legislature might be accurately informed of the circumstances that should guide them on subjects of the kind, it was of the utmost importance that these subjects should be publicly discussed at meetings by practical and scientific men. He was sorry to perceive a disposition on the part of some very eminent persons to recommend restrictions that he should think very injurious. For instance, Lord Brougham suggested that the speed of trains should be limited to 25 or 30 miles per hour. Now, under proper management and with care, a speed of 70 miles an hour could be made with as much safety as 17, for accidents seldom occurred but through mismanagement; and the proper course to adopt would be to enforce proper management and caution. The speaker in conclusion said Glasgow was a city that possessed the manufactures of Manchester, the shipping of Liverpool, the hardware of Birmingham, and the coal of Newcastle; and considering the vast extent and the great perfection to which some branches of its practical mechanics had arrived—especially its skilful iron shipbuilding and engine making—it could fairly be called the "metropolis of mechanics."

The Chairman then made some observations on Whitworth's decimal system as applied to divisions and gauges. Mr. Whitworth's proposal takes the inch as the unit. This was objected to by the majority of the meeting as being not sufficiently comprehensive. After some discussion, it was suggested that the aid of the English scientific societies be requested towards petitioning Parliament to hasten and facilitate the reform sought.

A paper was then read on M. Beaufumé's gas-flame furnace (see *ante* p. 362).

TRAMWAYS IN LONDON.

At a recent meeting of the London General Omnibus Company the directors submitted the details of a plan for working omnibuses on tramways laid down in the leading thoroughfares of the metropolis, where the width of the road is sufficient to admit of it without risk of interference with the ordinary traffic. A line of tramway of this description has been for nearly three years in use between Paris, Bois de Boulogne, and St. Cloud, and is now extended to Sevres and Versailles; and also in Lyons, New York, and Boston; and large omnibuses, carrying from sixty to eighty passengers each, are thereon propelled by two horses at 8 to 10 miles per hour with great facility. The directors, therefore, asked the sanction of the shareholders to apply part of the unused capital of the company for the establishment of tramways of this character in various parts of the metropolis, commencing with the road from Notting-hill-gate *viâ* Grand Junction-road, New-road, City-road, and Moorgate-street, to the Bank, with branches to the Great Western and London and North-Western railways, and to Fleet-street *viâ* Bagnigge-wells-road. The length of this line, with sidings, will be about 8½ miles, and the road, with the exception of inclines at Pentonville, is broad and eminently qualified for the experiment.

In the report of the engineer, Mr. James Samuel, it is stated that the gradients along the entire line proposed are unusually favourable; the only part of the route where additional horse-power would be required being at Pentonville-hill, where, for a length of about 450 yards on the Battle-bridge side, the rise is 1 in 25, and for 530 yards on the City side 1 in 33: on every other part two horses would be quite capable of drawing an omnibus containing at least 60 passengers, at an average rate of 8 miles per hour. The improved existing road omnibus weighs 21 cwt., and carries 21 passengers inside and out, at an average speed of 6 miles per hour. The new tramway omnibus would weigh about 2 tons; and the facility for stopping and starting it, with improved break, would be quite as great as in the ordinary road omnibus, so that there would be no loss of time on that account. It is this power in horses of starting or stopping almost instantaneously which makes the tramway, for short distances and frequent stoppages, equal, if not superior, to the railway with steam power. The tramway, when laid, will be perfectly flush with the general surface of the roadway, and will not in any way interfere with the passage along and across it of any ordinary road wagon or carriage, and as the new omnibuses in passing along will be confined to the tramway, which will consist of a double line in the centre of the roadway, the sides of the road, and indeed the entire width (except during the instant of passage) will be free to the general traffic, which will thus be carried on without interruption.

The proposed tramway will be constructed with longitudinal bearings, which will enable it to be diverted with great facility during any temporary repairs to gas, water, or sewage pipes, none of which will be in any way interfered with

Experiments, made by direction of the French government, on the tramway between Sevres and Versailles, prove that a horse can on a level tramway draw 3½ times the weight at the same speed, and with the same expenditure of power, that he can on an ordinary road. Up a gradient of 1 in 100, he is capable of drawing 2¼ times the weight, and up a gradient of 1 in 25, 1½ times the weight he could under similar circumstances on the ordinary road.

JORDAN IRON BRIDGE, PENNSYLVANIA, U.S.*

The railroad extending into the interior from the Crane Iron-works, at Catasaqua, for the conveyance of iron ore from various beds in Lehigh county, crosses the Jordan creek where the valley is nearly a quarter of a mile in width at grade, and about 1000 ft. at the bottom. The grade level at this crossing is nearly 90 feet high above low water in the Jordan, and its valley formed a very serious obstacle to encounter upon a merely local railroad. Proposals for an iron bridge were finally invited by the company, and the contract assigned to Mr. F. C. Lowthrop, a civil engineer of great experience and skill.

The extreme length of the bridge is 1165 feet, and the iron superstructure consists of 11 spans, of 100 feet each. These spans are of a suspension truss, each truss being 16 feet high, and the two trusses, necessary to carry a single track railroad, being spaced 10 feet clear apart. The trusses are supported upon a group of cast-iron pillars, of cruciform section, connected and braced together in stages, and firmly stayed laterally by heavy wrought-iron bracing-rods bolted to the masonry. These skeleton piers of cast and wrought iron stand upon low piers of solid masonry, raised above the line of flood, and pointed at both ends. The single track railway crosses upon the deck of the iron bridge in a continuous straight line.

Early in July, this bridge—which is believed to be the longest iron structure yet erected in the United States—was tested to the entire satisfaction of the company, with a loaded train drawn by a locomotive, the whole train weighing upon each span of 100 feet equal 113 tons, or more than 1 ton to the foot lineal, which was the test load contracted for.

This bridge is now in use, and attracts crowds of visitors. It presents a very light and graceful appearance. The first stone was laid August 27th, 1856, and the first locomotive crossed on July 14th, 1857, the whole having been completed in less than a year. It is in every sense a remarkable work, and does the highest credit to the energy and ability of the engineer and contractor. The cost has been less than $70 per foot run, or about $70,000 for the entire structure. Thus demonstrating conclusively the speed and economy with which iron bridges may be erected for railway purposes.

* From the 'Journal of the Franklin Institute.'

BOUCHERIE'S TIMBER PRESERVING PROCESS.*

By JOHN REID, jun., Glasgow.

THIS process forms an important improvement in the mode of preparing timber so as to preserve it from decay. It is the invention of an eminent French chemist, Dr. Boucherie, who has been engaged nearly twenty years in bringing it to perfection, and is one of the most effectual processes for rendering durable wood that is liable to decay.

The tubular structure of trees has long been known; but the fact that there is no lateral or transverse communication between the tubes has been ascertained only recently. This fact has been experimentally demonstrated by injecting a colouring liquid at one end of a log, a particular portion only of the end being exposed to the liquid; it was then found that in any transverse section of the log the wood was always stained in exactly the same part. In this manner the letters of a word have been driven from one end to the other of a piece of timber. This fact forms the basis of the present process, the principle of which consists in forcing into the timber a liquid of a preservative nature, causing it to infiltrate into the fibres of the trees as it would into a series of small parallel tubes.

In the first attempts, the vital energy of the trees was employed to draw in the liquid by means of the circulation of the sap, and the liquid was thus distributed into every part of the wood, and even into the finest tissues of the leaves. As the circulation of the sap however continues for several days, even after the tree has been felled and stripped of its foliage, another process was subsequently adopted, by which the liquid is forced through the timber by an end pressure in a simple and economical manner. The sap is thereby expelled and oozes out from the end of the timber, which is thus freed from the most active source of decomposition and at the same time injected with a liquid incapable of decomposition under all ordinary circumstances.

The following is the method which up to the present time has been found to be most economical and practicable for carrying out the process on a large scale in the preparation of railway sleepers. After the tree has been felled, a saw cut is made across the centre through about nine-tenths of the section of the tree. The tree is then slightly raised at the centre by a lever or wedge, so as to open the saw cut a little; a piece of string or cord is placed all round the edge of the saw cut, and on lowering the tree again, the cut closes upon the string, as in fig. 1, which thus forms a water-tight joint in a simple and effectual manner. An

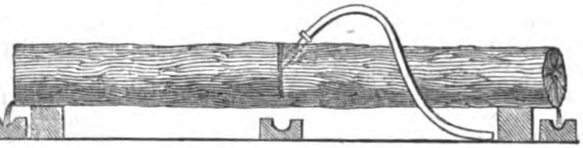


FIG. 1.

auger hole is then bored obliquely into the saw cut from the outside, into which is driven a hollow wooden plug. A flexible tube is fitted on the plug, the end of which is made slightly conical so that the tube may be pushed tight upon it. The tube communicates with a raised cistern, placed at a height of from 30 to 40 ft. above the timbers that are to be prepared, and containing the solution of sulphate of copper used for the purpose. When the preparations have been completed in this manner, the liquid flows through the tube into the saw cut in the tree, and forces itself along the log in both directions, driving the sap out at each end. As soon as the liquid has reached the ends of the log, the process is finished and the log is ready for use.

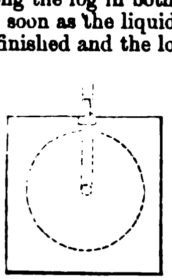


FIG. 2.

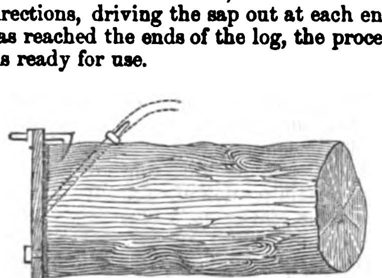


FIG. 3.

If the timber is required of the entire original length, the cross saw cut at the centre cannot be made, and in this case the plan shown in figs. 2 and 3 is substituted. A cap consisting of a piece of board ¾-inch or 1 inch thick, is fixed on the end of the log by screws through the board into the tree or by dogs screwed at the end and fitted with a nut; the joint is made by a piece of string or cord as before, and the cap is screwed up tight on the cord. As the direction of the grain in the board forming the cap is transverse to that of the tree, the liquid cannot pass through the cap, and the injection proceeds from one end of the log to the other.

In order to ascertain when the process has been continued for a sufficient length of time, so that the sap has been all expelled and replaced by the solution of sulphate of copper, a piece of prussiate of potash is rubbed on the end of the timber while in the damp state, and if the solution has reached the end of the log a deep reddish-brown stain is produced, showing that the timber is thoroughly impregnated with sulphate of copper.

The sap expelled from the timber in the process of impregnation contains at most only $\frac{1}{1000}$th part of organic matter in solution, and accordingly no inconvenience is experienced in employing it as a solvent for the sulphate of copper. It is indeed preferable to many kinds of spring water, particularly those containing lime, which decompose a considerable proportion of sulphate of copper. Troughs are therefore laid under the ends of the logs, as shown in fig. 1, to catch the sap and the waste solution, which are conducted to a reservoir to be pumped up to the cistern and mixed with sulphate of copper to the proper strength.

The solution that has been found most effectual for preserving the timber is composed of 1 part by weight of sulphate of copper and 100 parts by weight of water. The strength of the mixture is ascertained by a hydrometer having a properly graduated scale. The specific gravity of water at 60° Fah. being 1000, if 1 per cent. of sulphate of copper is added, the specific gravity of the mixture will be 1006 nearly.

The sooner the trees are prepared after being felled the better, and it is therefore advisable to prepare them as near as possible to the place where they are felled. Trees felled at any time between November and May may be prepared in May; but those cut down in May or at any time from May to the end of November should be prepared within three weeks from the time of being felled.

In the course of the operations carried out in the practical application of this process, the following facts have been ascertained:

All kinds of wood do not absorb equally, and the absorption of the liquid is more rapid in the sappy parts than in those nearer the heart of the tree.

The quantity of the solution forced into the timber is equal in cubic measure to at least one half of the cubic dimensions of the timber. When a solution containing about 2½ lb. of sulphate of copper in every 22 gallons has been forced through a log, it appears, after allowing for the sulphate carried off by the sap, that every 35 cubic feet of wood have retained from 11 lb. to 13 lb. of sulphate of copper.

For a log about 9 feet long the process of impregnation occupies two days, when the timber is newly felled and the solution is supplied by a head of about 3½ feet. If the wood has been felled three months, three days are required; and if four months, four days are necessary to complete the impregnation.

The greater the elevation of the cistern from which the liquid is supplied, the more rapid and complete is the process of saturation. The influence of pressure, however, is perceptible only in wood that readily admits of penetration, such as beech, hornbeam, birch, Scotch fir, &c. The attempts made to force the liquid by means of pressure into wood which under ordinary conditions is impenetrable have proved altogether ineffectual. Of different kinds of trees those which possess most moisture are most easily penetrated by the solution, and of the same kind those which have grown in the dampest soils. Hence the least valuable and cheapest kinds of timber are precisely those which give the best results when impregnated with the sulphate of copper.

The process may be carried on all the year round, except at temperatures so low as to freeze either the solution to be injected or the sap which oozes out of the timber.

The present process may be employed with advantage for preparing timber in all cases where it is liable to decay. Railway sleepers and telegraph posts, ship planking, timbering for mines,

* Paper read before the Institution of Mechanical Engineers.

wood fencing, gates, farm buildings, and other structures of wood, will last many additional years if prepared in this manner. It may be successfully applied to cheap wood of quick growth, such as Scotch fir, beech, elm, and other timber grown in this country; it is not necessary that the wood should be dried or seasoned before being prepared, but on the contrary the operation is best effected immediately after the tree is cut down.

The longest trial that has been made of the process has been with some railway sleepers in France, a number of which have been laid on the Northern Railway for a period of eight years, and continued quite sound and satisfactory.

REGISTER OF NEW PATENTS.

ELECTRIC TELEGRAPHS.

EDWARD HIGHTON, Gloucester-road, Regent's-park, *Patentee*. January 26, 1857.

Hitherto when electric telegraphs have been arranged so as to render it possible to communicate at the same time from and to each of the terminal stations by means of only one line wire and the earth, the influence of the current on the instrument at the sending station has usually been neutralised by dividing it into two halves or portions, which are caused to traverse the coils of such instrument in reverse directions. This invention consists in using an additional battery to neutralise the influence of the line current on the instrument at the sending station; and for this purpose the finger key is so arranged, that at the same time that the line circuit is made a short circuit is completed in the opposite direction, which includes the additional battery and the coils of the instrument.

In order to explain the mode of arrangement, the patentee takes for example two telegraphic instruments, one in England and the other in America; and instead of using the terms positive and negative as applied to the poles and batteries, he substitutes the words zincode and platinode. If the main battery and the counteracting battery be connected with a coil and line wire, and if the strength of the counteracting battery be such as to exactly neutralise the effect that otherwise would be produced in the coil at that station where those batteries are, no effect will be produced on the needle or electro-magnet or other apparatus placed there for producing signals; for it will be seen that as far as that portion of the line circuit comprised in the coil of the said instrument is concerned no electricity can pass through it from either battery, for in that part of the circuit we have two batteries tending to work in opposite directions. It will be observed that in all cases the counteracting battery must have a less number of cells than the main battery, because the electricity of the counteracting battery has only to pass through a circuit composed of the coil and its own cells; whereas the electricity from the main battery has to pass through a circuit composed of the line wire, the coil of the distant or receiving instrument, its own cells, and the earth. As the resistance of the line circuit depends entirely on its length and the conductive power of the intervening wire, both of which will vary according to circumstances, it is impossible to give any general rule; but after the main battery is connected with its circuit it will be very easy to ascertain, by increasing or diminishing as the case requires the number of cells to be employed in the counteracting battery, what that number should be.

In making the above remark the patentee refers to the use of batteries of the same elements, but different kinds of batteries may be used for the main and counteracting batteries, provided the power of the counteracting battery is so adjusted as to neutralise the effects that would otherwise be produced upon the coil were there no counteracting battery employed in the way mentioned. The electricity tending to pass through the zincode pole of the main battery *viâ* the wire of the home coil to the distant coil cannot pass *viâ* the wire of the home coil, but must pass through the counteracting battery (thereby having additional power imparted to it before it reaches the distant coil), because its passage through the wire of the home coil is prevented by the power of the counteracting battery. For the purpose of bringing into action this counteracting battery at the same instant at which the power of the main battery is thrown into the main circuit, it is simply necessary to have an insulated conducting medium from each end of the home coil to the key employed for sending the current along the main circuit, with contact makers so arranged thereon, that at the instant at which the electricity from the main battery is about to be thrown into the main circuit, the electricity from the counteracting battery is at that instant put into metallic connection with the home coil, in the way described, and thus prevents any electricity from the main battery passing through the home coil. Such a mechanical arrangement may be diversified in so many different ways by any one conversant with electricity and mechanics as to need no further description. It will be perceived that the peculiarity of the above arrangement is such that there is no necessity for a separate counteracting coil wire, and that each counteracting battery adds to the power of the effects produced by the main battery on the distant coil. When a main battery is used at each sending station, then the instrument coil at each distant station is to be provided with a counteracting battery.

The invention also consists in telegraphing through submarine wires by means of finger keys and apparatus so arranged as always to produce the telegraphic indication by connecting the zinc pole of the battery with the line wire, and the copper pole with the earth to complete the circuit, in place of arranging the finger keys and apparatus to connect the submarine wire at one time with one pole of the battery, and at another time with the opposite pole, as is now usual. In this way the wire is preserved from oxidation and decay from the action of the sea water, should it at any point happen to be in contact therewith.

The invention further consists in causing an electric current from the zinc pole of a battery to pass through the submarine wires of electric telegraphs, at all times when the telegraph is not in use, in order to prevent oxidation or decay. It is well known, that if any portion of a submarine or subterranean wire enclosed in insulating material be at any point exposed to the action of sea or other water by means of a hole in the insulating medium, such conducting wire will be oxidised; and if certain acids be present (such as humic), malic or several other acid salts of that metal will be produced, and at length the metallic continuity of the conducting wire will be destroyed. But under the well-known laws of electrotyping it is clear that if the zincode pole of a battery be alone connected with the line wire in the sending of telegraphic communications, during the sending of such messages the sea or other water would thereby be prevented from decomposing the conducting wire; and if after the telegraphic communication is completed and the wire is not required for any further communication for a time, a current in the above direction be allowed to pass continuously, all oxidation or destruction of the wire would be arrested during that period, and any slight decomposition that may have been produced during the intervals required between each successive current to form the several signals would be reconverted into metal, and thus the wire made whole again.

In great lengths of submarine telegraph, such as the one proposed between England and America, such an arragement appears to be of the highest importance, but it is equally applicable to submarine and subterranean telegraphs of shorter lengths. It is evident from the foregoing that if, for instance, between England and America, the conducting copper wire came in contact with the water of the ocean, in consequence of leakage in the gutta-percha covering or by means of a hole therein, and an oxide or salt of copper formed at such point of leakage, thus severing the metallic continuity of such conducting wire, by applying the zincode end of two batteries, the one in England and the other in America, and their respective platinodes to the earth, the oxides or salts of copper formed at the point of leakage would be converted into copper and thus metallic continuity re-established. In fact, it would be as it were depositing metal between the decayed ends of the wire by means of electricity, without leaving the shore of either country, and thus mending the interrupted metallic continuity of the wire, and thereby enabling such wire to resume its capability of transmitting telegraphic communications. It will be evident from the above, that although metallic continuity is established in such wire, yet a certain portion of electricity, intended to be transmitted to the distant station in forwarding a telegraphic message thereto, will pass by a short current, *viâ* the point of leakage, to the home station, yet by increasing the amount of quantity of electricity so transmitted, a sufficient amount of electricity for working purposes may thereby be caused to arrive at the distant station to produce the effects required thereat until the point of leakage is discovered, and the insulation thereat made perfect.

HOISTING APPARATUS FOR MINES.

JAMES OWEN, Worsley, *Patentee*, January 30, 1857.

This invention relates to a description of apparatus for arresting or stopping the descent of the cages employed in mines and other shafts, if the winding rope, band, or chain, by which it is suspended, should break or be dissevered. Upon each side of the cage two or more levers are situated, one on each side of the guide rod, extending from the top to the bottom of the shaft. These levers turn or hinge upon pins or studs secured to the side of the cage, and which form the bearing centres or fulcra of such levers. The ends of the levers nearest the fulcra are tapered in form, and provided with a rough serrated edge, in order to have a more perfect and effectual grip or hold upon the rods or guides. The opposite or longer ends of the levers are each secured by a hinge joint to the connecting rods, which are united together above the cage by the tie rods, to which a link is attached for securing the cage to the winding rope. When the cage is suspended, the tapered or holding ends of the levers are drawn away from the guide rods, the whole weight of the cage being supported upon the pins or fulcra of the levers, the connecting or tie rods forming the connection between the rope and such fulcra; but in the event of the rope, &c. breaking, the whole weight of the cage becomes thrown upon the fulcra and not suspended by the connecting rods; this causes the long ends of the levers to fall, and consequently the shorter ones to rise slightly and grip the guide rods, whereby the cage is supported between the fulcra and the short end of the lever, and the cage is prevented from falling or descending the shaft when unattached to the rope. A quicker and more certain action of the levers may be ensured by the application of springs pressing upon the long ends of the levers, so as to force the short ends against the guide rods immediately upon the breaking of the rope.

The second part of this invention relates to the novel formation and action of the bars or rods employed to retain the wagon, bucket, &c. in the cage, and consists in an arrangement of levers in the cage, which cause the bars or rods to rise or fall in front of both ends of the wagon, and thus open or close the passage to and from the cage simultaneously when raised or lowered at either side of the cage.

The action of the apparatus will be easily understood by the following description:—When the rope or suspending medium is perfect and entire, the levers will be kept free from contact with the guide rods, and allow of the uninterrupted ascent or descent of the cage in the shaft; but in the event of the rope becoming dissevered, or rendered incapable of retaining the cage in suspension, the weight of the cage is then thrown upon the fulcra of the levers, the longer ends being allowed to fall (in consequence of the disconnection from the rope) will cause the shorter ends to rise, and pressing inwards or gripping the guide rods will effect the instant stoppage of the descent of the cage.

Claim.—The description, construction, and arrangement of the mechanism or apparatus to be employed for the prevention of accident in ascending or descending the shafts of mines, hoists, &c. as described.

ORDNANCE.

DUNCAN MORRISON, Birmingham, *Patentee*, January 31, 1857.

This invention consists, firstly, in inserting a metallic core in the axis of the mould in which the ordnance is cast, the melted metal being poured into the annular space between the mould and the core. By this method of manufacture the bore of the ordnance will be both smooth and hard, and the ordinary process of boring rendered unnecessary. By making a suitable helical projection or projections upon the core, a corresponding groove or grooves will be formed in the casting, producing in the ordnance the effect called rifling. The core must not be made truly cylindrical, but must slightly taper in order to permit of its withdrawal. The method of supporting the core in the axis of the mould may be effected by means well known and commonly practised in casting operations. A metallic tubular lining may be inserted in ordnance made by the method last described.

Secondly, in casting ordnance upon a tube of copper, brass, or other suitable metal or alloy, which tube constitutes the bore of the ordnance and forms with the casting one compact mass. The tube may be kept cool during the casting by the introduction of a core of metal, or fine loam or sand, or by a water stream. A tube of wrought iron or steel may be used in place of a copper or brass tube for the casting to be formed upon. Touch-holes may either be formed in the casting, or tubes may be inserted for that purpose in the mould. When the tube is worn it may be bored out and replaced by another.

The patentee sometimes modifies the invention in the following manner:—Instead of casting metal upon the tube constituting the bore of the ordnance, the tube is supported and strengthened by applying bars of iron or steel to the exterior of the tube, and fixing them thereon by screwing or otherwise. A series of bars are preferred having a wedge shape in transverse section; that is to say, a series of bars of the form that would be produced by dividing a hollow cylinder in a series of planes whose common intersection is in the axis of the hollow cylinder. The sides of the bars may be made to engage with one another by projections in some of the bars entering depressions in the next ones.

Where steel bars of the kind last described are employed, the internal tube may be made very thin, or may be altogether omitted; the ordnance in the last case being made by the binding together of prismatic bars, so as to form a hollow cylinder, or a hollow cylinder closed at one end.

Claims.—1. Casting ordnance in moulds having a metal core, upon which the bore of the ordnance is cast, whether the core be plain or furnished with a curved projection to rifle the bore of the ordnance. Also in certain tubular metallic linings in the said ordnance.

2. Casting ordnance upon a metallic tube, which tube remains in the casting and constitutes the bore of the ordnance. Also boring out the tubes when worn and replacing them by new ones.

3. Manufacturing ordnance by supporting a tube by means of prismatic bars situated around and fixed upon the tube.

4. Manufacturing ordnance by binding together a series of bars of steel, of such forms that when bound together they constitute a hollow cylinder, or a hollow cylinder closed at one end.

CAST IRON PAVEMENTS.

H. CHAMBERLIN, jun., Narborough, *Patentee*, January 28, 1857.

This invention for paving or covering roads, streets, or ways, relates to the constructing and forming surfaces of cast-iron, offering a good foothold for horses, and which shall be reversible when one side is worn out or unfit for longer use, and at the same time permit a free passage for the water and dirt to pass from the surface. It consists of a grated structure of iron, which may be cast in pieces of any convenient size to suit the area of the street, but the larger they are the better it will answer the purpose. The meshes or openings in the grating may be about one and a-half or two and a-half inches square, and the breadth of the ribs say, about one inch. At the crossings of the ribs the parts are raised above the general level of the ribs, the surfaces of all the crossing ribs being on a uniform level. This grated structure must be of a depth to afford sufficient strength for the purpose required; the surface of the ribs, as also the projections or raised parts at the crossings, are the same on the top and bottom of the structure, to render them reversible. In order to lighten the weight of the structure the ribs may be thinner at the middle of their depth, if it is desirable to economise the metal; or, instead of making them thinner towards the middle of their depth, the ribs may be altogether thinner than the substance of metal at the crossings of the ribs.

By making both sides of these grated structures alike, when the one side becomes worn out the grated plate may be reversed. Instead of the meshes or openings being rectangular and the crossings at right angles, the openings may be five, six, or eight sided, or of other suitable shape, with the crossings or junctions of the ribs accordingly; but in all cases with the raised parts or projections before mentioned. These grated structures should be laid on a good hard subway, or even on the stone paved streets, taking care to bed them properly. The large size of these structures prevents them tilting or sinking under the weight of carriages, and they present a uniform surface, affording a good foothold for horses. The openings through them permit water to pass freely, which may flow towards the street gully or drain on the subway, and thus keep the surface always dry. Little dirt will arise from this paving, but such as accumulates enters the meshes or openings of the grated structure, and may be removed by lifting and cleansing them occasionally. With rectangular openings the ribs may run parallel and transverse to the length of street, or may both be placed diagonally thereto. If in line with and across the street, the tops of the cross ribs between the projections will form a smooth surface, on which the wheels of light vehicles may run, they being received between the projections; or raised, continuous rails may be formed throughout the length of the streets so paved, on which vehicles may travel.

Claim.—The construction and application of grated plates or structures as a covering or paving for roads, streets, or ways.

HARBOURS OF REFUGE.

Digest of Evidence taken before the Select Committee of the House of Commons.

ABERDEEN HARBOUR—

Capt. Vetch stated that the harbour of Aberdeen, which was formerly very difficult to take, has been very much improved latterly; the bar has been removed, and deep water procured. It is now in a very favourable state; and the peculiar dangers which used to attach to that harbour have been removed. At high tide there is now 21 feet of water: there is 12 feet of rise and fall, which would leave 9 feet at low water. It has a very noble dock, and steamers can coal in the harbour. Steamers of war could coal there.

ACTION OF THE SEA—

Mr. Coode was of opinion that wherever a breakwater only is required, and there are no piers, and masonry work can be entirely dispensed with, the deposit of rough material to the necessary height above high-water mark would be a very much cheaper mode of constructing such a breakwater than applying any masonry whatever, and in many cases that would be sufficient. There might be cases, however, where the cost of the rough material would be rather large, the exposure very great, and the facilities for obtaining stone fit for masonry purposes also great, where it would be more desirable to begin with a small rubble deposit, and then build at a certain depth below low water entirely of masonry. In most cases, if the material could be obtained, simply relying upon a rough deposit for a certain height above high-water mark would answer all the purpose, so far as solidity of construction went; but there may be cases where the violence of the sea would be so great, that the material above high water, without some protection, would be so disturbed that masonry would be necessary to perfect the security of the work; there are many cases in which a simple rubble deposit would be quite sufficient. The rubble deposit under low-water mark would be much more secure than that above high-water mark, although not so solid. Above about 12 feet—taken as the average—below low-water mark the action of the sea is very great, and tends to consolidate the material; but that does not obtain below about 12 feet under low-water mark, where the material remains just in the condition in which it originally falls; there is no disturbance or removal afterwards. Down to a certain depth there is, where the wave may act. Where the material was not on the spot, but had to be brought from a distance, if the system of building from 12 to 15 feet below low-water mark were adopted, it would be possible that rubble foundation should be laid by the ship that brought it; but in such a case the question of the precise mode of construction, as between vertical walls springing entirely from the bottom, and vertical walls springing from the rubble deposit, must be entirely guided by local circumstances. It may be very much cheaper, as at Dover, to build as they now do, direct from the bottom; and in other cases it may be more economical first of all to deposit a mass of rubble, and then to build from that. Walls founded at 15 feet below low water would be amply secure against any sea; the proportion of masonry must depend upon circumstances, but at that depth any masonry wall would be quite secure. In laying the rubble foundations of breakwaters, it is the usual practice to allow a certain period—three or four or five years—to elapse before commencing the construction of the masonry work upon the top. The action of the sea is so uniform, and the slopes are so regular, that it can be ascertained what quantity, yard for yard, will be consumed for the breakwater. As to the time that must necessarily elapse, it is not necessary to wait any time where the rough deposit is stopped at a depth below low water such as 12 or 15 feet; if the material is brought up regularly, and with some little precaution, building may be commenced immediately. But according to the amount of exposure on the coast, so would be the depth at which the action of the sea would take place.

ARDGLASS HARBOUR—

Capt. Washington stated that Ardglass had been very much pressed for a harbour of refuge, as was reported by Capt. Denham and Mr. Rendel as far back as 1852. Mr. Rendel recommended two breakwaters, one on the east and the other on the west side, sheltering an area of about 75 acres, with a depth exceeding 12 feet at low water, at a cost of 240,000*l*. A large harbour is not required. The present small harbour and the pier-head should be restored and put in proper condition; but did not think it a fit place for a large harbour of refuge.

Mr. Ramsay said, that for 25,000*l*. Carlingford Lough could be made to the fullest extent a most valuable harbour of refuge for the trade of the channel.

BANN RIVER—

Capt. Vetch said that some years ago his attention was called to the north coast of Ireland, and he was directed to make an inquiry into the navigation of the mouth of the river Bann, which is a very good navigation a little way above the mouth, but it has got a bar which may be removed by means of two piers run out across the foreshore, and an entrance obtained at all times of the tide, and so become a useful harbour.

BELFAST HARBOUR—

Capt. Washington stated that Belfast has been improved so greatly, that it may be called a harbour of refuge; there is no harbour in Ireland which has been so much improved, and in which so much enterprise and public spirit have been shown. Belfast Lough offers a natural harbour of refuge, but they have very greatly improved the approach to the city.

BRIDLINGTON BAY—

Capt. Washington said that at Flamborough Head, in Bridlington Bay, a great many wrecks occur; it is a calling place for vessels in a northerly wind. If a second harbour of refuge on the coast of England could be made, he should recommend one in Bridlington Bay, but not in preference to Tees Bay. He was of opinion, that with the Humber on the south, and a harbour of refuge at Tees Bay on the north, a great deal of the danger of that coast would be averted. With a north-west wind it is very much resorted to by vessels. If the inner harbour of Bridlington could be improved, it would be a great advantage to the numerous vessels that are forced to take shelter in the bay, where 3760 ships anchored last year.

BRISTOL CHANNEL—

Capt. Hoskyn did not know of any point at the north shore of the Bristol channel where it would be desirable to form a harbour of refuge. With easterly winds, Penarth roads is a very safe anchorage in the Bristol channel without anything being done to it. He did not know of any place on the north side of the Bristol channel where a harbour of refuge could be made.

CARLINGFORD—

Capt. Washington stated that the almost natural harbour of Carlingford Bay has an entrance of 18 feet at low water spring tides; but the entrance is tortuous, it could not be run for by vessels in a gale of wind. An outlay of 20,000*l*. would make it an admirable harbour of refuge; and it is a spot where it is as much wanted as any other on the east coast of Ireland. The Bay of Dublin affords a natural harbour 50 miles south of Carlingford, which is separate from Dublin in this way,—that as to vessels which come north about bound to Liverpool, Carlingford would be a harbour of refuge for them, while they would not think of going so far south as Dublin if they could avoid it. He was of opinion that an improvement of Carlingford Bay would supply many of the defects which at present exist on the north-east coast of Ireland, and it is a small outlay that would confer a large benefit. Further west, on the south coast, Waterford is in very much the same state as Carlingford,—a very fine natural harbour, but with a flat or bar having only 12 feet over it at low water spring tides. To dredge a channel through that to a depth of 18 or 20 feet, at a cost of 20,000*l*., would make it a good harbour. He considered that there are no two spots in the whole of the United Kingdom at which good harbours of refuge could be got at so small an outlay as at Waterford and Carlingford; 20,000*l*. laid out on each of those would render them available at all times for the greater part of the vessels that navigate the Irish sea.

Capt. Vetch said, there is good deep water inside Carlingford Lough, and it is only necessary to dredge an opening through the bar, which might be done at little cost. He did not know of any other part on the east coast of Ireland which he would suggest for those improvements.

Capt. Fraser considered that Carlingford Bay might be made a place of refuge at a comparatively small cost.

Capt. Hoskyn said, there is not any place to the north, excepting Carlingford, that is worthy of improvement. He had made a special survey of Carlingford, and had discovered a new channel of entrance giving 18 feet at low water, whereas the existing channel gives only 8 feet. It is circuitous, but if buoyed would be of great service to steam vessels, and to sailing vessels with a fair wind. The entrance might be rendered easy for sailing vessels by removing a portion of the bar by dredging; a straight channel of between 700 and 800 yards in width and 18 feet in depth could be dredged under a cost of 30,000*l*.

Mr. Ramsay stated that he had examined the bar at Carlingford, and found the top part consisted of loose boulder-stones, a little lower down gravel and sand, and subsequently a fine clay. If removed there would be no possibility of its silting up again. He would remove the boulder-stones by a diving-bell, and then dredge. If the improvements were effected the area inclosed would be 300 acres, or three times as much as at Kingston.

Cromarty Firth—

Capt. Washington stated that at present there is no harbour of refuge from the Forth to the Pentland Firth, except Cromarty Firth, which lies so deeply in the bay that it is a place which few vessels run for.

Capt. Vetch was of opinion that the Firth of Cromarty is a safe and remarkably fine harbour; but being in the very bight of the bay, few vessels would run so far in if they could avoid it.

Mr. Calver said, that Cromarty Bay is a beautiful harbour of refuge, there is 30 fathoms of water at the entrance. It is the most easy place on the coast of Scotland to run for. The Sutors which form the sides of the entrance are upright headlands, and under all circumstances of weather you can always see the opening through the shore, even on a dark night. He thought that it would be a good place to use as a coaling depôt for men-of-war in time of war; the only drawback being the depth at the head of the bight. He considered that Wick would be much superior to Cromarty for men-of-war, as far as position is concerned.

Dover Harbour—

Capt. Washington stated, that the whole of the works at Dover are an upright wall from the foundation, on account of the very limited space there. There is no instance, that he was aware of, where the foundation made in that manner has given way, the upright wall being laid below low-water mark. Some similar works on the coast of Ireland did give way; when the attempt was made to bring the slope up above high water it gave way, but where the rubble stone has been kept below low-water mark, and from thence an upright wall, there is no instance of its having given way; in fact, the heavy stroke of the sea appears to be about at half tide. That is the result of the experience at Cherbourg. The breakwater now in construction is being made of upright walls, with faced cut stones filled in with blocks of concrete, and that has been laid by diving-bell; the progress is very slow and costly, they are now at work solely on the western pier. It is intended to have an eastern and southern pier. The eastern pier should go on simultaneously, it ought to be begun immediately. One of the reasons why the eastern pier is to be made with cut-stone, is the difficulty of getting materials for the sloping walls, and also that the concrete and the shingle on the spot can be used advantageously.

Mr. Coode stated, that the process now in use at Dover is very expensive and very slow, but it is one that is rendered necessary by the circumstances at Dover; they have no material within a reasonable distance which they could use for the purpose of rough deposit in a breakwater; therefore they have necessarily to resort to a smaller quantity of material, bestowing a greater amount of labour upon it. Their stone is all sea-borne; it is principally granite, with some small quantity of stone from Portland, the roach Portland, and also artificial concrete blocks, made with shingle. In the event of stone being carried a great distance, and being sea-borne, the plan of using small and large stone indiscriminately, and throwing it into the sea, would be equally applicable, but there would be a very great cost entailed in landing the stone from the vessels in order to put it into railway carriages; it is applicable, but as a question of economy he doubted its being advisable. It is quite possible to construct a breakwater in that way, but the cost would be much greater than if it were discharged from the vessel. The foundation at Dover is made entirely by masonry; the bottom is chalk, which is levelled by divers, and they first began to set the blocks upon the bottom of the bay, the walls are built in masonry from the foundation, the whole work is done by diving-bells and masons. Where the stone is brought from a great distance and by sea, he should certainly recommend the plan adopted at Dover; he thought that they had no alternative. It is only where a large quantity of rough material is found immediately in the neighbourhood, that it would answer to use the plan of throwing the stone indiscriminately into the water, for the purpose of creating a natural breakwater, but when it could be done a breakwater so constructed would be very much less costly than one constructed by mason work from the bottom. He was not aware of any difficulty in obtaining the proper materials for forming those blocks of concrete, they were made from the shingle some time since, and there has been always an ample supply; the quantity of shingle travelling on that part of the coast is considered one of the difficulties that they have to deal with. He did not consider that the chalk could have been used for the centre part in the shape of a breakwater, instead of a pier; there are very few beds in the chalk formation that are really applicable to such a work, and in order to obtain these beds, it would be necessary to remove so large a quantity that would have been useless, that it would have been very bad economy.

Falmouth Harbour—

Capt. Washington.—Falmouth is in some measure a natural harbour of refuge, but it might be improved very much; a small outlay there would be equivalent to a very much larger outlay elsewhere. Sooner or later, no doubt, some of our packets will move westward again, and the necessity for improvement there will be more evident. There is not any part of that coast which offers advantages so great as Falmouth for the purposes of a harbour of refuge. He thought that as soon as the railway is completed to Falmouth, the mails being landed there will arrive earlier in London, Manchester, and Glasgow, and the vessels avoid the risk of running up Channel, which is a risk, as was shown by a large steamer being wrecked in the spring on Kimmeridge Ledge, almost at the entrance of the Needles. Falmouth is ready made, it only wants a little internal improvement to make it available.

Capt. Vetch.—Falmouth is a fine harbour; and all that is required is, dredging away a great accumulation of soft mud from the front of the town. It is readily improvable at no very large cost.

Capt. Sulivan.—There is a rock at the mouth of Falmouth harbour, right in the entrance. He should rather be inclined to keep that rock; there is a pyramid upon it; has never heard of a vessel being wrecked on it; and as it is above water, right in the centre of the mouth of the harbour, and has a good passage on each side, and as the principal anchorage is exactly inside it, he would retain it; it helps to make it such a safe harbour in southerly winds, because there is no harbour naturally on the south coast of England so safe. In the November gale of 1824, every vessel that was at anchor inside the breakwater went on shore, and every soul perished in some; and every vessel at Spithead went ashore, or into Portsmouth harbour, the gale being from south south-west to south south-east; it was a very bad gale for Falmouth, and though there were 200 outward-bound vessels in the harbour, not one was lost, and only one drove, and she held on to an Indiaman and was saved. Did not think that a light ought to be placed upon that rock, there is a light at the entrance which vessels keep close to, and so get away from the rock; the lighthouse is on the east head, which is a bold one, and the vessels pass close to it, and so keep clear of the rock; it acts as a small breakwater. The great want of Falmouth is something in the shallow harbour, the inner harbour, which has been gradually shallowing up for some years; it must eventually, he supposed, become a packet station, and therefore something must be done there; but that is a thing that the trade will itself lead to.

Capt. Hoskyn said that he thought the access to Falmouth Harbour might be much improved by the rock at the entrance being removed, which could be done without difficulty and would very much improve the harbour for the entry of sailing ships, on dark nights especially. It is not always visible, and it has not sufficient base to have any effect in breaking off the sea. The depth of water in the harbour varies, The least depth in the inner harbour is about 14 or 15 feet at the low water spring-tides; and in the outer harbour five or six fathoms in the ordinary anchorage. St. Just Pool, near Falmouth would be a very good place of refuge. There is more difficulty in getting into it, than Falmouth, but when there a safer place cannot possibly be.

HARTLEPOOL—

Capt. Washington gave evidence strongly in favour of the formation of a harbour of refuge at Hartlepool.

Capt. Vetch was of opinion that Hartlepool is by far the most eligible site for a harbour of refuge on that side of the coast. The vast number of vessels constantly passing it, and the statistics of the wreck-chart point to this locality as one having perhaps a stronger claim than any other in the United Kingdom for a harbour of refuge.

Mr. Calver had no doubt whatever in recommending Hartlepool Bay as the point on that part of the coast best adapted for a harbour of refuge. The whole space would be required for a harbour of refuge. He recommended a detached breakwater, leaving an ingress and egress north and south, so that there should be a constant scourage of water either way, no interference with the tide, and as little as necessary with the wave. It would not interfere with the current running through the harbour in the smallest way. In order to insure the suspension of material in the water, a current of that kind is an advantage. Observing in gales of wind that the wave is charged even to the depth of 12 fathoms on the eastern coast of England, it is quite clear that to form there a close harbour of refuge would be a very dangerous experiment.

Mr. Jackson stated that Hartlepool Bay is peculiarly eligible as a harbour of refuge, which would be not only a local benefit but of the greatest value to the entire trade of the east coast. About 150,000 ships, of an average tonnage of 140 tons each, pass almost within sight of Hartlepool every year.

HOLYHEAD HARBOUR—

Mr. Calver said that the works at Holyhead are going on very satisfactorily indeed. When the harbour is well known, it will be considered an inestimable advantage. The mode pursued in making that harbour is Mr. Rendel's invention, the stage plan appears to be very well calculated for the purpose, it is very simple, rapid, and certain, and is a saving of time, expense, and casualties. The large northern breakwater is complete in the main mass, and the extension within 400 or 500 feet of the end; the rubble is complete for that portion, above high-water mark springs, to within 400 or 500 feet of the outer limit of the furthest extension. The last extension sanctioned by the Treasury doubles the value of the whole harbour. It has doubled the area of the protected water, when the harbour is required for refuge. With regard to the mode of constructing the pier he thought that it could not be improved. A wall of masonry is now forming through the very summit of the breakwater, to act as a sort of back-bone; this is formed of rough rocks, as they are blasted from the quarry; they are brought down, set in mortar, and founded below low-water springs, in the very centre of the breakwater.

LIVERPOOL—

Capt. Sulivan stated his belief that the trade of the Mersey has become inconveniently large for the convenience it affords. The port of Liverpool is such, that a vessel of 400 tons in which he happened to be in 1851 could not run for it, fearing they should not hit the right time of tide, and it would be certain destruction if they did not. The captain was afraid to run for Liverpool, and kept out at sea for two days under great danger rather than risk it. It is a most dangerous place for such a trade. In a case of that sort Holyhead Harbour would be invaluable. There is no good anchorage at Liverpool when in; the bottom is not good holding-ground; he referred to that open space from the docks to the opposite shore abreast of Liverpool, abreast of the docks. Vessels get into the docks at once if the weather is bad. Holyhead is in the immediate neighbourhood of the whole passing trade of Liverpool; vessels are constantly caught in gales, and that is the only safe port to approach when they dare not run into the bay of Liverpool.

Capt. Fraser said, there is a bar at Liverpool which it had been unsuccessfully tried to improve by raking. Raking would have a tendency to disturb the matter, whatever it may be, from one place, to deposit in another, whereas in dredging you lift it up and take it away altogether.

MILFORD HAVEN—

Capt. Washington considered that Milford Haven is a very valuable natural harbour; did not think any other is required on the west coast. Many wrecks occur in Cardigan Bay, but, with the very large refuge harbour of Holyhead in the immediate vicinity, he could not recommend an outlay of public money there. A little more care and attention to the set of the tides would save many of the wrecks that occur there.

Capt. Sulivan stated, that he had formed a very high opinion of Milford Bay; he considered there is no port like it in England. He did not think anything can be done at Liverpool; his idea is that as steam trade increases, now that railways are open, Milford must take such a portion of the trade away from Liverpool, that it will prevent Liverpool being more crowded. Milford is such a superior port, that it will prevent the trade of Liverpool going on increasing. Milford is so admirably situated for all vessels bound round Cape Clear, and they save so many risks by going there, that he would put Holyhead in comparison with Milford as a port; Holyhead is a little nearer the manufacturing districts; but London is nearer to Milford, and Milford is nearer to all the western manufacturing districts, and the Pottery districts; but the steamers landing their mails, and the light goods that they carry at Milford, would give them a very great advantage over Liverpool; passengers landing at Milford would be in London before they would be in Liverpool, going up the Channel.

Mr. Wherland stated, that a vessel having the choice of Waterford Harbour on the one side and the Smalls on the other, could make Milford Haven in a north-west or south-west gale; but she would have the disadvantage of being on a lee shore when the wind veered to the north-west, and she would have a difficulty in getting clear of the Scillies, or into the great in-draught up the Channel; whereas, in the case of Waterford, she would have the advantage of a weather shore. Outward-bound vessels do not avail themselves much of Milford Haven at present, owing to the difficulty of getting out.

Mr. Bourne said, that Milford Haven is of service for vessels in the Bristol Channel, and to vessels running past Cork, because there is no other harbour but Milford. It is a very good harbour to go in, but it is a very bad harbour to get out of with the wind into the harbour.

PENZANCE—

Capt. Washington stated, that it has been contemplated to construct another harbour near Penzance in Mount's Bay. There is a great facility for making a breakwater at Penlee Point; everything, however, would have to be done. Falmouth is ready made, it only wants a little internal improvement to make it available. He did not think a national harbour is wanted in Mount's Bay; but a fishery harbour might be very valuable indeed, and the fishermen with their fine boats well deserve it. Great improvements have been made at Penzance; further to the southward, in Guavas Lake, at Penlee Point, or off Mousehole, there is deeper water and greater facility for a fishing harbour.

Capt. Sulivan said, that as to the necessity of there being a harbour of refuge somewhere near the Land's End, the only harbour of refuge that he thought wanted at Penzance is for the fishermen at Mousehole. Some little shelter there for fishing-boats would be very desirable; but, as a harbour of refuge for ships, as Falmouth is so near it, he did not think it necessary.

PLYMOUTH HARBOUR—

Capt. Washington said, that Plymouth is a natural harbour of refuge, and has been very much improved by a breakwater. Plymouth is one of the most perfect harbours of refuge throughout the coast; vessels of the largest dimensions may run for it at any time. With Plymouth and Portland he thought that the south coast of England is at the present time very well furnished with secure harbours of refuge. As soon as you draw towards the Land's End, the Wreck-chart is covered with black dots. Somewhere about the Land's End a better harbour is wanted.

Mr. Coode stated that, in the early formation of Plymouth breakwater they had erroneously used exclusively large stones; small stone and chippings were discarded, and large stones almost entirely were used; the consequence was, that the interstices there were proved by the late Mr. Rendel to amount to something like

30 per cent. of the whole mass. Great disturbances took place during very heavy gales, and the only remedy that they found for that, was to resort to the small chippings and rubble which they had previously discarded, and drop them amongst the large stones to consolidate the mass. The whole of the workings of a quarry could be used in this work, always supposing that that quarry afforded a reasonable percentage of stones, say from three to six tons in weight. It is essential that there should be a certain proportion of large stones.

Mr. Calver said, that for purposes of refuge Plymouth breakwater is a very effective work.

PORTLAND—

Capt. Washington stated that Portland is being made cheaper than any other breakwater in the United Kingdom,—partly by convict labour; and, independently of that, Portland is being made at the rate of 85*l.* a lineal foot, which is the cheapest harbour of that kind ever constructed. The superstructure will cost 35*l.* in addition; but this is independent of the deep-water circular heads and lighthouses. It will cost altogether upwards of a million.

Mr. Coode said, that the deposit of the stone, as conducted at Portland, by means of a fixed stage, has been quite successful, more so than any other mode of constructing a breakwater. It is an essential condition in forming the breakwater, to use stone of various sizes, so as to prevent large interstices. The consolidation and distribution of the stones are left to the action of the sea for four or five winters before the masonry is commenced; a solid mass is thereby formed for a foundation. Some granite is used in facing a portion of the sea wall. The breakwater will be completed in about four years: it rests upon the Kimmeridge clay.

SAINT IVES—

Capt. Washington stated that around the Land's End, St. Ives is the most eligible point for a harbour of refuge, and would afford most useful shelter. The estimate of Capt. Vetch for St. Ives harbour was 175,000*l.* The Bristol Channel would be especially accommodated by the proposed harbour.

Capt. Sulivan said that the south part of Cornwall is well supplied with harbours; there are Fowey and Falmouth, Falmouth being probably the best, except Milford Haven, in England, merely looking to it as a harbour of refuge, but it is also most important from its western position. St. Ives is the only harbour on the north coast of Cornwall, and if a harbour of refuge was erected on that coast, he should think St. Ives would be much the best place; its position would give it advantages to the outward-bound trade taking refuge there over every other place; vessels caught in north-west gales on the coast, being outward bound, would find it a very good place of refuge.

Capt. Vetch was of opinion that at St. Ives a harbour of refuge would be extremely useful. The total estimate for the entire works proposed by him is 174,000*l.*, but one half of that amount would accomplish much. He was in favour of the proposed harbour at St. Ives instead of one at Penzance, or any other place along the coast. The anchorage at St. Ives is very good. He recommended that the pier should be carried out to the extent of 20,000 feet, which would give a shelter of 80 acres of 12 feet and upwards, and 56 acres of 18 feet and upwards, which would be ample accommodation for the vessels of the port, and for the refuge of those likely to run there for shelter. As to cost, the materials were good, and were at hand, and other conveniences tended to render the cost less than at other places; and the accommodation to be so procured was ample for the ends in view. As a first step in the improvement, the work might be stopped at 1200 feet, and reserve the further outlay until the necessity arose for extending the first cost to about 100,000*l.*

SUNDERLAND—

Mr. Calver stated that he would not suggest the formation at Sunderland of a harbour of refuge or any works except for a local purpose.

Mr. Jackson was of opinion that neither Hendon Bay, nor the White Stones, near Sunderland, is an eligible locality for a harbour of refuge.

Mr. Cowen considered that money might be very advantageously expended at Sunderland.

Mr. Robinson believed that the mouth of the river at Sunderland might be very much improved to facilitate the admission of the local trade: it is very bad at present.

Mr. Simey stated, that a company has made a very excellent dock at Sunderland, having an outlet to the sea, with very much increased draught of water over the old bar at the mouth of the Wear. Outside the bar, piers might be run off from the north and south to encircle some water and improve the place; but it would never answer as a harbour of refuge, it is too shoal. A harbour of refuge might be constructed at Hendon Bay. The best plan he had seen is that proposed by Mr. Murray, across two shoals that lie in the face of Hendon Bay, and which would encircle a great deal of water, leaving two clear openings, one from the south and the other from the north; in the inside of which ships could come at all times of the tide, and bring up and anchor in safety. Sunderland is the largest ship-building port in the kingdom. The estimated cost of Mr. Murray's harbour is 850,000*l.* The area proposed to be enclosed is from 600 to 700 acres; the length of the breakwater would be nearly 10,000 feet.

SOUTH WALES INSTITUTE OF ENGINEERS.

A general meeting was held at Merthyr last month, for the purpose of forming a new association, to be called the "South Wales Institute of Engineers:" about fifty gentlemen connected with engineering were present. Mr. Meneloes, of Dowlais, presided. After agreeing to various rules, the members proceeded to the election of officers, when Mr. Williams, of Dowlais, the first proposer and originator of the institute, was unanimously elected president for the ensuing year. The vice-presidents elected were—Mr. Rogers, Abercarn; Mr. Adams, Ebbw Vale; Mr. Martin, Dowlais; Mr. T. Evans, Dowlais; Mr. Clarke, Aberdare. The council are—Mr. Truran, Dowlais; Mr. R. H. Rhys, Aberdare; Mr. D. Williams and Mr. Bedlington, Rhymney; Mr. Edward Williams, Dowlais; Mr. S. B. Rogers, Nant-y-glo; Mr. Huxham, Pontypridd; Mr. Richards, Ebbw Vale; Mr. Pearce, Cyfarthfa; Mr. D. Roberts, Rhymney; Mr. Cox, Newport; Mr. J. James, Blaina. The members afterwards dined together.

GIBSON'S SELF-ACTING RAILWAY SIGNALS.

AT a meeting of the Institution of Civil Engineers, on the 24th ult., a model was exhibited of Gibson's self-acting Signal and Telegraph for Railways. It was described as being intended to supply the want of a system of railway signalling, which should be efficient, and whilst answering every purpose for which railway signals could be required, should be simple in construction, and not liable to be misunderstood or to get out of repair; being, at the same time, independent of the attention or the neglect of servants. The apparatus consisted of a continuous arrangement of signalling set in motion by the engine, which in passing over a lever placed close within side the rail in any desired situation, caused a signal-post No. 1 to rotate partially, and so to indicate to the following train the close proximity of a preceding train. The signal-post No. 1 remained in this position, until the engine arrived at the next signal-post No. 2, the lever opposite to which, when depressed by the engine, caused it to rotate similarly to the signal-post No. 1 previously passed, which was at the same time replaced in its original position. The engine then reached signal-post No. 3, and it and No. 2 would be simultaneously acted upon as were Nos. 1 and 2. Then No. 4 received the responsibility, and released No. 3, and so on. It answered equally well by night and day; and the present signal-posts could be adapted to it.

By the same motion of the horizontal levers, audible or visible telegraphic communications could be made with any station or stations, either in advance or in the rear of the moving train; thus indicating, by the continual ringing of a bell, if necessary, the approach, departure, present position, or passage through a tunnel or over any dangerous part of the line. On foggy or stormy nights, or where there were sharp curves, &c., this would be found very valuable.

Another important part of the system was the contrivance for the self-acting contraction and expansion of stretched wire, by means of which hand signals, &c., could be acted upon at a distance of 2000 yards, being far beyond the present working distance; and the wire, both in summer and winter, would always be at the same degree of tension.

The whole apparatus was described as having been in efficient action for some time, at Binns' Junction, on the North-Eastern Railway, where thirty trains ran daily over it, to the perfect satisfaction of the engineers and the officers of the line.

ON AN IMPROVED LOCOMOTIVE BOILER.*

By Walter Neilson, of Glasgow.

The locomotive boiler, from the very high pressure at which steam is now used, has demanded much attention, in order to obtain a form of great strength and safety. The parallel boiler has of late years been adopted, as giving greater strength in its form and greater durability than the raised firebox form, which latter, although made sufficient by stays, is exposed to constantly varying expansions and strains, leading to leakage at the angles. The parallel form however has the objection, more particularly in large engines where much heating surface is necessary, that the steam space is contracted or limited, besides being much occupied by stays, as well as by the steam-pipe and regulator. The water level is necessarily high in the boiler, leaving only a small segment of the circular area for the regulation of the proper water line; so that the engine-driver has very little variation to work upon between too much water and too little, the former causing the engine to prime, and the latter involving danger of burning the firebox or bursting the boiler.

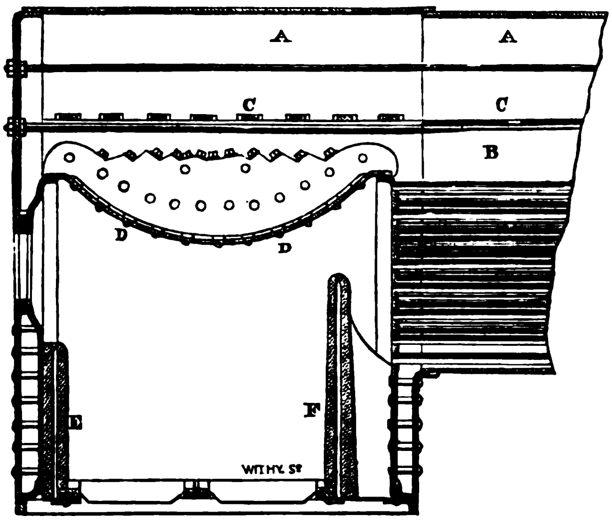


Fig. 1.

The boiler described in the present paper, and shown in figs. 1 and 2, is designed by the writer to obviate this defect; and for this pupose there is added on the top of the boiler a steam chamber A, consisting of a portion of a cylinder of smaller diameter than the barrel of the boiler B, the two cylinders being connected at their junction by a strong diaphragm plate C, forming as it were a common chord to the two circles given by the section of the cylinders, as seen in fig. 2. By this construction a correct form is obtained, the strength of which is equal to the full resistance of the plates to the internal pressure of steam. It will be observed that no angle iron is used in this construction of boiler, and that the strain is entirely in the direction of the plates.

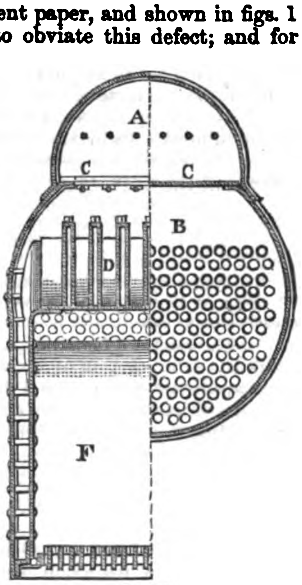


Fig. 2.

In order to provide against the danger of explosion from overheating the roof of the firebox, in consequence of the water getting too low, which the writer believes is the cause of most explosions, the firebox roof D, is depressed in a circular shape, fig. 1, whereby a more correct form of roof girder or crown stay is obtained, and which is really the strongest that can be got to support the weight or pressure upon the roof. The ordinary parallel girder is not correct in form, the greatest strain for rupture being across the centre of the firebox roof, where the parallel girder has the least power of resistance. In the new plan of firebox the circular shape of the roof also gives the plates greater power of resistance, independently of the roof girders. As an additional precaution the top row of tubes is somewhat raised at the smokebox end. The result of this arrangement is that a considerably greater range of water level is obtained with perfect safety; for in case the water line gets as low as the top of the firebox, the crown will be perfectly safe, and the top row of tubes at the smokebox end will be the first to give way; and should the water get lower, the part of the crown first exposed to be heated is the strongest portion, and will stand safely until the tubes burn and give warning of the danger. It may be objected to the depressed firebox crown that it will be more apt to collect deposit than the flat crown; but the writer thinks there need not be much apprehension on this point, as there is a free and level communication across the top of the firebox from side to side. It should be remarked however that the locomotive engine is never worked to economy with bad water; and money expended in obtaining proper water is more than compensated for in the saving on the engines and in the safety of the boilers.

Another improvement in the boiler now described consists in an arrangement for using coal instead of coke. In the ordinary firebox the production of gaseous matters from the coal is too rapid to obtain a proper combustion; and even if oxygen is supplied by the admission of air into the firebox, the very great variation of temperature in the furnace, caused by every fresh supply of fuel, renders the complete combustion of the gaseous products very difficult. To get over this difficulty, the back part of the firebox under the door is lined with large firebrick blocks E, having tubular openings through them forming a communication between the interior and exterior of the firebox; in the same manner a bridge F, is formed in front of the fire with a similar series of tubular openings through it. The firebrick blocks will become highly heated by the action of the fire, and consequently the air drawn through them will also be highly heated, ready for effecting the combustion of the gases the moment the air enters the furnace in the form of jets. They also maintain a more equal degree of heat in the furnace at each new supply of fuel, which is of great importance. It is thought that no difficulty need be anticipated in the fixing and maintaining of the firebrick blocks.

Prof. Rankine said, in the unavoidable absence of Mr. Neilson, he had been requested to give any requisite explanations respecting the paper. He observed that the principal object had been to prevent the failure of the roof of the firebox, as the result of such an accident was very serious and generally fatal, whilst the failure of the other portion of the boiler, the tubes, seldom caused more than delay. He had been struck with the importance of the subject by seeing recently the result of the failure of a firebox with a level top, where all the roof girders broke across the top, two only of the girders having been notched at that part. An exactly similar firebox was tested with water pressure, and it was found that 470 lb. pressure per square inch was required to make the roof give way in a similar manner, being nearly five times the working pressure; that pressure however must have been attained in the case of the accident referred to. The object of the plan now proposed was both to strengthen the roof by giving it a curved form and increasing the depth of the girders, and to protect it by preventing it from being laid bare of water in the centre, leaving the tubes to be first exposed when the water got low. He now suggested the slightly curving the roof in a convex form transversely, to give the deposit a tendency to clear itself at the sides.

Mr. Fenton observed, that it was very unusual for a failure of the roof girders to occur; when the roof of a firebox had given way, it had generally come down in one piece with the roof girders entire. The case that had been referred to was the only instance he believed on record of a roof failing across, and in that case there were also no stays from the roof up to the outer shell. A supplementary steam chamber as proposed in the paper might perhaps have some advantage, and he remembered some being so constructed under his superintendence for the Hanoverian railway.

Mr. Tosh had found great difficulty in preventing an injurious accumulation of sediment on flat-roofed fireboxes, even with $1\frac{1}{2}$-inch water spaces between the copper roof and the roof bars; any hollow form of roof must increase the evil.

* Paper read before the Institution of Mechanical Engineers.

INSTITUTION OF CIVIL ENGINEERS.

Nov. 10.—ROBERT STEPHENSON, M.P., President, in the Chair.

The first meeting of the Session 1857-8 was occupied by receiving a Paper "*On Lighting Mines by Gas.*" By ALEXANDER WRIGHT, Assoc. Inst. C.E.

The Paper commenced by noticing the almost universal introduction of gas for the purpose of illumination, and the causes of the attention of the author being turned to its adaptation to the lighting of mines, where the present mode of employing tallow candles or oil lamps was found to be prejudicial to the health of the miners, whilst the light afforded was so inadequate that the men could not perform their duty properly. It was stated that the expenditure of oil and tallow in the mines of England might be roughly estimated at 500,000*l.* per annum. In Cornwall and Devon alone there were about 30,000 men employed underground, who were lighted at an annual expense of 90,000*l.* per annum; and in one of the large mines the annual expenditure for candles had reached as high as 7000*l.*

A general review of the state of lighting and ventilation of the Cornish mines induced the attention of the author to the introduction of gas for superseding candles and oil-lamps. Previously to this an attempt had been made at the Tresevean mine in Gwennap, but it was abandoned. He concurred that it was preferable to make the trial upon a mine where explosive gases were not given off, as in coal mines; and where the work was closer and did not extend so rapidly. The Cornish mines varied in depth from 1000 to 2000 feet, with extensive lateral galleries, the approach to which was by a shaft with ladders, sometimes twisted in all directions. Each miner in descending or in ascending stuck his candle in a lump of clay, by which it adhered to his hat; the wind caused it to flare, and not only to waste much tallow, but to give off carbonaceous substances, which were swallowed by the men, and produced very prejudicial effects on their lungs. The first object then was to light the ladders, and afterwards to extend the system to the working chambers following the lode. The mine selected for the experiment was the Balleswidden mine; the depth of the shaft was described as being about 780 feet, whence there branched out several levels and tramways, at various depths and in numerous directions. There were about 340 miners employed underground, in two changes or shifts, each of about eight hours' duration. Each man worked about five days of the week underground, and one day above ground. In the ordinary mode of lighting each miner burned four candles in eight hours, obtaining only an inadequate light for the expense incurred.

The gas which was introduced to this mine was manufactured at the surface, and was forced by a pump into a heavy gas-holder, composed of cast-iron plates, whence it issued by a descending pipe into the mine under a pressure equal to 18·7 inches of water. The shaft and levels were fitted with wrought-iron tubes, proved by high-pressure steam, and from the branches flexible tubes and burners were carried into the pitches and chambers for the miners, and to the floors for picking the ore. The tramways also had a sufficient number of burners to preclude the necessity for using any candles or lamps in the mine. The quantity of gas consumed was about 4000 cubic feet per day of two shifts of miners.

The comparative expense of the two systems of lighting was stated to be much in favour of gas; as the annual cost of candles was 834*l.* 3*s.* 4*d.*, whereas that of gas was 487*l.* 2*s.*, including interest on plant, wear and tear, and all expenses. If several mines combined the economy would be still greater; and when the system became more general, modifications would doubtless be advantageously introduced.

It was stated that the sanitary condition of the mine was visibly improved;—the ventilation was better, and there was an entire absence of the sickening smoke and bad odour previously pervading the mine, which the author believed to arise from some particular compounds of hydrogen and carbon, given off during the imperfect combustion of the candles.

The advantages to be derived from the introduction of gas in copper, tin, lead, and other mines (and, probably, ultimately to coal mines), were stated to be,—1. The saving of nearly 50 per cent. of the annual cost. 2. The better work, on account of the increased light. 3. The saving of time to the workman in not having the candle or lamp to attend to. 4. The improvement in the ventilation and in the quality of the air breathed by the miners.

The experiment was stated to have been completely successful, and there did not appear to be any reason why the system should not be extended to mines generally, and, under certain precautionary measures, to coal mines.

Nov. 17.—J. LOCKE, M.P., V.P., in the Chair.

The Paper read was "*On the Conversion of Wood by Machinery.*" By G. L. MOLESWORTH.

In briefly glancing at the history of wood conversion, the author noticed the early application of machinery for the purpose, and also the introduction of the circular saw, the planing machine, and the band saw. The inventions of Bentham and Brunel were mentioned as having contributed largely to the advance of this branch of engineering.

A comparison was then drawn, showing the more rapid progress of wood conversion in America than in England. This was ascribed to the greater cheapness of material and the scarcity of skilled labour in the former country, which gave a stimulus to invention; whilst in England the case was different, the material was comparatively expensive, and skilled artizans were abundant. Nor was the system of the subdivision of labour as yet fully carried out, the conversion of wood being hitherto in the hands of a class who could not employ much capital in machinery, or keep it constantly at work to the greatest advantage, even when they had it; and, at the same time, the prejudices of foremen and the combinations of workmen had operated powerfully against the introduction of new machines. Many of the machines of English construction had been of too costly a character, and in designing them sufficient attention had not been given to economy of the converted material. The cheap and simple character of the American machines was mentioned, and some of their characteristic details were described.

An account of the different kinds of saws, as well as the form of teeth, the modes of setting them, and the velocities adopted in England and in America was given, and the silent friction feed, the American "muley" saw, the author's arrangement of a revolving wedge, the methods of cross cutting, the pendulous saw, Macdowall's circular saw, the pendulum, the dished saw, the scroll and the band saws, were briefly described, and mention was made of Mr. Exall's improvements in the band saw.

The author then proceeded to enumerate the varieties of planing machines, which he classified under five heads, viz. :—

(1.) The reciprocating plane;
(2.) The fixed cutter plane;
(3.) The rotatory cutters, on Muir's principle;
(4.) Ditto with vertical axis, on Bramah's plan;
(5.) The socket plane.

In describing these machines, the action of the carpenter's plane was compared with that of the machines, and some of the methods were mentioned by which its action had been attempted to be assimilated in the machines.

The planing machines were shortly described, as well as the different forms and speeds adopted in England and America.

It was argued, that in order to produce good work the conditions to be fulfilled were, a high velocity of cutters, not too rapid travel of work, a solid bed to cut against, the working parts well balanced, the bearings steady, and the angles of the cutters properly determined. The author condemned the usual empirical method of determining the angle of the cutters, and insisted upon the desirability of taking into consideration the nature of the material, as well as the character of the work, and the diameter of the cutters, in fixing upon the proper angle. He then stated those angles which he considered best for different kinds of woods and varieties of work.

Brief descriptions and diagrams illustrative of the principles of the following processes and machines were then given :—

1. The American shaping machine, with pattern and concentrical collar guide, for planing irregular work.

2. The different methods of tenoning with chisels, or with an assemblage of circular saws, or with the ordinary tenoning cutters.

3. The copying machine for producing fac-similes of a cast-iron pattern of any irregular shape, by means of rotatory cutters made to recede or advance by the pattern, which revolves simultaneously with the work.

4. Hughes' spoke machine with tubular cutter-shaft, and moveable cutters, acted upon by a traversing pattern.

5. The railway key machine, invented by the author, for cutting the taper simultaneously on two sides of the key.

6. Steel's oar machine, as used at Chatham dockyard, for roughing out the oar with swivelling circular saws, and finishing it by a series of cutters acted upon by a "feeler iron," so as to produce a varying form of blade and "loom."

7. The methods of dovetailing on Wimshurst's plan, by a series of rotating cutters, and on Burley's plan by a series of reciprocating chisels and circular saws.

8. The method adopted in America of forming the dovetail on the mitre.

The different boring tools were then noticed, and an account given of the modes of mortising, by giving motion to the chisel and reversing it, as well as the forms of mortising chisels, and the devices for clearing the mortise of chips.

The subject of timber bending was briefly noticed, and a description given of Hookey's mode of bending ships' timbers, Meadows' patent for bending veneers into and around the sharp angles of mouldings, and Blanchard's method of bending all kinds of timber, by applying end pressure to it, while it was wound round a cam of the desired shape.

In conclusion, the author considered that wood conversion was not fully developed in this country, and hoped that this Paper would direct the attention and ingenuity of engineers to the subject.

Nov. 24.—An *Appendix* to Mr. Molesworth's Paper was read on this evening.

The manufacture of casks by machinery was cited as an example of a branch in which many failures had occurred, in consequence of the machines having been frequently designed without a view to effecting economy of material, so that the waste of valuable wood was not counterbalanced by the saving of labour. The best machines in use for performing the following processes in the manufacture of casks were briefly described.

The process of cutting up the "blanks" into staves, either by circular or by reciprocating saws, and of converting without waste irregular and twisted blanks into staves, by the use of weighted rollers pressing the work against an adjustable fence in the saw frame;—the cutting out "tonguers" and "doublets" by a travelling template, which determined the position of the fence; and the plan adopted at Deptford Dockyard, for irregular blanks, tonguers, and doublets; as well as the American mode of cutting staves for dry casks;—the process of jointing by moving the stave through a curved path in the direction of its length against circular saws;—Robertson's mode of backing staves, by passing them on a travelling platform under cutters; and Green's mode of passing them over a pair of cutters arranged on each side of a guide collar, whilst the stave was pressed down by a heavy fluted feed roller;—the processes of "trussing" on Rosenborg's principle, by a series of radial forcing levers, actuated simultaneously by screws, and on Robertson's principle by by means of strong cones into which the staves were forced by hydraulic pressure;—the plan of "crozing and chining" by turning the cask up on a vertical lathe, after trussing; or by passing each stave separately under cutters;—and the process of finishing the heads with an oval motion, to allow for shrinkage of the wood across the grain; thus completing the different processes in manufacturing casks.

Hamilton's machine for sawing curved ship timbers was described as having an inner gate, and the blade so hung as to allow of a transverse as well as a swivelling motion, for curvilinear work; the log being so arranged as to be turned on its axis whilst travelling, and to be cut to any desired bevil. Green's method of adapting an indicator roller to this machine for cutting variable bevils from a small scale diagram was also mentioned.

The largest circular saws were stated to be those used for cutting veneers from the log; their size, velocity, and mode of action were given, as well as the attempt to supersede them by a revolving knife-edge, with the causes of its failure. The Russian method of cutting veneers was briefly touched upon, as well as the reasons for its non-adoption in England; and also the French method, with a reciprocating knife-edge.

A description of Jordan's wood-carving machinery was given, with his method of producing a species of floating movement in the table carrying the pattern and the work under a frame furnished with a series of drill-cutters and a tracing-knob, so as to produce several copies simultaneously from one pattern; the plan of carving under-cut parts by swivelling the pattern and work simultaneously was also described.

The Appendix concluded with an account of Messrs. Ransome and May's manufacture of compressed railway keys and trenails, and also of the mode adopted in her Majesty's dockyard, Portsmouth, of shaping trenails cleft from timber of irregular or twisted grain.

A description was given of Wilson's machinery at the Midland Counties Timber Company's Works at Banbury, for the conversion of wood into mop and broom handles, of which very large quantities were manufactured. Cylindrical gouge cutters were used, so that by turning them gradually in their sockets they always presented a cutting edge, which would work for sixteen hours without sharpening, and a tool would last three months. The surface produced was excellent, and the machine was now about to be used for making pencils.

The carving machinery invented by Mr. Jordan, and used for the decorations of the New Palace at Westminster, was alluded to; and a description was given of the ingenious machines, also invented by him, for making the frames of school slates, at Colonel Pennant's quarries near Bangor. The logs of American birch were first cut up by frame saws; the planks were then seasoned for six months, and were afterwards cross cut to proper lengths,—passed over a series of circular saws and grooving cutters alternately fixed on the same shaft,—the mortises and tenons were cut in two other machines,—the end mortises, tenons, and shoulders were then cut, and the slates encircled by four of these pieces. The frame thus formed was then laid against two stops, and a pair of drills descended upon the opposite corners, making two holes; it was then reversed, and another pair of holes were made in the other two corners; pegs were inserted, and the work was completed. Up to that point, the result was excellent, but it had been found impossible entirely to finish the work with the delicacy with which the human hand could do it. In all such machinery the vital importance of high speed and perfect balance were insisted upon, and many curious instances of failure resulting from neglect of these points were given.

Messrs. Ransome and May's trenail and key machines were further described, and the advantages of the pendulum saw for cross cutting were strongly insisted on.

Green's stave-cutting machinery was explained, and the great quantity of work which could be executed by it was shown.

It was announced that the discussion would be continued at the next meeting, Tuesday, December 1st, when the monthly ballot for members would take place, and if time permitted, the following Paper would be read, "On Self-acting Tools employed in the Manufacture of Engines, and in Shearing, Punching, and Riveting Boiler Plates," by T. S. Sawyer.

INSTITUTION OF MECHANICAL ENGINEERS.

Nov. 18.—SAMUEL LLOYD, Esq., in the Chair.

"*Description of Naylor's Improved Steam-Hammer.*" By CHARLES MARKHAM, of Derby.

In this hammer in addition to the steam being admitted underneath the piston to raise the hammer, as in the ordinary construction, it can be let on also above the piston, so as to increase the force of the blow given by the fall of the hammer, according to the pressure of the steam. This is effected by means of two cylindrical steam-valves, one at each end of the cylinder, fixed on the same spindle, the upper one having openings on opposite sides only; and by turning the valve round in its seating by a hand lever, the openings in the valve can either be made to coincide with those in the port, so as to admit steam upon the top of the piston to any desired extent, or can be so placed as to exclude the steam entirely from the top of the piston, as in ordinary hammers, thus working the hammer either double-acting or single-acting. The valve is worked up and down by means of rollers fixed on the hammer block, which, as the hammer rises and falls, strike against two projecting wedges, connected with the valve rod by levers; by adjusting the height of these wedges, the length of stroke of the hammer is regulated as desired. The adjustment of the wedges is effected by hand levers, instead of by the ordinary screw gear; the working can thus be altered quickly and easily, the valve being nearly in equilibrium, and offering little resistance to being moved. By admitting the steam above the piston, a much greater number of blows is obtained in the same time with the hammer than by the ordinary steam-hammer, giving the advantages that so much more work can be done in one heat, and the force of blow can be increased when required for large forgings. This hammer is also intended to be applied to riveting thick plates of iron, in order to gain the advantage of quick light blows at first, with heavy finishing blows to complete the rivet.

"*On Lighting Railway Trains with Gas, with a description of Mr. T. J. Thompson's System.*" By J. Kitson, of Leeds.

The use of gas for this purpose possesses important advantages over oil, in the constant brilliancy of the light, saving in expense of lighting, and also saving by turning off the lights from unoccupied carriages; but the difficulties in practically carrying out the plan for employing it in railway carriages have hitherto prevented its adoption. The plan proposed in the paper is to have a travelling gas-holder in each train, fixed on the tender or the guard's van, the sides of the gas-holder descending in a narrow water space all round, avoiding the oscillation and weight of water that would attend the use of a large quantity of water as in the ordinary construction of gasometers. The supply pipe of each carriage is connected by a flexible tube with coupling joints, the couplings being constructed so that in the act of un-coupling, or in accidental breakage, the communication between the carriages is cut off, and the gas is thereby prevented from escaping; a flap-valve is placed at the gas-holder preventing any return current of the gas in consequence of oscillations. The lights are kept in for a considerable time. when the carriage is detached and cut off from the gas-holder, by means of an elastic bag, which gradually contracts with a slightly decreasing pressure. The gasometers to supply the trains at principal stations are of ordinary construction, but having a shallow tank of water on the top, in order to give an increased pressure for forcing the gas rapidly into the travelling gas-holder; the station gasometer is first filled from the gas main at the ordinary pressure, and the water is then let in to the tank on the top of the gasometer to increase the pressure.

"*Description of a Ventilating Apparatus for Buildings,*" *&c.* By SAMUEL THORNTON, of Birmingham.

In this apparatus, which is the invention of Mr. Charles Watson, of Halifax, the fresh air is introduced at the top of the building or place to be ventilated, allowing of its diffusion over the room as it gradually descends, and admitting of a simple arrangement being employed for the purpose of the supply and discharge of air, convenient of application and regulation. The ventilator consists of a vertical tube, divided into two passages by a central partition, with a regulating damper or valve at the bottom; one half of the tube rises slightly higher than the other, which is found sufficient to determine the passage of the heated air up through the longer, while the cold air passes down through the other. Two regular currents of air are thus maintained, and a continuous change of air is carried on, without objectionable draughts or currents of cold air. This ventilator has been successfully applied to drying houses of dye-works, &c., and proves completely efficient in removing the constant vapour ordinarily experienced there; it has also been employed with advantage in ships, and found to preserve ventilation whilst the hatches were fastened down for several days during a storm.

ROYAL SCOTTISH SOCIETY OF ARTS.

Nov. 23.—George Wilson, M.D., President, in the Chair.

The President opened the session with an introductory address, which was ordered to appear in the Transactions of the Society.

The report of the Prize Committee, awarding the prizes for session 1856-57 was read, and the prizes delivered by the President to the successful candidates, viz.:—

1. To Professor C. Piazzi Smyth, F.R.S.E.,—for his Communications (1st), "On the Angular Disturbances of Ships, the measurement of their amount, and elimination of their effects;" and (2), his "Experiences with his Free Revolver Stand for a Telescope at Sea, and his Naval Clinometer, during a voyage to Teneriffe in the summer of 1856."—The Keith prize, value thirty sovereigns.

2. To James Melville Balfour, C.E., Edinburgh—for his "Description of a Refraction Protractor, and on its application to the designing of the Prisms employed in Lighthouse Apparatus." The Society's Silver Medal and Plate, value fifteen sovereigns.

3. To John Zuill Kay, gas engineer, Dundee—for his description of "a Gas Hood, or apparatus for enabling a person to enter a gasometer full of gas, or any chamber filled with noxious air, without injury."—The Society's Silver Medal and Plate, value ten sovereigns.

4. To Thomas Login, F.R.S.E., C.E.—for his "Short Description of the Ganges Canal."—The Society's Silver Medal.

5. To Ralph and William Moore, mining engineers, Glasgow—for their "Description of Combined Pumps (to raise water from pits), without Clacks.—The Society's Silver Medal."

6. To Henry Craigie, Falcon Hall—for his "Notice and Specimens of durable and indelible Labels or Tallies for Plants."—The Society's Silver Medal.

7. To Robert Trotter, engineer at Donaldson's Hospital, Edinburgh—for his "Description of a Self-acting Ventilator, for Private Rooms, Offices, Halls, Hospitals, &c."—The Society's Silver Medal.

8. To Daniel Campbell, forester at Wemyss Castle, Fifeshire—for (1st), his "Description of Improved Iron Rake," for uprooting weeds left untouched by the Dutch hoe, and for thinning and weeding onions or carrots in rows, and making the rut in drilling; and (2nd), "Description of his Improved Pruning-Bill," combining the bill, saw, measuring-rod, and walking-staff.—The Society's Silver Medal.

9. To Henry Kerr, watchmaker, Edinburgh—for the superior workmanship displayed in the execution of an Electric Clock Pendulum, exhibited by him on 13th April, 1857—The Reid and Auld Prize, value three sovereigns. *Note.*—This prize is awarded by the committee, not for the pendulum, but for the superior workmanship shown in it, the Reid and Auld Prize Fund being for awarding superior workmanship exhibited in anything new in the art of clock or watchmaking by journeymen or masters.

Pressure-Gauges.—At the West Riding Geological and Polytechnic Society, Mr. W. S. Ward (hon. sec.) read a Paper from Mr. W. H. Bartholomew, C.E., resident engineer of the Aire and Calder Navigation Company, "On an Improvement in Pressure Gauges." A model was shown, and it appeared that the improvement consisted in an index-finger being attached to the inside of the glass face of the steam pressure-gauge, which was moveable forwards by the dial-finger of the gauge, and would thus show the highest pressure attained. Thus, supposing an engine-driver on a railway, in order to make up lost time, put on a great pressure during his journey, the index-finger would show at the end of his journey the highest pressure to which the engine had been subjected. The adoption of such "tell-tales," as they were termed, would thus, in case of railway accidents, be of great use in deciding upn the cause.

ARTESIAN WELLS.

The necessity for an abundant supply of wholesome water to the metropolis has become so urgent, that it behoves us at once to see how it can be best obtained. It cannot be procured by the present mode of abstracting our drinking water from the polluted Thames, even at Teddington, above which point the increasing contributions of sewage from some fifty towns and villages, commencing with Oxford and extending to Teddington, enter the river. It is true the water at Teddington is apparently pure; but it is so only to the eye even after filtration. The evil may be denied and palliated by interested water companies, but the fact cannot be disproved.

In low-lying districts, such as Bermondsey, Camberwell, Deptford, Lambeth, Wandsworth, for want of free and deep river tunnel conduits the sewage waters are driven back by tidal influence, and percolate through the various strata, finding their way into the wells of these districts; so that not only the river waters, but the well waters, are highly charged with the sewage.

The best mode of obtaining pure, soft, wholesome water in abundance, is undoubtedly by artesian wells, the success of which in France, and lately in the deserts of Sahara (see "Society of Arts Journal," Oct. 14th, 1857, page 649) has been proved; and it only requires the adoption of artesian wells to secure equally satisfactory results in our metropolis. The subject of artesian wells has been repeatedly alluded to in this *Journal.* Mr. W. Austin has devoted considerable attention to it, and has had the co-operation of Mr. D. Greenley of Pentonville, who for forty years has been engaged in the execution of such works.

There are no impediments to the general introduction of artesian wells in the metropolis. All that is required is the judicious application of capital to secure great results. It is much to be wished that the abandoned Artesian Well works at Kentishtown should be resumed, extending the boring three or four hundred feet.

REVIEWS.

Reports of Cases relating to Letters Patent for Inventions. By Edmund Macrory, Esq., of the Middle Temple, Barrister-at-law. London: Benning and Co. 1857.

Mr. Macrory, a gentleman of the bar, of great experience in Patent cases, has commenced a series of reports of cases relating to patents decided in the Courts of Law and Equity, and before the Judicial Committee of the Privy Council. Part I. contains reports of the following cases:—Harrison's Case, in which a claim to a machine has been construed by the Court of Common Pleas as extending to each of the parts of which it is composed.—Tetley's Case: this was an action for the infringement by Messrs. Easton and Amos of an invention for certain improvements in machinery for raising and impelling water and other liquids, and also thereby to obtain mechanical power. A verdict was entered for defendant. On application by plaintiff for a new trial, the Court of Queen's Bench held, that parts of a machine described and not disclaimed, must be deemed to be claimed.—Bateman and Moore's Case: in this case the Court of Exchequer held, that pleas to the novelty of an invention do not put in issue the sufficiency of the specification.—Cutler's Case: the Court of Queen's Bench in this case decided that the new use or application of an old article is not the subject of a patent, also that when two modes of performing an invention are described, one of which is useless, the patent fails.—Bush's Case: in this the Court of Exchequer decided the same point, that a patent for a mere new application cannot be supported; also that a claim to a machine for a purpose described, imparts a claim to the machine itself, irrespective of its application.—Day's Case: the Queen's Bench in this case decided, that when a patented invention consists of a new mode of making a piece of mechanism, the use or imitation of any material part in the making of a similar piece of mechanism is an infringement of the patent, although all the other parts are performed in a different manner.—Thompson's Case: the Lord Chief Baron at the trial of this case, ruled that a patentee may be asked what he took his patent from, and that the specification is not conclusive evidence of that for which the patent was obtained. Two cases with the forms of application for leave to enter disclaimers are given in Part II. These reports are illustrated with wood engravings, which enable the reader to clearly understand the points in issue.

MANUFACTURE OF PROJECTILES.

John Coope Haddan, C. E., *Patentee*, April 9, 1857.

(*With Engraving, Plate* XXXII.)

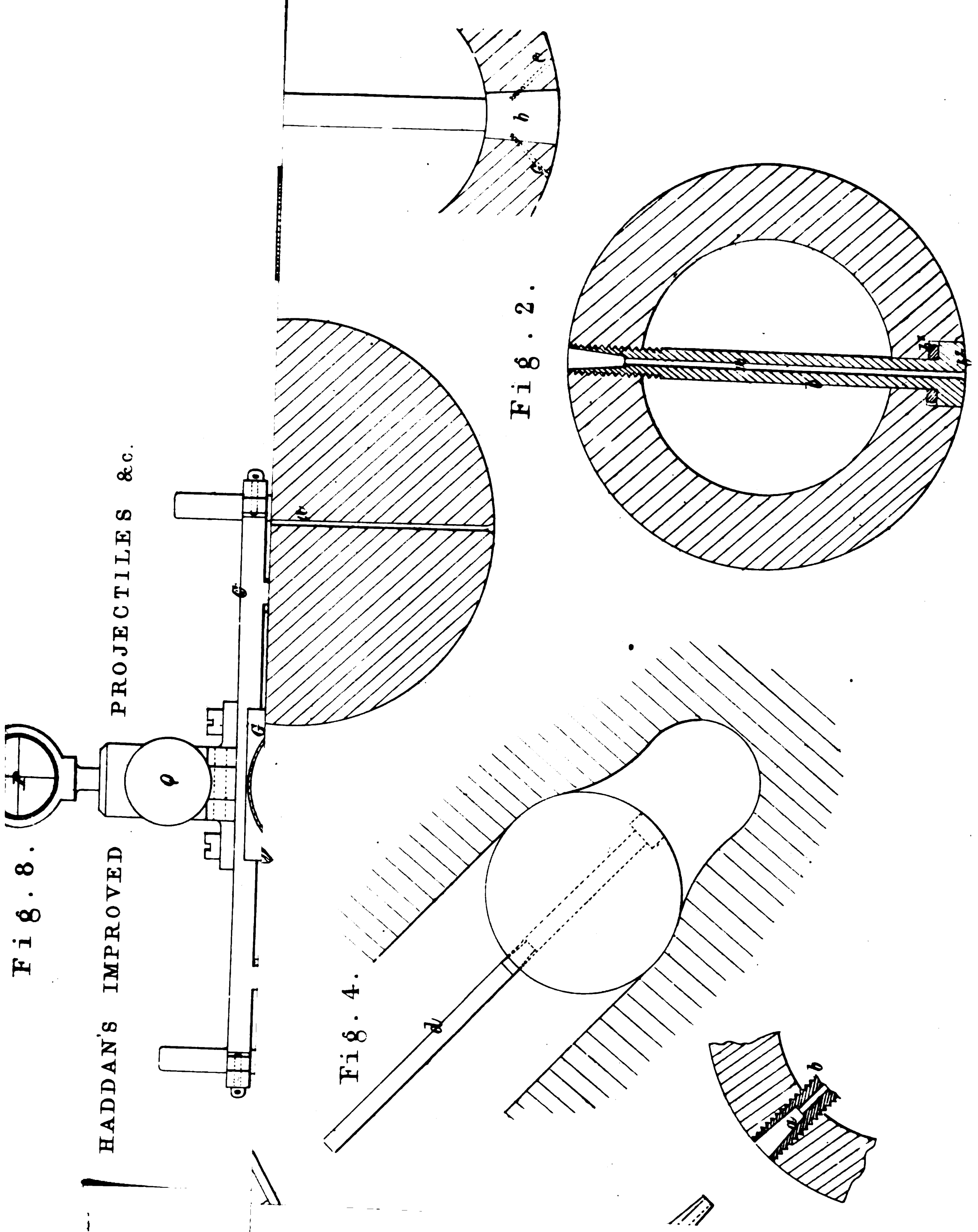
This invention consists, firstly, in manufacturing projectiles with touch-holes, openings, or channels through or upon them, for the purpose of igniting from the muzzle of a common mortar or gun the powder or charge employed for the propulsion of the projectiles, and in discharging such projectiles by means of electric wires or fuses, or other equivalent means, inserted through such touch-holes, openings, or channels either before or after placing the projectiles in the cannon, mortar, or gun.

The following figures illustrate the manner of performing this part of the invention. Fig. 1 is a section of an improved solid shot, similar to an ordinary solid shot, with the simple exception of the hole, opening, or channel *a*, which is formed either at the time of casting or may be drilled in it afterwards; fig. 2 is a section of an improved hollow shot or shell, also of the ordinary description, the tube *b*, screwed into it for forming the channel *a*. b^* is a leather or other washer for the collar b^2 of the tube to bear against, so as to make a tight joint. Fig. 3 is a section of part of an improved shell, similar to that shown at fig. 2, excepting that instead of a screw fitting for the tube *b* a taper fitting is adopted, and the tube is fixed by two small screwed pins *c*, *c*. Fig. 4 is a sectional view of the chamber end of an ordinary mortar, showing the method of firing the improved projectiles. For this purpose, a small stick *d*, is employed, as seen at fig. 5 opposite to the channel *a* of an improved shell, the upper end of the channel being enlarged (as represented here, and also in figs. 1 and 2), for the purpose of receiving the lower end of the stick, which is to be placed into it before firing. It is to be understood that the stick has a hollow passage or channel through it, as indicated by dotted lines in fig. 5, and that this channel, and also the channel *a* in the several projectiles, are to be filled with powder or any suitable igniting composition either at or immediately before the time of firing, or previously, so as to be ready for use when required. The discharge is to be effected by means of an ordinary fuse, placed on the end of the stick when required, or by a light applied directly to the end of the stick, or by means of an ordinary quill and lanyard; or the tube may have wires previously fixed or placed therein for the purpose of firing by electricity. The patentee prefers to make one wire hollow or tubular, or of an U-shaped section, so as to lap round or inclose the other, and they are to be insulated from each other with a gutta percha or other covering, and united with a fine wire or small strip of platinum at the point intended to be inserted into or next to the composition or powder, for the purpose of igniting it when the platinum becomes heated by the passage of electricity along it. The wires are intended to pass completely through the stick, and down and protruding through the channel *a* in the projectile, (which channel is not to be filled with powder or composition when electric firing is intended), and so as to become inserted in the propelling charge employed in the chamber of the mortar.

The second part of the invention consists in discharging projectiles (whether manufactured as above set forth or otherwise) the more accurately in any required direction by means of an improved single or double telescope or sighting tube, or apparatus fitted with legs, limbs, standards, or supports (adjustable or otherwise) jointly with pointed or V surfaces of contact, for resting in corresponding holes, grooves, or notches in or upon the cannon or gun, so that the legs, limbs, standards, or supports may be removed with the telescope or sighting tube or apparatus itself from the cannon or gun immediately before discharging it. The following is the manner of performing this part of the invention. Fig. 6 is a side elevation of an improved apparatus adapted for the purpose referred to; fig. 7, a plan view; and fig. 8 an elevation of one end of the same. A is an ordinary telescope fitted with "cross hairs," intended to be seen or looked through in the direction denoted by the arrow B, in figs. 6 and 7; C is a frame at one end; and D, a frame at the other end, in which the telescope A is mounted; both frames admitting of vertical adjustment by means of the screws E, E, and the screw F respectively. The method of mounting in the frames is by means of slides G and H respectively, the slide G allowing a horizontal adjustment of the forward end of the telescope within the frame C, so as to turn or direct it in any horizontal direction (within certain limits) from the frame D as a centre, as denoted by the arrows I, I, in fig. 7. K is a rack fixed to a frame C, and L the handle of a pinion gearing with it for effecting this adjustment. The apparatus generally is intended to be made of brass or gun metal, but the adjusting screws E, E, which form two out of its three legs or feet, terminate in steel pins or points E*, E*. The third leg or foot M, which also has a steel pin or point M*, is fitted to the frame D so as to be adjustable therein, for the purpose of fixing the points by means of the clamping screw M^2 at the same distance from each other under varying positions of the vertical adjustment, in fact, so as to adapt it to register correctly under the varying circumstances mentioned within small holes made for their reception in the cannon or gun, for the more accurate discharging of which the apparatus is intended to be used. P is a cross telescope of ordinary construction, likewise fitted with "cross hairs," and mounted upon the frame C by means of a ball and socket swivel joint, which allows it to turn completely round, and also affords considerable vertical adjustment, and Q is a clamping screw for fixing it when adjusted. Spirit levels may be fixed on one or both of the telescopes. The mode of using the apparatus is as follows:—The cannon or gun having been directed or laid, the apparatus is to be placed upon it with the feet or points E*, E*, and M* resting in the corresponding holes, one of which (intended for the point M*) may be the touch-hole of the cannon or gun. The telescope A is then to be directed so that its "cross hairs" may coincide with some fixed object forwards, or somewhat in the intended direction of firing, and likewise also the telescope P is to be or may be directed so that its "cross hairs" may coincide with some fixed object lying at right angles or obliquely with regard to the direction of the telescope A. The various clamping screws are then to be fixed and the instrument carefully removed, when the cannon or gun may be discharged without injuring it. If the shot or shell should have struck or reached the exact intended destination, the apparatus being carefully replaced upon the cannon or gun, will afford the means of directing or laying it exactly as before, for which purpose it must be shifted or moved until by inspection through the telescopes the cross hairs are found again to coincide with the fixed objects to which they were originally directed. If the direction of the shot or shell should prove incorrect, repeated alterations of the position of the cannon or gun are to be made and repeated adjustments of the telescopes made till a successful result is obtained. The more particular object of the telescope P is for fixing the direction when the forward view commanded by the telescope A is clouded with the smoke of repeated discharges. It is to be remarked, that instead of pointed feet, V-shaped feet or surfaces of contact may be substituted, the holes in the cannon or gun being replaced by grooves or notches to correspond.

This invention has reference, thirdly, to the manufacture of projectiles which consist jointly of a projectile and a wad, the projectile tapering towards its tail end, and the wad being readily separable from the projectile. Or, this part of the invention may be considered as a means of or an apparatus for discharging projectiles; in either case the projectile intended being of a more than ordinary length, or the angle of the tail end being such as to render inapplicable or inconvenient the ordinary or hitherto published methods of applying the wad. And this said part of the invention consists in interposing between the back or tail end of the projectile and the wad a metal plate, disc, or cup, so constructed as to maintain the tail end of the projectile in the centre line of the bore of the cannon or gun, and receive the pressure of the wad against it, and either so that rotation may thereby be imparted to the projectile or otherwise, but in all cases so as that the projectile itself may readily leave both the plate, disc, or cup, and the wad behind it in its flight. The following figures of 9 to 12 illustrate the manner of performing this part of the invention.

The fig. 7 represents the general idea, use, and application suggested by the foregoing definition. The dotted lines *m* indicate a longitudinal section of the bore of an ordinary cannon or gun. *n* is the elongated tapering projectile proper (in exterior view); *o*, the separable wad (in section); and *p*, the interposed "metal plate, disc, or cup" (in section), here represented as of a conical form. The cross section of the projectile, fig. 10, and the reference letters *q*, *q*, *q*, are intended to show that it may have the swellings or projections upon it, as set forth in a former specification of the patentee bearing date the 30th day of October 1854. Fig. 11 is a detached view of the extreme tail end of the projectile, the reference *s* in this figure, and also in other figures, denoting an iron rod employed when the projectile is made of lead or soft metal, for the purpose of strengthening it, (the metal



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... or soft metal, for the purpose of strengthening it, (the metal either being cast around the iron rod, or the rod being afterwards fitted in the projectile). The front end of the rod is pointed, the intention being, that in the event of its becoming driven or forced further into the projectile it may cause it to expand slightly at its greatest diameter, and force the swellings *q*, *q*, *q*, more tightly into the bore of the cannon or gun; the back end is also pointed to fit against the conical plate *p*. When the projectile is made of hard instead of soft metal the rod is not required.

The patentee shows other slight modifications, such as the conical plate being presented in a reverse direction, in the form of the frustrum of a cone instead of a complete cone. He observes in all cases that the tail end of the projectile corresponds with the plate, and the wad is also to be of a suitable corresponding form. The operation of the disc and wad is to keep the tail end of the projectile in the centre line of the bore of the gun. It is to be noted, that the plates, discs, or cups may be formed either of iron, brass, or other suitable metal or material by punching, casting, or in any other convenient manner, and also that they may have any other suitable form or proportions than those represented; and also that there is no special feature of novelty in the material or mode of making the wads, which may be as heretofore, excepting only that they require to be of a shape corresponding with the particular form or plate, disc, or cup which is employed.

ARCHITECTURAL COMPETITIONS.

Mr. Edward Mallandine lately read a paper before the Architectural Association, on "Architecture and its connection with Competition." A discussion ensued, in the course of which Mr. Wigley observed that, it was the duty of the Association to draw up and establish a code of competition, which should be sent for approval to other societies at home and abroad, and with this view he proposed the following resolutions:—

"1. That Messrs. Billings, Capes, Colling, Gray, Hayward, Rickman, Truefitt and Young, with power to add to their number, be requested to join the members of the committee, to revise and publish a new competition code, first printed by the Association in 1850.

2. That it be made binding on all members of the Association, present and future, to sign the competition code when approved by a special general meeting, after the code has been read at a previous meeting; and that any breach of such code shall render the members liable to exclusion from the Association,

3. That the competition code be published by means of a loose sheet inserted in the professional papers once every year.

4. That a copy of the competition code be forwarded by the secretary of the Association to every competition committee, with a request that it be adopted, so as to allow of the members of the Association taking part in the competition.

5. That a special competition fund be raised by the Association from among its members and their friends, to carry on the expense of publishing.

6. That every member of the Association, who is also a member of the Institute, be invited to concur in a memorial to the council of the Institute, representing what has been done and resolved on by the Association, and calling upon the Institute to do the same.

7. That the same invitation be sent by the officers of the Association to all the other architectural associations, at home and abroad; and that either the president or the secretary of the Association, or both, be requested to communicate with the local and professional papers, in the name of the Association, whenever any defects on competition judgments are pointed out to them, or come under their notice."

Mr. Benwell seconded the resolutions; and after remarks by Mr. Capes, Mr. Rickman, Mr. Lloyd, and Mr. Bunker, the resolutions were carried.

Signor de Cristoforis lately exhibited at the Institution of Civil Engineers, an apparatus proposed for aiding in the ascent of steep inclines. The system consisted in attaching to the periphery of the driving wheels of the engine a number of small wheels, which, abutting against a series of cogs connected with the rails, it was assumed would constantly support the train in its ascent.

NOTES OF THE MONTH.

The Manchester City Council have elected Mr. James Gascoigne Lynde, of Westminster, to the office of city surveyor, at the salary of 750*l*. per annum. Mr. C. E. Cawley, of Manchester, and Mr. G. W. Stevenson, of Halifax, were also proposed.

The New Corn Exchange, Didcot, has been opened for business though not yet completed. The exchange is very close to the covered station at Didcot. The contractors are Messrs. Domvelle, of Greenwich; and the architect is Mr. R. G. Fisher, jun. of Westminster. The building is being carried out under the superintendence of Mr. W. E. Crake, of London. The estimate was 1011*l*.

The King of Denmark has conferred the order of the Danebrog upon Mr. Paton, civil engineer, for his pamphlet on the Jutland Railway, and other services. This is the second time during the present reign that this order, the highest but one in Denmark, has been given to an Englishman; Sir S. M. Peto having been invested with it on the occasion of the opening, by the King of Denmark, of the Royal Danish Railway.

From Colonel Serrell's plan for the proposed suspension-bridge at Clifton, it appears that the span of the structure will be 703 feet, and the principal supports iron-wire cables, of several thousands of strands of the best and strongest iron wire, about the size of a common quill-pen each. They will be done up in bundles, and wrapped round with soft wire. From these wire cables the platform will be suspended. On either side of the roadway a parapet of timber is to be built, 5 feet high. The cables, although of wire, are composed of great numbers, and are bound together in solid masses: it is intended to have so many strands that, collectively they will carry seven times their own weight and the weight of the suspending-rods and roadway, and seven times as much weight upon the roadway as it would have upon it if filled quite full and crowded with people. The cables will be carried over the towers, and secured in anchor-pits on the rocks, in the usual manner. Each separate strand is to be coated with a varnish, made of unoxidizable material, and the interstices between them are to be filled with boiled linseed oil, and the oxide of Franklinite, which cements them into a solid, elastic, and waterproof mass. The roadway is to be 19½ feet wide, and similar to the flush-deck of a ship, the planks being laid lengthwise. The beams are to be of hard pine, and the flooring of spruce. The parapet, 5 feet in height, is to be in the form of trusses, fastened by iron bolts at the section of each panel of the truss, and, inside of this, an iron network is to be secured. There are now in use four heavy wire suspension-bridges, each of much longer span than the Clifton. They are the Lewiston Niagara Bridge, 1042 feet span—the longest in the world—and erected by Colonel Serrell in 1850; the second, 1010 feet span, over the Ohio river, at Wheeling, built by the Hon. C. Ellet, in 1848; the third at Friburg, 870 feet span engineer, Mons. Challey, built in 1834; and the other is over the Niagara at Bellevue, 758 feet, begun in 1848, by Mr. Ellet, and finished in 1855, by Mr. Roebling.

The town council of Ipswich have agreed to a plan of sewerage submitted by Mr. Peter Bruff to the sewerage committee, and recommended by them for adoption by the council. Mr. Bruff proposes the formation of a main intercepting sewer equal to 2½ miles in length, and other works. The estimated net cost of executing the whole, including outfall works for storage of storm-waters, lateral sewers and street drains, but exclusive of compensation to owners and occupiers of private property, is 25,794*l*. of which sum 21,479*l*. is for Ipswich town, and 4315*l*. for Stoke suburb. Compensation, &c., inclusive, the probable expenditure in all is estimated at 30,000*l*.

Several improvements have been and are about to be effected in Hyde Park; fresh roads and paths and flower beds are being made, which will add materially to the beauty of the park. Opposite Albert-road a new entrance, with a lodge, is about to be erected by the proprietors of the adjacent property, who will be answerable for any expense that may be incurred in making the fresh road. The new lodge at Cumberland Gate is nearly completed, and an illuminated clock is about to be put up, similar to the one at the lodge at Hyde Park-corner. The principal improvement completed since last spring is the formation of a walk nearly three-quarters of a mile in length, running parallel with the Bayswater-road from the Marble Arch to Kensington Gardens. On each side of the path there are wide beds filled with some thousands of shrubs, which, when they are sufficiently grown, will make this walk the finest in the park. Before the formation of these beds the difference of the height from the top of the wall to the ground was six feet; it is now reduced to an average height of about two feet and a half, the beds being so formed as to slope inwards towards the park. This portion of the park was considered a great eyesore, and was a complete nuisance; it will now be one of the most favourite walks. During the autumn a similar walk has been made from the Marble Arch along the front of Park-lane as far as Stanhope Gate. This will be completed in the course of a few days, the beds having been already planted and the pathway being nearly made. The walk will be nearly half a mile in length, and will form a continuous promenade with that already referred to. It is also proposed to introduce into these beds a number of rhododendrons and other American plants, and in the spring a quantity of half hardy plants, so that in fact these paths will be very similar to the most favourite walks in Kensington Gardens. It is also proposed next year to form a walk of the same description from the gate at Hyde Park-corner to the new entrance at Albert-road, but before this can be accomplished the House of Commons' pulse will have to be felt; and when it is seen what has been accomplished with the little money in hand they will probably be disposed to be a little more liberal.

A railway called the Eden Valley Railway has been projected. This line will commence at Clifton, near Penrith, on the Lancaster and Carlisle line, and extend to the South Durham and Lancashire Union Railway (now in course of construction), at Kirkby Stephen. By this railway the produce of the Durham coal field can be readily conveyed to extensive districts of England and Ireland which have hitherto been supplied with an inferior quality of coal, at a comparatively high price. The gradients upon the line are favourable, the works of an easy character, and the traffic from coal, coke, lime, and minerals, together with passengers and merchandise, will, it is believed by the promoters, be fully remunerative to the shareholders. The line will be twenty-two miles in lenght, and the capital proposed to be raised is 135,000*l*.

In reporting upon the tunnelling of Mount Cenis, M. Ranco, chief engineer of this stupendous work, has communicated the following data to one of the French periodicals:—"The tunnel will extend to the length of 12 to 15 kilomètres, and as man has never before gone so far into the entrails of the earth, the march is towards the unknown. The next difficulty is the rather large lake situated at the top of Mount Cenis, and the level of the tunnel has been laid so deep for avoiding the danger of these waters percolating to a surface composed of loose sand. The great height of Mount Cenis and the lake prevent the piercing of air shafts for ventilation. Two parallel galleries, communicating with each other, are intended to obviate this inconvenience. Conjointly with the explosion of mines, a huge machine (shield) will operate the work of piercеage. It is calculated that six years' time, and forty millions of francs will be required for completing the perforation of the Alps. The company, "Victor Emmanuel," think that they will thereby obtain the largest share of the traffic of France with Italy and the East. Victor Emmanuel, considering that this is a work interesting to humanity, is disposed to give the half of the above sum from the revenues of the state, and the company has to pay the other half—but only when 4 kilomètres of the tunnel have been completed."

At the Bristol Mining School, the first lecture of the session was given by Mr. Thomas Austin, C.E., on "Surveying and Drawing Instruments." Much importance was at one time attached to the introduction of several wires into the warp of the wire tape; but as these wires were necessarily converted by the woof into helices in the process of manufacture, this tape was more liable to stretch than the ordinary tape. The double linen tape, with ribbed warp, was the least objectionable of any of the tapes, and was very useful in taking offsets, or amongst buildings or other intricate work. The American rule was an implement usually made in yard or two yard lengths, in pieces of horn or whalebone, four or six inches long, about half an inch wide, and one sixteenth of an inch thick, and made to adhere together by the application of thin glue: they were then reduced to their proper form, and the inches marked off upon one of their surfaces: at these marks a hole was drilled, through the entire number, and a silver wire drawn through the holes. These, when completed, were remarkably correct.

COMPETITIONS.

Plans are required for the enlargement of the Workhouse at Stapleton, Bristol. Premiums, 30*l*. and 20*l*. Particulars may be had of Mr. W. B. Wilmot, clerk to the guardians, St. Peter's Workhouse, Bristol. To be sent in by the 5th instant.

The Town Council of Walsall are desirous of receiving plans and estimates for the erection at Walsall of a Free Library. The building to comprise a room for the library, a lecture-room, a reading-room, and a house for the librarian. The total cost to be about 1000*l*. No premium, but the usual commission to the successful competitor for superintending the erection of the building. Designs to be sent to Mr. Samuel Wilkinson, jun., town clerk, by the 16th instant.

The Burial Board of Ashford, Kent, are desirous of receiving plans, designs, and specifications, with estimates, for laying out and enclosing the new Burial-ground, including the erection of an entrance-lodge, boundary-fences, the planting, and necessary roads. Premium of 20*l*. for the approved plan. A plan of the ground, and any other information, may be obtained on application to Mr. Robert Furley, clerk to the Board, to whom the plans are to be forwarded by the 19th inst.

Designs are invited for the erection of Public Baths at Halifax. Premium fifty guineas. Particulars may be obtained of Mr. G. W. Stevenson, the borough engineer, Halifax, Yorkshire.

Plans, with specifications and estimate are invited for forming and laying out an additional Churchyard at Harrow, Middlesex. Premium, 15*l*. Information may be obtained of Mr. W. Winkley, jun., vestry clerk, Harrow, to whom plans must be sent by the 1st January next.

The Local Board of Health for the Minster District, Isle of Sheppey, are desirous of supplying the inhabitants of Sheerness with an abundance of spring water in their respective houses; and invite the attention of engineers to the subject. A premium of 100*l*. for the Plan, Specifications, and Estimates of requisite works is offered. Plans to be sent in by the 1st of January next. For particulars apply to Mr. Chas. Atkins, 20, Albion-place, Mile-town; or to Mr. James Beal, Sheerness.

Plans, with estimates, are invited for a College to be erected at Rawden, about midway between Bradford and Leeds, for the Northern Baptist Education Society. Premiums 50*l*. and 25*l*. Information may be obtained on application to Mr. Henry Dowson, Secretary, Horton College, Bradford. Plans to be sent in by the 27th of January next.

Drawings or models of designs are invited for the erection of a Memorial of the Great Exhibition of 1851. Premium 100 guineas. The time for sending in designs is extended to February 2, 1858. A scale of 2 inches to the foot is suggested, but not insisted on.

Competitions Awarded.

The four designs for the Islington Vestry Hall which have received the favourable recommendation of the committee are "Utility," No. 50; "Con Amore," No. 46; "Whyttington," No. 57; and "A.B.C." The design having the motto "Utility" received the highest number of votes, and "Con Amore" the next, and to these two were accordingly awarded the first and second premiums, but in the words of the resolution, "for this purpose only, and without reference to the design that may be ultimately determined upon." The design "Utility" was by Mr. Henry Cooper, architect, of 7, South-square, Gray's inn; and "Con Amore" by Mr. Thomas Allom, architect, of Hanover Chambers, Buckingham-street, Strand.

In reply to an offer of a premium of 50*l*. by the London General Omnibus Company, for "the best model or design for a Break, to be worked by the driver, and applicable to the present style of omnibuses," 127 competitors sent in designs. The referees, Messrs. Joseph Wright, Gowar, and Miller, have made their award, and selected for the premium the model No. 1, by Mr. Thomas Barker.

The Brighton Pavilion competition committee have awarded the first premium of 100*l*. (a second of 100*l*. to be given on a tender for the work being accepted, or it being abandoned) to "Unity is strength," and 50*l*. to "Cavendo Tutus," both on condition of a declaration that the work can be done for 10,000*l*. The authors of the design marked "Unity is strength," chosen as first in the competition, are Mr. W. J. Green and Mr. Deville.

Designs to the number of 120 were received for the new Cemetery at Belper, and those prepared by Mr. Edward Holmes, architect, of Birmingham, were unanimously adopted.

NEW PATENTS.

PROVISIONAL PROTECTIONS GRANTED UNDER THE PATENT LAWS AMENDMENT ACT.

Dated June 30.

1824. J. T. Pitman, Gracechurch-street—Improved method of making carburetted hydrogen gas. (Communication)

Dated July 27.

2044. F. B. Anderson, Gravesend—Mechanical slow match for submarine or other blasting and mining operations

Dated August 15.

2174. G. T. Bousfield, Loughborough-park, Brixton—Improvements in the preparation of dough for bread, pastry, cake, and other farinaceous articles of food. (Communication from J. Berry and E. Fitzgerald, New York)

Dated September 1.

2288. J. Taylor, Glasgow—Improvements in the construction and alteration of doors, shutters, blinds, and other closures to buildings and erections so as to allow of their illumination, which improvements are also applicable to omnibuses and other vehicles, and to clock-dials, lamps, and postal pillars

Dated September 2.

2300. T. Hardcastle, Bradshaw, near Bolton-le-Moors—Improvements in machinery for washing textile fabrics and fibrous substances

Dated September 15.

2392. T. Archer, jun., Dunston, Gateshead—Improvements in machinery for cutting off and heading lengths of metals, applicable to the manufacture of rivets and other articles

Dated September 21.

2448. E. B. West, Kent-terrace, Regent's-park—Improvements in the manner of preparing and applying materials used in brewing to that purpose, and in the various processes and apparatus used in connection with the same, and for novel apparatus connected with the same. (Communication)

Dated September 29.

2498. W. W. White and W. Bull, St. John's-square—Improvements in rollers applicable for blinds, maps, and other purposes

2502. R. Williams, Bishop's-road, Victoria-park—The manufacturing of soap with materials hitherto not introduced by any person in the chemical combination of various ingredients when manufactured known by the name of soap

Dated September 30.

2514. C. C. Creeke, Bournemouth, Hants—Improvements in the construction or manufacture of earthenware pipes

2516. W. Sandilands, Inveresk, Midlothian—Improvements in chimney cans or apparatus for promoting draught in chimneys
2517. W. Henderson, Bristol—Improvements in treating certain ores and alloys, and in obtaining products therefrom, and in recovering or producing all or part of the materials used
2518. J. Harris, Hanwell—Improvements in and connected with cocks and valves, especially adapted to preventing the bursting of water pipes from frost

Dated October 1.

2524. S. D. Hamilton, Great James-street, Bedford-row—Improvements in Jacquard machinery. (Communication)

Dated October 3.

2536. J. Dyson, E. W. Shirt, and H. Shirt, Sheffield—Improved straps or driving bands for machinery

Dated October 5.

2552. J. Combe, Belfast—Improvements in machinery for hackling and preparing flax and other fibrous substances

Dated October 6.

2555. E. Cavendy, New York—An instrument for taking zenith observations at sea (when the horizon is obscured) of any planet

Dated October 9.

2591. L. Pujol, Paris—Improvements in envelopes and letter paper

Dated October 10.

2597. C. N. Leroy, Essex-street, Strand—Preventing accidents and collisions on railways
2598. G. F. Lombard, Essex-street, Strand—Improvements in steam-engines

Dated October 12.

2610. P. B. Kyishogloo, Constantinople—Improvements in obtaining and applying motive power

Dated October 13.

2612. W. Brookes, Chancery-lane—Improvements in combing wool and other fibres. (Communication)
2614. C. C. Alger, Newburg, New York, U.S.—Improved furnace for smelting iron
2615. E. Deane, Arthur-street—Improved weapon to be used either as a sword or as a pistol, or both
2616. T. Bell, Plaistow—Improvements in the manufacture of alkaline salts
2618. M. Martin, Madrid—Improved apparatus for retarding and stopping railway carriages
2620. J. Yates, Little Bolton, Lancashire—Improvements in machinery or apparatus used in preparing and spinning fibrous materials

Dated October 14.

2622. C. G. Copisch, Gibson-square—Improvements in propelling vessels by means of heated air, without screw or paddle, thereby saving ship's fuel and room
2624. A. B. Ellena, Paris—A new mechanical means of rocking cradles
2626. J. H. Johnson, Lincoln's-inn-fields—Improvements in producing figured paper to be used in teaching writing and drawing. (Communication)
2628. F. H. Holmes, Blackwall—Improvements in magneto-electric machines
2630. T. Restell, New Kent-road—Improvements in breech-loading fire-arms, in projectiles, and in cartridges for breech-loading arms
2632. J. C. Plomley, Maidstone—Improved method of drying malt, hops, and other produce

Dated October 15.

2634. E. Wilkins, Walworth—Improvements in frames for horticultural and vegetative purposes
2635. W. A. Rooke, New Brentford—Using and employing dextrine in the making and sizing of paper
2636. C. Reeves, Birmingham—Improvements in the manufacture of swords, matchets, and knives
2637. R. G. Balderston, Bishopbriggs, Lanarkshire—Apparatus for cultivating land
2638. F. Priestley, Berners-street—Improvements in signal instruments or apparatus for making or transmitting electric telegraphic signals
2639. T. Richardson, Newcastle-upon-Tyne, and M. Prentice, of Stowmarket—Improvements in the manufacture of salts and preparations of phosphoric acid
2640. W. B. Hopper, Camberwell—Improvements in floating docks
2642. J. Gibbs, Abingdon-street—A method of treating phormium tenax, in order to render it fit for the manufacture of pulp
2643. P. Heilmann, Mulhouse, France—Improvements in spinning silk, cotton, wool, and other fibrous substances
2644. C. Walker, New Lanark—Improvements in atmospheric railways
2645. C. Walker, New Lanark—Improvements in the manufacture of manure from sewerage or drainage matters
2646. G. Seear, and J. Pollard, Burnley—Improvements in power looms for weaving
2647. R. Wright, Brighton—Improvements in the application of certain fluid and other matters to heating purposes, and in apparatus for the same

Dated October 16.

2648. D. Guthrie and J. Vavasseur, New Park-street, Southwark—A machine for cutting, chipping, or rasping dye-woods or other similar fibrous substances, for the purpose of obtaining extracts
2649. J. Wright, Sheffield—Improvements in preparing or treating strips of steel for hardening and tempering
2650. W. Holroyd, Halifax, and S. Smith, Shipley, near Bradford—Improvements in looms for weaving
2651. J. Bernard, the Albany, Piccadilly—Improvements in the manufacture or production of boots and shoes or other coverings for the feet, and in machinery, apparatus, and materials to be employed in such manufacture
2652. L. Arbel, Rive de Gier, France—Improvements in manufacturing wheels for carriages on railways
2653. R. A. Brooman, Fleet-street—An apparatus for scoring games and points at games. (Communication)
2654. J. Chadwick, Rochdale—Improvements in rollers or cylinders for printing or staining the surfaces of woven fabrics, yarns, paper, and other materials

Dated October 17.

2655. T. Holt, Little Bolton—Improvements in looms
2656. R. J. Badge, Newton Heath, near Manchester—Improved mode or method of securing railway chairs to the sleepers
2657. J. Bentley, Liverpool—Improvements in fire-arms
2658. E. Humphrys, Deptford—Improvements in engines worked by steam or vapour
2659. J. Eastwood, Derby—Improvement in working the valves of steam hammers by a direct self-acting motion
2660. R. A. Brooman, Fleet-street—Improvements in forming the joints of pipes for conveying water, gas, and other fluids. (Communication)
2661. T. Massey, Birchin-lane, and T. Savage, Soley-terrace, Pentonville—Improvements in sounding machines
2662. W. Osborne, Bow-churchyard, Cheapside—Improvements in ladies' petticoats, under skirts, and dresses
2663. L. Lewenberg, New York—Improvements in railway alarms, and marine alarms or fog signals

Dated October 19.

2664. L. De Cristoforis, Lower Thames-street—Improvement on the system of vehicle wheels, to be called the "De Cristoforis Conical Wheels"
2665. J. J. Sieber, Baring-street—Improvements in power looms. (Communication)
2667. V. Péan, South-street, Finsbury—Improvements in protecting the walls, ceilings, wainscots, and other parts of buildings from humidity
2669. R. A. Brooman, Fleet-street—Improvements in producing figured fabrics in which the design is applied by printing. (Communication)
2670. B. Barnard and A. Rosenthal, Cheapside—A new ornamental fringe or fringed fabric, also the means of producing the same
2671. M. Henry, Fleet-street—Improved machinery for unmaking rope or cordage. (Communication)
2672. H. Wimball, Aldermaston—Improvements in machinery or apparatus for the manufacture of bricks, tiles, pipes, and other articles of a similar nature
2673. E. Cockey, H. Cockey, and F. C. Cockey, Frome Iron Foundry—Improvements in regulating the flow of fluids
2674. W. E. Newton, Chancery-lane—Improvements in the manufacture of drawing rollers. (Communication)
2675. W. Bentham, Halifax—Improvements in harmoniums and other similar reed instruments
2677. D. Partridge, Plumstead Common—Improvements in shaft bearings

Dated October 20.

2678. M. A. F. Mennons, France—Improved hydraulic press
2679. E. Briggs, Rochdale—Improved manufacture of printed piled fabric
2680. R. Atkinson and T. Brearey, Baildon, near Bradford—Improvements in loom pickers
2681. G. H. Smith, Norfolk-street, Strand—Improved governor or regulator for steam or other engines
2682. F. Windhausen, Duderstadt, Hanover—Improvements in increasing the adhesion of the wheels of locomotive engines to rails when moist
2683. J. H. Johnson, Lincoln's-inn-fields—Improvement in Jacquard machines, and in the cards employed therein. (Communication)
2684. C. Tooth and W. W. Wynne, Burton-on-Trent—Improved refrigerator or apparatus for cooling or attempering liquids

Dated October 21.

2685. I. Storey and J. H. Storey, Manchester—Improvements in water gauges for steam boilers, and in taps for steam and other fluids
2686. R. Clark, Glasgow—Improvements in effecting the consumption or prevention of smoke, applicable to steam boilers and other furnaces
2688. A. V. Newton, Chancery-lane—Improvements in the construction of sewing machines, and in the mode of operating such machinery. (Communication)
2689. R. Duke, Dover—Improvements in the means of communicating power to ships' pumps

Dated October 22.

2690. C. Reeves, Birmingham—Improvements in repeating or revolving fire-arms
2691. J. Bethell, Parliament-street—Improvements in machinery or apparatus for trenching, cutting, digging, or cultivating land
2692. J. Hinks, Birmingham—Improvements in stiffeners for wearing apparel
2693. A. H. C. Chiandi, Paris—Improvements in the manufacture and combustion of certain products of peat, and in the apparatus employed therein
2694. M. A. F. Mennons, France—Improvements in machinery for the preparation of peat. (Communication)
2695. T. Hamilton and J. Hamilton, Glasgow—Improvements in turning, cutting, shaping, or reducing wood and other substances
2696. J. Milne, Royton, Lancashire—Improvements in carding engines
2697. T. Cardwell, Manchester—Improvements in machinery for compressing cotton and other articles
2698. D. H. Saunders, Perth—Improvements in the preparation and manufacture of textile fabrics and materials
2699. J. Smith, Bristol—Improvement in horsehair crinoline for petticoats

Dated October 23.

2700. T. Rand and G. Beckley, Oxford-street—Improvement in saddle-trees
2701. B. Parker, Clapham—Improvements in the permanent way of railways
2702. A. T. Blakeley, Tunbridge Wells—Improvements in laying submarine telegraph cables
2703. R. Harrild and H. Harrild, Farringdon-street—Improvement in the manufacture of the composition for printers' rollers
2704. W. H. H. Akerman, Bridgewater—Improvements in organs and similar musical instruments

Dated October 24.

2705. F. C. Kirkman, Royal-street, Lambeth—Improvements in machinery for winding and unwinding ropes and cables, which is applicable to electric cables for submarine purposes
2706. A. V. Newton, Chancery-lane—Improvement in the process of making wrought-iron beams or girders. (Communication)
2707. J. Macintosh, North-bank, Regent's-park—Improvements in the construction and laying of telegraphic cables
2708. J. Thom and H. McNaught, Glasgow—Improvements in looms for weaving
2709. J. M. Pearson, Basinghall-street—Improvements in the manufacture of coke. (Communication)

Dated October 26.

2711. J. Fairclough, J. Fairclough, and J. Cowan, Liverpool—Improvements for suspending and working window hangings and other drapery curtains
2712. I. Jones, St. Helen's, Lancashire—Improvements in the manufacture of sheet glass
2713. C. de Clippèle, Mark-lane—Improvements in the manufacture of boots and shoes, harness and driving straps, which improvements are applicable to uniting various materials together, and also for waterproofing
2714. J. Horrocks, Manchester—Improvements in winding machines, and in the bobbins employed therein, and also improvements in shuttles for weaving with such bobbins
2715. J. W. Lee, Chelmsford—Improvements in communicating between the different parts of railway trains
2716. J. Ferrabee, and C. Whitmore, Stroud—Improvements applicable to machinery for carding, scribbling, and condensing wool and other fibrous substances
2717. A. Marks, London-wall—Improved fastening for gloves and other articles

Dated October 27.

2718. W. Clarke, Laybourne-road, Camden-town—Improved means of connecting and working breaks for railway carriages
2719. C. Cadby, Liquorpond-street—Improvements in pianofortes
2720. T. Mottram, Rockingham-street, Sheffield—Improvements in knife handles
2721. J. Newall, Bury—Improvements in railway breaks and signals, and in the machinery or apparatus for working the same
2722. R. A. Margetson, Norwich—Improved means of communicating between the guard and driver on railways
2723. M. A. F. Mennons, South-street, Finsbury—Improved varnish. (Communication)
2724. R. Urie, Paisley, and W. Sutherland, Greenock—Improvements in the manufacture of knitted and weft-netted warp fabrics

Dated October 28.

2725. W. Irlam, Newton Heath, near Manchester—Improvements in wrought-iron railway chairs, sleepers, and crossings

2726. H. J. Daniell, Donington-park, Derby—Improvements in communicating by signals between the pilot and steersman, and between other parts of vessels by means of dial apparatuses
2727. J. Addison, Tours—Discovering and destroying hydrogen or carburetted hydrogen gas and other gases in coal-mines dwelling-houses, and other places
2728. J. E. F. Luedeke, Birmingham—New or improved motive power engine
2729. W. Smith, Salisbury-street, Adelphi—Improvements in couplings or connections for shafts. (Communication)
2730. P. A. M. Maury, Paris—Improvements in cutting the pile of velvets and other pile fabrics
2731. A. West, Hoddesdon, Herts—Improvements in the manufacture of candles
2732. A. Bourgeois, New Oxford-street—Improvement in preparing liquor for tanning hides and skins. (Communication)
2733. G. Shillibeer, Commercial-place, City-road, and G. Giles, Gray's-inn-square—Improvements in omnibuses
2734. J. Sloper, Oxford-street—Improved means of, and apparatus for, obtaining motive power for propelling ships or driving machinery
2735. W. Clark, Chancery-lane—Improvement in rails for railways. (Communication)
2736. W. Clark, Chancery-lane—Improvements in the manufacture of murexide. (Communication)
2737. W. Clark, Chancery-lane—Improvements in machinery for carding cotton, wool, and other fibrous substances. (Communication)
2738. W. E. Newton, Chancery-lane—Improvements in the manufacture of sewing silk, twist, and different kinds of thread. (Communication)
2739. E. McDowall, Johnstone, Renfrewshire—Improvements in steam-hammers. (Communication)
2740. J. Child and J. Child, Birmingham—A double-barelled gun with an elevated rifled tubular rib
2741. H. Taylor, Staleybridge, Lancashire—Improvement in the "cans" employed in connection with machinery for preparing cotton and other fibrous materials for spinning
2742. J. Fraser, Glasgow—Improvements in the manufacture of saltpetre
2743. R. A. Ronald, Paisley—Improvements in the manufacture of shawls
2744. W. Greening, Lower Edmonton—Improvements in enamelling and ornamenting metals and other surfaces

Dated October 29.

2745. W. Delf, Great Bentley, Essex—Improvements in ploughs
2746. D. de la Cherois Gourley, Wilton House, Regent's-park—Improvements in ambulance carriages
2747. P. Feloj, Holborn-hill—Improvement of an illuminating reflector of light from gas, oil, or candle
2748. T. Cook, Old Kent-road—Improvements in machinery for cutting, framing, and packing lucifer and other like wood matches
2749. D. Allison and J. Livingston, Manchester—Improvements in machinery or apparatus for regulating the weight or pressure to top rollers used in spinning or preparing fibrous materials to be spun
2750. W. Padgett, Poole, Dorsetshire—The manufacture of earthenware pipes for drains and sewers
2751. J. Craven, Bradford—Improvements in machinery or apparatus used in weaving
2752. E. Smith, Carlisle-street—An improved safety hook or fastening, particularly applicable to securing watch chains and watches to waistcoats and other garments
2753. G. W. Robinson, Barton-on-Humber—Improvements in clod-crushing rollers

Dated October 30.

2754. J. Evans, Lower-road, Islington—Improvements in the method or methods of affixing or securing patterns or designs upon rollers and blocks used for imprinting on paper and other substances
2755. J. B. Fraser, Kenilworth—Improvements in lubricating shafts, axles, screws, and other articles requiring lubrication
2756. H. Charlesworth and W. Chapman, Hudderfield—Improvements in machinery or apparatus for preparing woollen or other fibrous substances to be spun
2757. W. Clark, Chancery-lane—Improvements in tackle blocks. (Communication)
2758. W. Shields, Salford—Improvements in machinery or apparatus for etching, engraving, and cutting cylinders and other surfaces, to be used in printing and embossing
2759. W. Harwood, Mendlesham, Suffolk—Improvements in reaping machines
2760. J. Davy and W. Bentley, Bradford—Improvements in looms for weaving
2761. J. Lawson, Leeds—Improvements in machinery for roving flax and other fibrous substances. (Communication)
2762. T. S. Prideaux, Charing-cross—Improvements in apparatus for regulating the supply of air furnaces
2763. S. Knowles, Tottington Mill, near Bury—Improvements in dunging fabrics preparatory to dyeing
2764. M. Stodart, Golden-square—Improvement in the construction of the sound boards of pianofortes

Dated October 31.

2765. G. B. Galloway, Basinghall-street—Improvements in the construction of merchant ships and other vessels, in motive powers, propulsion and boiler furnaces
2766. H. J. Viault and J. Viault, Essex-street, Strand—An apparatus or mechanism for making signals on railways, and preventing collisions on the same
2767. J. Owen, Worsley—Improvements in machinery or apparatus for the prevention of accidents, applicable to hoisting and other lifting machines
2768. T. Lowe, Birmingham—New or improved method of feeding screws, blanks, shanks, pins, and other such like articles, to turning, nicking, and worming lathes or machines
2769. R. Martin, E. Hall, and J. Hall, Sheffield—Improvements in steam hammers
2770. L. de Laudfort, Higher Broughton, near Manchester—An apparatus for protecting the contents of pockets of wearing apparel from theft and loss
2771. R. A. Brooman, Fleet-street—Improvements in the construction of boats.
2772. J. J. Schuessel, Breslau, and P. J. Thouret, Berlin—The manufacture of a composition which will render inflammable materials incombustible
2773. W. Woodhead, J. Woodhead, and J. Woodhead, Eccleshill, near Leeds—Improvements in the manufacture of kiln tiles, and in the machinery or apparatus employed therein
2774. P. Gabbitass, Worksop, Nottingham—Improvements in washing machines
2775. P. B. Kyishogloo, Constantinople—Improvements in obtaining and applying motive power
2776. J. Fry, Watling-street—Improvement in cementing fabrics when india-rubber is employed
2777. G. H. Cottam and H. R. Cottam, Old St. Pancras-road—Improvements in stable fittings
2778. J. L. Norton, Bow, Middlesex, and E. Wilkinson, Leeds—Improvement in extracting oil and grease from wood previous to its being manufactured into yarn or fabrics, and also when in the state of yarn or fabrics, and in scouring or cleansing such wool, yarn, and fabrics

Dated November 2.

2779. R. Kirkman, St. Helen's Lancaster—Improvements in the fuses of lever and other watches
2781. E. Murray, Woolwich—Preventing accidents on railways
2783. C. Iles, Birmingham—Improvements in wardrobes or similar receptacles for articles for dress, and in stands, frames, and pins for holding or suspending articles of dress
2785. J. Apperley and W. Clissold, Dudbridge, Gloucester—Improvements applicable to carding and condensing engines

Dated November 3.

2787. S. Hoga, Charlotte-street, Fitzroy-square—Improvements in electric telegraphs
2789. J. E. Boyd, Lewisham—Improvements in skates
2791. D. Harcourt, Birmingham—Improvements in wrenches
2793. R. Wappenstein, Manchester—Improvements in doctors or scrapers used for cleaning engraved surfaces
2795. W. E. Newton, Chancery-lane—Improved machinery for cutting files. (Communication)

Dated November 4.

2797. R. Laming, Hayward's Heath, Sussex—Improvements in purifying gas and in apparatus useful for that purpose
2799. F. Higgenson, Eling, Hants—Submerging, extending, and laying down submarine, electric, magnetic, and every other description of submerged or immersed electrical telegraph cables, wire ropes, and combined wire, gutta-percha, spun-yarn, or other compound electrical cables whatsoever
2801. R. I. C. Dubus, Brussels—A method of treating certain plants or vegetable substances, in order to extract from the same, 1st, a kind of fecula or farina proper both for alimentary and finishing or starching purposes; 2nd, an alcoholic liquor; and 3rd, a natural ferment or yeast
2803. C. Clay, Walton, near Wakefield—Improvements in machinery for grubbing or cutting up weeds and otherwise scarifying and cultivating land
2805. J. Miller, Alpha-road, Regent's-park—Improved arrangement of marine steam-engines

Dated November 5.

2807. J. Bunnett, Deptford—Improvements in machinery for bending and shaping metals
2809. G. Robinson, High-street, Deptford—Improvements in apparatus for shelling or hulling coffee and other berries and seeds
2811. J. J. Cousins, Leeds—Improvements in the construction of steam ploughs
2813 W. Sharman, Sheffield—Improved metallic compound, applicable to the manufacture of useful and ornamental articles for which German silver and compounds resembling German silver are at present used

Dated November 6.

2815. F. Lipscombe, Strand—Improvements in the mode of conveying water and other liquids
2817. G. Canouil, Paris—Improvements in the manufacture of matches
2819. H. Bessemer, Queen-street-place, New Cannon-street—Improvements in the manufacture of malleable iron and steel, and also in the manufacture of railway bars, and other bars, plates, and rods from iron or steel so manufactured

Dated November 7.

2821. H. Baines, Manchester—Improvements in machinery or apparatus for the prevention of accidents, applicable to hoisting and other lifting machines
2823. J. H. Pepper, Regent-street—Improvements in displaying various devices when revolving discs or surfaces are used
2825. W. Wilson, Newington, and J. J. J. Field, Wandsworth-road—Improvements in casting or moulding liquified and other substances

Dated November 9.

2827. W. Hardie, Pitt-street, Edinburgh—Improved stereoscope
2829. P. A. Balestrini, Brescia, Italy—Improvements in machinery and apparatus for paying out submarine telegraph cables, and for regulating and controlling the paying out thereof
2833. G. Weedon, Gloucester-place, Portman-square, and T. T. Weedon, Plumstead—Improved knife-cleaning machine
2835. J. Reeve, Rutland-gate, Hyde-park—Improvements in propelling vessels

Dated November 10.

2837. T. Rowcliffe, Upper-park-place, Dorset-square—Improvements in machinery for making and pressing bricks, drain pipes, and tiles, and in preparing material to be used for such like purposes
2839. J. Townsend, Glasgow—Improvements in the manufacture or production of sulphurous acid
2841. J. T. Way, Welbeck-street, Cavendish-square—Improvements in obtaining light by electricity
2843. H. C. Bartlett, Ampthill-square, Hampstead-road—Improvements in the manufacture of paper

Dated November 11.

2845. P. Madden, Russell-place, Dublin—Improvements in kilns for drying corn, malt, or other granular substances, part of these improvements being applicable to the screening or sifting of such substances during the process of drying
2847. O. W. Wahl, Leadenhall-street—Improvements in manufacturing farinaceous products from potatoes. (Communication)
2851. J. Williams, Neath, Glamorganshire—Improvement in coupling and connecting carriages on railways

Dated November 12.

2853. J. Stevenson, jun., Glasgow—Improvements in lighting apartments and passages
2855. S. Webster, Bolton-le-Moors, Lancashire—Improvements in machinery or apparatus for tanning
2857. G. T. Bousfield, Loughborough-park, Brixton—Improvements in castors. (Communication from J. C. Dubois)

Dated November 13.

2861. A. H. A. Durant, Conservative Club, St. James's—Improved apparatus for husking and winnowing castor seeds for the purpose of obtaining the larger quantity and a purer kind of oil therefrom when pressed than heretofore with the outer skin or cuticle on

Dated November 14.

2863. G. Haseltine, St Helen's-place—Improvements in machinery for the manufacture of small metallic chains. (Communication)
2865. J. H. Bennett, Vanbrugh-place, Leith—Improved compound safety-valves
2867. A. V. Newton, Chancery-lane—Improvements in apparatus for retarding and stopping the progress of railway trains. (Communication)
2869. J. Fereday, Wolverhampton—Improved form of steam engine

PATENTS APPLIED FOR WITH COMPLETE SPECIFICATION.

2849. E. H. Ashcroft, Massachusetts, U.S.—Improved mode of preventing the overheating and bursting of steam boilers. (Communication from J. Absterdam and W. Burnett, Massachusetts)—November 11
2879. J. Gedge, Wellington-street South, Strand—Improved means for stopping or retarding carriages used on ordinary roads. (Communication from W. A. Zemplner, Vienna)—November 17
2901. H. D. Pochin and J. Woolley, Manchester—Improvements in the manufacture of gum or dextrine from amylaceous substances.—November 19

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