THE ASTOR LIBRARY, NEW YORK.

About three years and a-half ago, the sum of 400,000 dollars was left, by the late John Jacob Astor, for the purpose of establishing and building a public library in New York. He appointed twelve trustees for carrying the object into effect. The bequest was to be applied as follows:—75,000 dollars for the erection of the building, 120,000 dollars for the purchase of books and rare manuscripts, and the surplus—205,000 dollars, after paying for the site—to be invested as a fund for the support and increase of the library.

In September 1848, the trustees decided upon a site in Lafayette Place, as one in every way adapted for the purpose, affording, from its situation, that remoteness from the public thoroughfare so necessary to secure quietness during the time of study. In the following month the superintendent, Dr. Cogswell, was appointed by his fellow trustees to proceed to Europe, and purchase, at his discretion, books to the amount of 20,000 dollars. He accordingly went, and the result has been most satisfactory, his purchases having been selected with care and discretion, and obtained at low rates, consequent on the disturbed political condition of Europe in the year 1848, and the reduction of prices attendant thereon. The plans for the building were executed by Mr. Saeltzer, the eminent architect, and were immediately acted upon.

The building is constructed after the style of the Byzantine school of architecture. The first story and part of the second are built of brown stone; the columns, architraves of windows, the cornice, parapet and the ornamental work are of the same material. The height of the front of the building from the level of the side-walk up to the top line of the parapet, is 67½ feet; the length 125 feet, and breadth 65 feet. The ascent to the entrance will be by six stone steps to a brown stone platform into the front vestibule, ornamented on either side by a stone sphynx, from thence to a flight of thirty-two marble steps, 8 feet in breadth, leading to the library hall floor; upon approaching the summit of these steps, the visitor finds himself near the centre of an immense alcove, encircled by fourteen piers formed of brick, plastered and finished to resemble white marble, and supporting galleries of iron, midway between the floor and the ceiling. The side walls form a continued row of shelving and book-cases, estimated to cost 12,500 dollars, and capable of containing one hundred thousand volumes. They are reached by means of the main gallery, in connection with which are four iron spiral stairways, and an intervening gallery of a lighter and smaller description, connected by eight staircases with the main gallery. The whole are arranged and appropriately ornamented in a style corresponding with the architecture of the building. Above the floor of the main-hall, at an elevation of 52 feet, is the principal skylight, 54 feet long, and 14 feet broad, formed of thick glass, set in iron. Besides these there are circular side skylights of smaller dimensions. All needful light is furnished by these, and by the windows in the front and rear walls. Thorough ventilation is secured by iron fretwork in suitable portions of the ceiling. In the extreme rear are the two rooms for the librarian, access to which is had by means of the main galleries. The first-floor contains reading and lecture-rooms, with corridors and vestibules communicating, and will accommodate five hundred persons. The latter are on each side of the building, and separated from the library hall stairway at the front entrance by two corridors, leading to the rear vestibule, and thence to the lecture-room still further in the rear.

The basement story is arched with quoin arches, so as to render them fire-proof, and contains the keepers' rooms, cellars, coal vaults, air furnaces, &c. The whole building will be lighted by five hundred gas lights, and is the first, of such considerable extent, that has ever been called at once into existence. That of Gottingen, the nearest parallel, was founded more than a century ago, when the whole number of printed books was less than half the present number.

The library will be arranged after the most approved European system, and should it equal that of Gottingen in completeness and excellence, it will be a credit to the new world.

Necrology.—Dr. Paul Erman, the Nestor of Prussian *savans*, died a few days ago at Berlin, at the advanced age of 87. In addition to innumerable articles on different subjects in scientific periodicals, he published important works on electricity, galvanism, magnetism, physiology, and optics.—Auguste de Bourge, Engineer of Bridges and Works, France, Officer of the Legion of Honour, has died at Grignon, aged 76.

INSTITUTION OF CIVIL ENGINEERS.

Nov. 11.—Sir William Cubitt, President, in the Chair.

The business of the session was commenced by the announcement of the dates of the Ordinary Meetings of the Session; of the appointment of December 23rd for the Annual General Meeting, for the election of the President, Council, and Officers; and of the 25th May, 1852, for the President's Conversazione.

The paper read was, "*An Investigation of the Strains upon the Diagonals of Lattice-beams, with the resulting Formulæ,*" by W. T. Doyne, Assoc. Inst. C E., and Professor W. B. Blood.

The experiments detailed in the paper were made on a model 12 feet in length, so constructed that the diagonals in compression, which were strips of mahogany let into the top and bottom, but not fastened to them, and the ties, which were of hoop-iron chains, must of necessity take their respective bearing and strain, and by the substitution of a dynamometer for any one of the ties, the strain on it could be accurately measured.

The results of the investigation, which were given in a table, showing a remarkable coincidence between the strains as measured and calculated, were, that for a parallel beam, of one span, supported at each end and loaded at the centre, the strains throughout the diagonals were uniform, and the horizontal strains were greatest at the centre, decreasing uniformly at the points of support. For a similar beam, uniformly loaded over its entire length, the strains on the diagonals commenced at the centre, increasing uniformly to the points of support, while the horizontal strains decreased from the centre to the ends, in the ratio of the ordinates of a parabola. These results were arrived at by different methods of reasoning, and the formulæ derived from them were stated to be applicable to the more complex form of a closely intersected lattice, taking into consideration the increased number of triangulations.

The paper then proceeded to show that the same reasoning might be applied to beams with solid sides, and their proportions calculated accordingly. As a practical illustration of this principle, the author exhibited a drawing of the Glynn Taff viaduct, constructed by him, for the Aberdare Iron Company, in which the main bay, over the river Taff, was 140 feet span, and the weight of iron-work 53 tons. This bridge was capable of carrying a constant load of 73 tons, and the weight necessary to break it was calculated at 359 tons.

In an appendix, the formulæ were extended to the cases of beams fixed at one end only; and also to those having several points of support; in the latter case, it appeared, that the greatest possible strain due to a moving load upon the diagonals, at the centre, was only one-fourth that at the points of support, where the bridge was of one span only, and when there was more than one span, that a portion of the value of continuity was lost in the case of a moving load, in consequence of the point of contrary flexure changing its position. The paper was illustrated by diagrams, and the experiments upon the model were explained by the author.

The President recalled to those gentlemen who had been recently elected, the engagement entered into on their election, to present original communications, books, &c., in order to promote the interest of the meetings, or increase the library.

The meeting was adjourned to Tuesday Evening, November 18th, when the following paper will be read:—"Description of a new Metallic Manometer, and other Instruments for measuring Pressures and Temperatures," by M. Eugène Bourdon, of Paris.

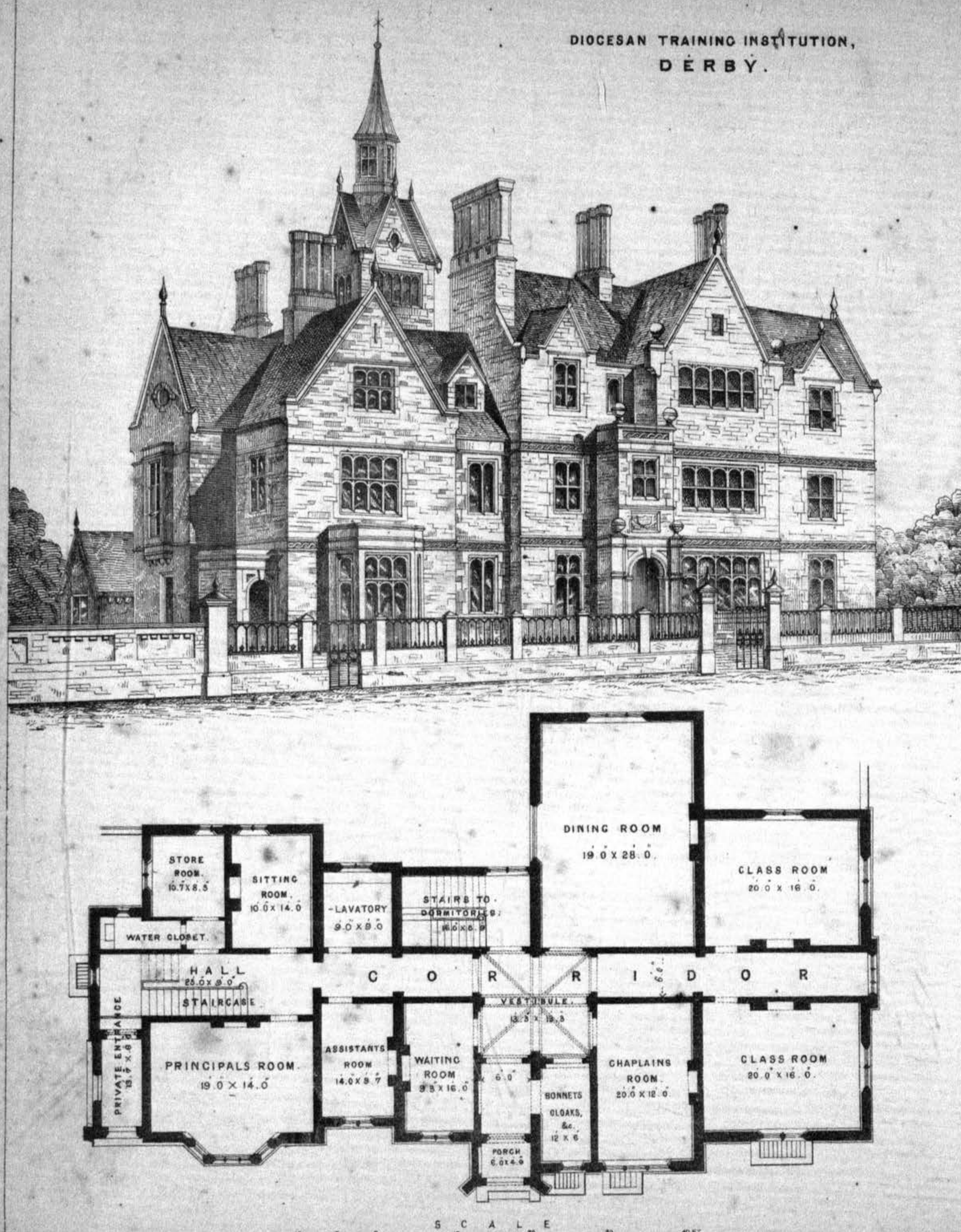
NOTES OF THE WEEK.

Galvanoplastic Art.—One of the greatest examples of this art as yet executed is the colossal statue of Christ, after Thorwaldsen, which has just been produced in the factory of Messrs. Winkelmann, at Berlin. The statue weighs nearly a ton and a-half, and is for the Church of Peace, at Potsdam. This instance, and that of the bronze decorations for the Isaac Church at St. Petersburgh, afford good hints to architects of the resources of the galvanoplastic art for internal and external decoration.

Herr Hittorff, the author of the magnificent work on the polychromatic architecture of the Greeks, and on whom the King of Prussia bestowed the Cross of Commander of the Red Eagle of Prussia, has been presented by King Maximilian of Bavaria with the Cross of Commander of the Order of Merit of St. Michel, and by the King of Wurtemberg with the Order of Crown.

Museum of the Royal College of Surgeons.—The removal of the houses in Lincoln's-inn-fields adjoining the College, for the construction of the new museum, has been commenced. The buildings were lately in the occupation of Alderman Copeland; originally they formed Ben Jonson's Portugal Theatre, on the boards of which some of Shakspeare's principal plays were produced. Mr. Barry is the architect, and Mr. Lucas the builder of the new museum.

DIOCESAN TRAINING INSTITUTION,
DERBY.



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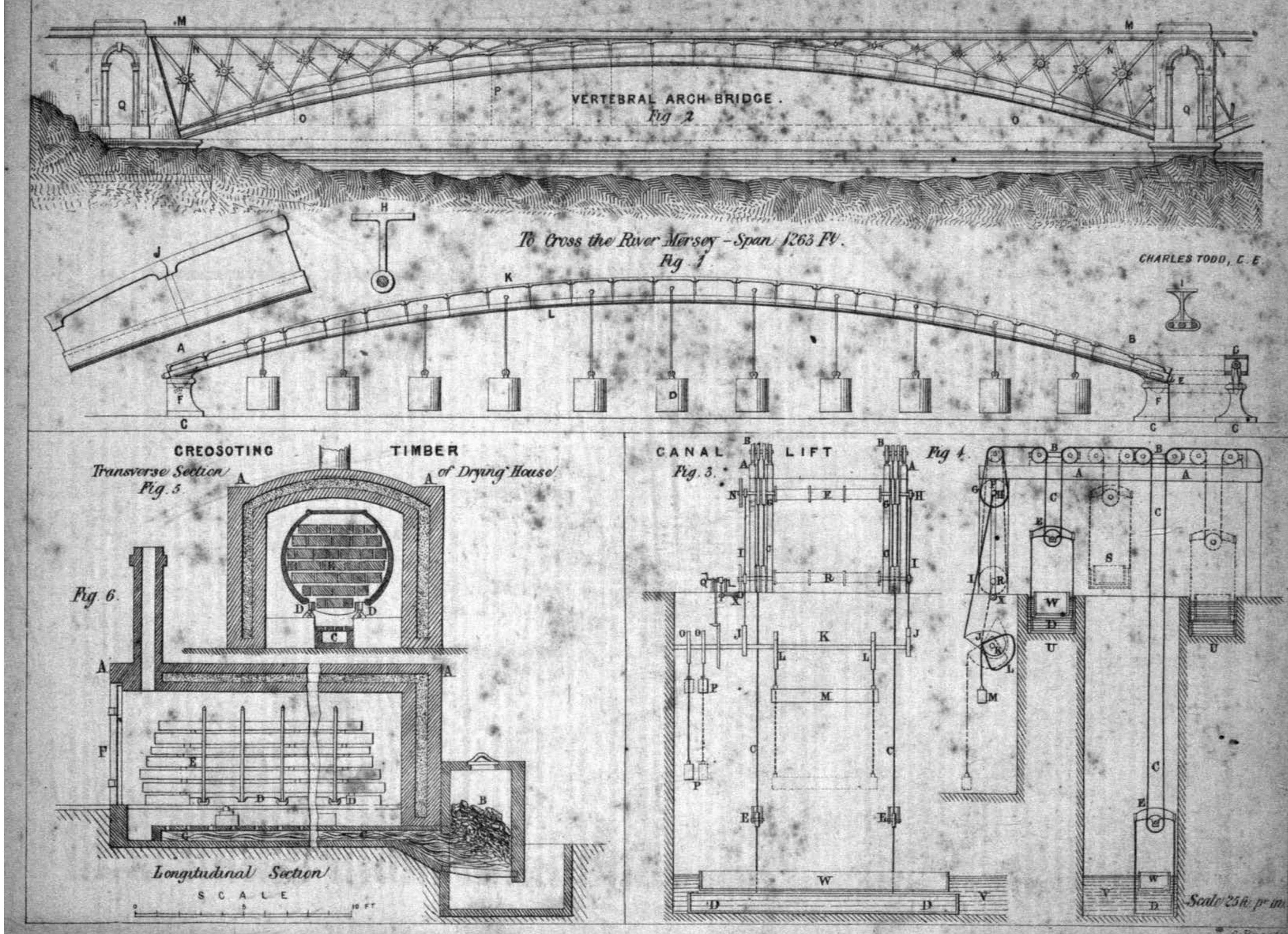

VERTEBRAL ARCH BRIDGE.
Fig. 2
To Cross the River Mersey - Span 1263 Ft.
Fig. 1
CHARLES TODD, C. E.
CREOSOTING TIMBER
Transverse Section of Drying House
Fig. 5
Fig. 6
Longitudinal Section
SCALE
CANAL LIFT
Fig. 3.
Fig. 4
Scale 25 ft. pr. in.

DIOCESAN INSTITUTION FOR TRAINING SCHOOL-MISTRESSES, DERBY.

H. I. Stevens, Esq., Architect.

(*With an Engraving, Plate* XXII.)

The training institutions formed in the several dioceses have, in the first place, employed the architects, and it is to be hoped they will be equally beneficial to the pupils. The engraving which we now give represents the institution just opened at Derby, and of which Mr. H. I. Stevens is the architect. It is treated as a domestic building of the time of James I.; and the plan is so treated as to afford masses for grouping. But little has been spent in ornament, so that the outlay (about 7000*l.*) has been principally devoted to the accommodation of the establishment. The institution provides for the residence of a principal, assistants, and a large number of pupils; with class-rooms, and servants' offices.

The disposition of the ground-floor will be seen from the plan given with the engraving. Here are placed the principal apartments.

On the first floor, the wing over the principal's room is occupied by her private apartment and the infirmaries. The chief part of the rest of the floor is laid out into apartments, numbered as dormitories, and each of which includes several bed compartments, about 10 feet by 4½, and having a separate casement. The second floor is likewise occupied by sleeping apartments.

GIRDER BRIDGE.

(*With Engravings, Figs.* 1 *and* 2, *Plate* XXIII.)

On the Vertebral Arch, or Improved Girder, representing its most simple form; originally invented and designed for a Bridge to cross the River Mersey at Runcorn Gap, in one span of 1263 *feet; which invention and design were laid before the Corporation of Liverpool, when the late Thomas Colley Porter, Esq. was Mayor for that Borough, in* 1827. (*Exhibited at the Exhibition of All Nations*, 1851—Class 7, No. 52.)

By Charles Todd, Engineer, Leeds, Yorkshire.

When it was in agitation to erect a bridge at Runcorn Gap, near Liverpool, to facilitate the mail route between that town and London, the circumstance created much attention, not only as a public accommodation, but from the difficulties attendant on the construction of a bridge to suit all the requirements of the case. The proposition drew into active operation the talents of Captain Brown, and the late Mr. Telford, C.E., both of whom tendered designs and reports for suspension bridges. In the year 1817, those of Mr. Telford were published and partially circulated—a copy of which was put into my hands; but why his design and report, which seem to have been the most approved of, were not adopted I have not been able to learn. Most probably, the *suspension* bridge was considered too flexible or loose in its build for durability and safety on so large a scale. The following is an extract from Mr. Telford's report:—

"The proposed site is in every respect favourable, it having on the Cheshire side a steep bank, and a bold rock down to its water's edge; also, on the opposite side a projecting point of land of considerable elevation, with a flat rocky shore down to low-water mark. The channel for about 1000 feet of its width, is occupied by a mass of sand and mud to a very considerable depth. The last circumstance would render the construction of any pier or embankment at this place, if not impracticable, at least hazardous and expensive.

"But there are, in my opinion, still more serious objections to introducing any obstructions to the tideway. The general economy of this important estuary is maintained by the flowing tide passing with great velocity through a comparatively narrow channel at Liverpool; afterwards spreading over a space of from three to four miles in breadth, up to opposite the river Weaver; next rushing with violence through the narrow pass at Runcorn Gap; thence again spreading over a wide space for a considerable distance; and finally passing up the Mersey Channel, at Warrington. The ebbing tide performing similar operations in a reverse order.

"In this manner the whole economy is adjusted, and the spaces adjacent to the Narrows at Liverpool, and Runcorn, maintained at a proper depth. But even the present powerful reflux, aided by fresh water, is not more than sufficient to repress the great body of sand and mud constantly moved forward by the strong westerly wind, and thereby threatening the entrance to the Weaver Navigation, and also that of the Duke's Basins; but if the tide was interrupted at Runcorn Gap, and of course the reflux destroyed or much diminished, there are strong reasons to expect that the upper end of the whole bay would be filled with sand and mud. If this did take place, not only would the entrance to the Sankey, the old river, the Duke's, and the Weaver Navigations be dangerously affected, but the gradually lessening flux and reflux would unavoidably have a proportionate effect upon the port of Liverpool. Viewing the matter in this light, all projects which tend to stop or lessen the tideway at Runcorn should be avoided.

"This requires the bridge, upon whatever principle it is constructed, to maintain an entire span or clear opening for a watercourse of 1263 feet. It will be necessary also to preserve the headway across the river at a sufficient height to permit the vessels which navigate the old river to pass with their masts up; and this will require a clear height in the centre of the span, above high water, of 70 feet."

My attention was drawn to this subject in the year 1826, and being of opinion that any bridge constructed on the *chain*-suspension principle is not such as should be adopted on so large a scale, I began to consider whether some other mode of bridge building could not be devised, to render the fabric more substantial and safe, and yet give all the requirements claimed for it in Mr. Telford's report.

The result was, the design for a bridge got up under a consideration of the mechanical construction of the *back-bone* of an animal; and I took the back-bone of the human frame chiefly for my model. Here I find the principles of a self-abutting arch of the utmost flexibility and of the greatest rigidity, formed by the combination of a number of bones of convenient lengths, fitted together on their upper edges by ball and socket joints, to give them the property of swivelling and curving in the direction of their length; the whole being well braced together along their bottom edge by a series of strong and compact ligaments, terminating and made fast at their ends in the two extreme bones, which in human anatomy are called the base and capital. These ligaments the animal functions have the power to contract and relax to suit the circumstances under which the animal is placed. They are contracted when great force and firmness are required to be exerted in an upright position, binding the bones together so as to render the back stiff like a pillar; and yet they can be suddenly or slowly relaxed to give the animal power to throw itself forward, backward, or sideway at pleasure. So also if the back be brought into an horizontal position, for the purpose of carrying a weight, the same property of contracting the ligaments is brought into operation—but at this time to give it the properties of an arch, the arch thereby being rendered more or less the segment of a circle as the weight to be sustained is greater or less. The bones are the arch blocks, and the ligaments are the strings uniting with the extreme ends of the base and capital to form the abutments. Thus did I obtain the principles of a *self-abutting arch* upon which to construct my model. The vertebræ being the arch blocks, and the ligaments being the string bolt or bolts passing and taking, or bearing on the bottom edge thereof, and secured at each end by screw and nut, or some other equivalent mode of fastening, to give an abutment. Hence by a due proportion given to the blocks, bolts, and rise of the arch, any amount of strength may be obtained even of very large extent; and my calculations of its capabilities induced me to offer a design for a bridge on this plan, for Runcorn Gap, with a span of 1263 feet.

The model which I have had the honour and pleasure of exhibiting at the Great Exhibition of the Works of all Nations in Hyde Park, London, 1851, is a representation of what I call the *vertebral arch* in its most simple form, which, together with a drawing similar to the one hereunto annexed, were laid before the Corporation of Liverpool in the year 1827, for their consideration, as a design for a bridge to cross Runcorn Gap, in one span of 1263 feet. The idea was pleasing to them as a novel invention; and I had several interviews with them on the subject. But they said, that they could not think of adopting it without its first being tested on a scale sufficiently large to prove its applicability to a bridge of the magnitude which they required; and they were not willing to go to the expense of getting up such experiments. Hence the thing was given up, and the model has laid by me ever since, almost forgotten by reason of my other engagements, until I determined to give the scheme to the public by sending it to the Great Exhibition of 1851.

The following is a popular description of the accompanying engravings:—

Fig. 1 is a representation of the model as seen in the Exhibition. The vertebral (or backbone) arch A B, is formed of twenty-five cast-iron blocks, united together in the direction of their length by a wrought-iron bolt E, passing through a tube at their bottom edge L, and firmly screwed up to suit the pitch of the arch by a nut at each, their upper edge being formed with an horizontal plate K, giving to these blocks the T form, as seen at H. The horizontal plate K, receives the compressing, and the string bolt E, the tensile strain of the whole weight laid upon the arch, both by the material forming its construction and any weight which may have to pass over it. This arch or girder, so fitted up, was placed upon two cast-iron stands F F, one at each end. The end B, of the girder is formed with a feather edge, rounded at the bottom, as shown by the dotted line, and placed in a suitable groove in the stand, so as to admit of its moving or turning freely as on a joint, in the event of any rising or falling of the arch; while at the same time the other end A, formed in a similar way, but flat at the under edge, rests on a roller placed at the bottom of the groove formed in the stand, which admits of that end of the girder moving freely in the direction of its length, should any variation take place in the length of the chord of the arc, through expansion, contraction, or otherwise. The span of the arch of the model is 31 feet, being about $\frac{1}{40}$ the span proposed for the bridge at Runcorn Gap, and the rise or versed sine of the arc to the underside of the arch blocks, is 2 ft. 3 in.; the centre block being 9 inches deep. The plates forming the T part are $\frac{3}{8}$-inch thick; the manner in which these blocks are formed and put together being shown more distinctly at J. The string-bolt is $1\frac{1}{3}$ inch diameter, being as large as could be got through the tube. The girder, in this state, with its twenty-five cast-iron blocks, and wrought-iron bolt, weighs 12 cwt., or 1344 lb., and had suspended to it, during the whole time of exhibition, without the least derangement of its parts, eleven cast-iron weights D, of 482 lb. each, or, in the gross, 5302 lb., being nearly four times its own weight; and apparently, the arch blocks would sustain a weight equal to three times the strength of the string-bolt used.

This model, with its stand and weights, rested on the floor C C C, requiring no fastening thereto, as no force is exerted in any direction to overturn it, the whole being simply a gravitation weight. An end view of the girder is represented at O, from the joint B; and I represents a section of an arch block, formed to carry more string-bolts than one; but the engineer will conceive that a variety of modifications may be adopted to carry a multifarious set of bolts. Fig. 2 is a representation of fig. 1, as applied to bridge building, with framework, approaches, pier, &c., for forming a roadway. Any convenient number of ribs or girders may be placed side by side, united together by cross-stays, &c., to make up an arch upon which to build a roadway, as at M M. But the roadway may be carried on other levels, as at N N, or O O, or otherwise, to suit circumstances, by forming side arches of these girders, and suspending the roadway from them by means of rods, as at P. Fig. 2 also represents a design for a bridge composed of one or more arches. An entire arch is drawn to a scale giving to it a span of 1263 feet, by a clear headway in the centre for navigation of 100 feet. The openings Q, in the masonry of the approach and pier, are simply to show that something of the sort will be required to get at and examine the ends of the string-bolts of the girders.

The vertebral principle may be also applied to the construction of girders, for roofs of buildings, particularly where the absence of pillars is desirable, and by means of which the roofs may be made light, ornamental, and cheap.

Thus have I endeavoured to give an account of the above invention, and I send it forth into the world, to be there judged. I am of opinion, however, that my engineering brethren will find it worth their attention. Had patents been less expensive things, probably the world would have been in possession of it long since.

CHARLES TODD, C.E.

EQUILIBRIUM CANAL LIFT.

New Equilibrium Canal Lift, for Transferring Boats from one Level to another, without Loss of Water or of Power. By ARCHIBALD SLATE, of Dudley.*

(*With Engravings, Figs.* 3 *and* 4, *Plate* XXIII.)

THE scarcity of water in the inland navigation during the summer months, and the consequent inconvenience to the manufacturers who are dependent for an outlet on that mode of conveyance, having led the author of the present paper to the investigation of the various plans which had been proposed or tried, for transferring boats from one level to another without the loss of water which occurs in the use of locks—he found that there existed in these plans what appeared to him an insuperable objection—the necessity of water-tight gates or sluices, to be opened and shut in the passage of each boat, and the least derangement of which might not only stop the traffic of the canal, but be productive of most serious consequences. There occurred in some plans the very serious evil of the boats being transferred from their proper water bearing to a dry or partially dry cradle, causing serious risk of injury to the boat, by the strains arising from the unequal bearing.

It appeared, then, that to the successful application of any lift or method of transferring boats, two points were essential; first, that the boats should float in water during transfer; and next, that there should be a total absence of gates or sluices in the main line of the canal. To make the boats float into a caisson or tank, sunk in the water, disposed of both the above points at once; and the only thing then to be sought for was the proper mechanical arrangement by which the caisson, with the boat floating in it, might be lifted out of the water at the one level, and transferred to the other level, without the loss of water, or the use of more power than is necessary to overcome the friction of the machinery. The method by which this is proposed to be accomplished is shown in figs. 3 and 4, Plate XXIII.

The upper level of the canal is divided into two branches or arms U U, each of a sufficient width, and carried along each side of the lower level of the canal V, to a sufficient length, to receive an ordinary canal boat. The sides of the canal forming the upper levels may be constructed of stone and brickwork, as in ordinary locks, or of iron carried upon timber framing. The depth of each branch of the canal is sufficient to permit a boat W, with a full load, to float over the ends of a caisson or tank D D, that is of sufficient size to contain water enough to float a loaded boat. Over these branches of the canal is erected a timber or iron framework, upon the top of which, at points immediately over the upper and lower branches of the canal, are fixed rails A A, and on these rails are placed carriages B B, containing a series of wheels, over which run the chains C C, for lifting the caissons. At the bottom of one of the branches of the canal, on the upper level, and of one on the lower level, are placed the iron caissons or tanks D D, which are carried by straps, attached to cross bearers E E, and suspended by the chains at points immediately under the framework. At one side of the framework, in two vertical grooves, is suspended the large shaft F F, carrying the four drums G G, on which the suspending chains wind and unwind in the operation of raising and lowering the caissons; the two sets of chains being wound on the respective drums in opposite directions, so that when one caisson is raised, the other is at the same time lowered. On each end of this shaft F, is a bearing or journal, which is grasped by an eye or strap H H, in which it can revolve; to these straps is attached one end of the equilibrium connecting chains I I, the other ends of which are fixed to the cams J J. These cams are keyed fast on the shaft K, and on the same shaft are also keyed two other cams L L, to which is attached, by two chains, the balance weight M. On the same shaft are keyed the large wheel N, and two drums O O, to which are attached, on opposite sides, the two water buckets P P, for the purpose of aiding, if required, the manual power in working the lift. The balance weight M, is nearly equal to the weight of the caissons in the water, when working through the shortest leverage of the cams; the caissons being allowed a little weight in excess, in order that they may freely sink to the bottom of the water. The balance weight when acting through the longest leverage (as shown by the dotted lines), is equal to balance the caissons when out of the water and full of water; this weight of the caissons being *the same under all circumstances*, on account of the relative displacement of water, whether they contain a loaded boat or an empty boat, or are merely filled with water, without any boat. The form of the cams between these two extreme points is regulated by the form and depth of the caissons.

The following is the action of the Equilibrium Lift:—Supposing two loaded boats approaching the lift, one on the upper and the other on the lower level of the canal (but the same description applies to empty boats, or to a single boat), each boat is floated into the arm of the canal, over the caisson lying at the bottom, in the same way as into ordinary locks. The first operation of lifting is to raise both caissons out of the water, with the boats floating in them: this is done by applying power to the series of wheels Q, which turn the shaft K; by which operation the chains I I, are wound on the cams, causing the shaft F, with the drums and suspending chains, to move down the vertical grooves in the framework to the position shown by the dotted lines at R, and thus raising the caissons and boats out of the water. This operation may be performed either by manual power or by means of the water buckets P P, by turning on water from the upper level into the

* Paper read at the Institution of Mechanical Engineers, October 22nd, 1851.

descending bucket, and letting out the water by a self-acting valve, on the bucket reaching the bottom. The varying weight of the caissons, in progress of being raised from the bottom to the surface, until out of the water, is allowed for, so as to preserve the equilibrium throughout the operation, by the varying leverage of the balance weight acting upon and through the four cams; so that the power has little more than the friction of the machinery to overcome.

Having by this means lifted both caissons out of the water, that one which is required to descend to the lower level is moved across the bank of the canal by means of the railway A A, on the top of the framework, in a similar manner to an ordinary traversing crane, until it is suspended over the lower branch of the canal, ready to descend, as shown by the dotted lines at S. When in this position, the wheel T, on the end of the shaft F, is geared to the series of motion wheels Q, by means of a shifting clutch at X; the power is then applied, and the shaft caused to revolve, which by unwinding the chains attached to the descending caisson, and winding up the ascending one, carries them to a relative position opposite to that from which they started; and they are stopped at the proper point by the top of the cross bearers E, coming in contact with the bottom of the chain carriage B. The caisson which has been raised from the lower level is then moved, as before, by means of the railway, across the bank of the canal, and suspended over the upper branch; the clutch is then ungeared, the power again applied to the shaft carrying the cams with the balance weight, and the caissons are simultaneously lowered to the bottom of the canal, and the boats floated over their ends and away to their destination.

Various plans for passing boats from one level of a canal to another, by vertical lifts, have been proposed, and some partially carried out in practice. In most of these, however, there is a loss or consumption of water from the upper ponds of the canal in excess of that consumed, or in diminution of that supplied, in passing the upward or downward trade respectively. It will be obvious that the plan above proposed occasions no waste of water; that in passing the upward trade the water consumed is equal to the tonnage of the ascending trade; and in the opposite direction, the water supplied to the upper ponds of the canal is equal to the tonnage of the descending trade; so that a weight of water equal to the whole downward tonnage will be absolutely transferred from the lower to the higher levels of the canal.

The difference of the levels of the two branches of a canal to which this Equilibrium Lift may be applied, is limited only by the strength of materials and convenience of working.

In the present system of locks, the amount of traffic on canals is really limited to the supply of water, and this, in many cases, is deficient for the ordinary traffic; so that any reduction of the present rates of carriage on canals becomes hopeless under the present system. But by the adoption of such a system as the one proposed, on the summit levels of canals, their capacities for traffic may be so increased as to enable them successfully to compete with the railway system, which now threatens to swamp three-fourths of the canal property in the kingdom.

This Equilibrium Lift may be made single or double. In its double form it is estimated that it would pass one boat up and another down in about three to five minutes, according to the height of lift.

The value of this lift is its capacity for an almost unlimited amount of traffic, without any expense of water, instead of incurring the constant loss that attends the present locks, amounting to more than 100 tons of water each time that a boat passes through. The enormous annual expense of water to replace the loss by the locks, on many of the canals in the midland districts, is too well known to those acquainted with their practical working to require any observation. Supposing the proposed plan applied in several parts of the surrounding district, where there are from 16 even to 30 locks situated close together, and the loss of time to every boat in passing the series of locks is from 2½ to 5 hours, a most important saving of time would be effected; as, with one and two lifts respectively in those cases, the whole time required for a boat to pass would be only from 10 to 20 minutes.

It is of course impossible to calculate the expense of the lift fo the various heights, without knowing the exact position, but it is considered that for a height of about twenty-one feet, or three ordinary locks, the lift would be as cheap as locks. For a less height the comparative expense would be greater; but for a greater height, within reasonable limits, the lift would be considerably cheaper than locks. In cases where it might be desirable to transfer the boats through a great height, they might be passed at one lift through a shaft into a tunnel below, at any depth that might be required.

After the reading of the paper the author observed, that in former plans for lifts there was danger of the boat suddenly striking the surface of the water, with the momentum of descending, but that was not possible in the present plan: the boat was necessarily stopped before reaching the surface of the water, and it was then lowered into the water gradually by a second movement. The boat was completely guided in its situation over the caisson; and there was no danger of the boat going wrong in working the lift; even if a boat happened to be caught by the top of the caisson in lifting no damage could be done, as the man would not be able to lift it, having only power enough to overcome the friction of the apparatus. In this plan, there was no risk of loss of water from carelessness or accident; but, in some plans, where the end of the canal was closed by a sluice, a boat striking the end, by coming in too fast, might do serious injury, and risk the loss of the water in that section of the canal. The expense of locks might be estimated at about 1000*l.* each; and for a height of three locks, or 21 feet, the cost would be about 3000*l.*, and the lift would be about the same; but the higher they went with the locks, the better would his plan be suited, and the saving proportionally greater, as most of the expense of the extra locks would be saved. He observed, that his object was to show the applicability of the lift, leaving those interested in canals to judge of its advantages.

ON THE PRESERVATION OF TIMBER BY CREOSOTE.*

By J. E. Clift, of Birmingham.

(*With Engravings, Figs. 5 and 6, Plate* XXIII.)

In the present day, when the requirements for timber in the various mining, engineering, and other works are so great, it becomes necessary to consider carefully the best means of rendering it as durable as possible, and that at the least expense; and the writer cannot think that sufficient attention has been paid to the subject by the parties most interested, from the fact that but few of the larger consumers of that article have adopted any plans for its preservation; and this fact must be the apology for bringing before the Institution a paper upon a process which has been partially in use for several years.

In looking through the colliery districts, it is found that thousands of loads of timber are taken green from the forests and used every year; and the greater portion is used in the pits where, owing to damp atmosphere and increased temperature, it is rotted in a few months; whereas, with a small expense, it might be made to last for years. It may be observed, also, that the railway engineers are seeking for a more durable bearing for the rails in iron sleepers, and overlooking the means of making wood, which is allowed to be the most agreeable for travelling upon, and the most durable, as well as the most economical, material for the permanent way.

The plan which is the subject of the present paper is the one invented by Mr. Bethell, for the use of a material obtained by the distillation of coal-tar. This material consists of a series of bituminous oils, combined with a portion of creosote, this latter substance being acknowledged to possess the most powerful antiseptic properties. The action of this material may be thus described:—When injected into a piece of wood, the creosote coagulates the albumen, thus preventing the putrefactive decomposition, and the bituminous oils enter the whole of the capillary tubes, incasing the woody fibre as with a shield, and closing-up the whole of the pores, so as entirely to exclude both water and air; and these bituminous oils being insoluble in water, and unaffected by air, renders the process applicable to any situation. So little is this oil affected by atmospheric change that the writer has seen wrought-iron pipes that had merely been painted over with it, and laid in a light ground 1 foot beneath the surface, taken up after twenty years, and they appeared and smelt then as fresh as when first laid down. By using these bituminous oils, the most inferior timber, and that which would otherwise soonest decay from being more porous and containing more sap, or being cut too young or at the wrong season, is rendered the most durable. This will be readily understood when it is considered that this porous wood will absorb a larger portion of the preserving material than the more close and hard woods: in fact, the soft woods are rendered hard by this process. By this means, therefore, engineers will be enabled to use a cheaper timber with greater advantage than they could use

* Paper read at the Institution of Mechanical Engineers, October 22nd, 1851.

a more expensive timber uncreosoted; thus, taking the cost of a sleeper of American yellow pine at 4*s*., and one of Scotch fir at 3*s*., and then adding 1*s*. to the latter for creosoting, the two would be the same cost; but the former one would last, under the most favourable circumstances, not more than ten or twelve years, and the other would be good, under any circumstances in all probability, in a hundred years.

This system of preserving timber has been in use on several railways, and other works, for several years past. A portion of the London and North-Western Railway, about 17 miles in length, has been laid with the creosoted sleepers from nine to eleven years, during which period the engineer reports that no instance has occurred in which any decay has been detected in them; and they continue quite as sound as when first put down. On the Stockton and Darlington Railway creosoted sleepers have also been laid for ten years, and are found to continue without any appearance of change or decay; also, on the Lancashire and Yorkshire Railway creosoted timber has been used for five years, as paving-blocks, posts, &c.: the upper part becomes very hard, and the part underground appears as fresh as when taken out of the creosote-tank, though the timber was of inferior, sappy quality. In a trial commenced twelve years since, by Mr. Price, of Gloucester, of the comparative durability of timber in the covers of a melon-pit, where it was exposed constantly to the combined action of decomposing matter and the atmosphere, the unprepared timber became decayed in one year, and required replacing in a few years; a portion of the timber that had been Kyanised lasted well for about seven years, but then gradually, though very slowly, became quite decayed; but the timber that had been creosoted still continues as sound as when first put down, twelve years since. From these facts, it appears not unreasonable to infer, that if timber be made to continue unchanged, and to show no symptom of decay for ten or twelve years, under circumstances that reduce unprepared timber to dust in two years, and in the absence of any proof to the contrary, we may expect to find that it will last an unlimited period, and that one hundred years will be a moderate life to assign to it. And not only does this creosoting process render wood free from decay, but it also preserves it from the attacks of the teredo worm, when used for shipbuilding, harbours, docks, and other work contiguous to the sea.

This has been satisfactorily proved at Lowestoft Harbour, where the plan has had a very extensive trial for four years; and the superintendent reports that there is no instance whatever of an uncreosoted pile being sound; they are all attacked by the limnoria and the teredo to a very great extent, and the piles in some instances are eaten through; but there is no instance whatever of a creosoted pile being touched, either by the teredo or the limnoria, and all the creosoted piles are quite sound, though covered with vegetation, which generally attracts the teredo. This extraordinary fact is to be accounted for by the creosote remaining intact in the timber, either wet or dry; and, being destructive to all animal life, is proof against the attack of these parasites;—whereas, with the other processes, the metallic salts are washed out, or that portion which unites with and coagulates the albumen is rendered quite innocuous by the process. Several specimens exhibited proved that the ravages of the worm reduce the unprepared timber to a completely honeycombed state in two years; but the creosoted timber remains untouched after a period of four years.

There are two processes in use by Mr. Bethell, for impregnating timber with creosote;—one is by placing the wood in a strong iron cylinder, and exhausting the air from it by an air-pump, until a vacuum is created, equal to about 12 lb. on the square inch; the creosote is then allowed to flow into the cylinder, and afterwards a pressure is put upon the creosote, by a force-pump, equal to about 150 lb. on the square inch; the timber when taken out is fit for use.

The second process is by placing the timber in a drying-house, as shown in figs. 5 and 6, Plate XXIII., and passing the products of combustion through it; thereby not only drying the timber rapidly, but impregnating it, to a certain extent, with the volatile oily matter and creosote contained in the products given off from the fuel used to heat the house. When the timber is taken out of this house, it is at once immersed in hot creosote in an open tank, thus avoiding the use of a steam-engine, or pumps.

A A, Drying-house, built with hollow walls, filled in with ashes. B, Fire-place. C C, Flue, running the whole length of the building, covered with iron-plates, perforated for half the length farthest from the fire, to allow the products of combustion to pass through the timber on the way to the chimney. D, Carriages for holding the timber E, that is to be creosoted, running on a railway for facilitating the charging and discharging of the drying-house. F, Iron doors, closing the end of the drying-house.

Specimens were exhibited of creosoted sleepers which had been in use for ten years on the London and North-Western Railway, they were still perfectly sound and unchanged; also specimens of creosoted piles from Lowestoft Harbour, which had been in the sea for four years, and continued quite fresh and sound, and without being touched by the worm; with specimens of similar piles uncreosoted, from the same situation, which were completely eaten away and honeycombed by the worm in the same period.

Mr. Bethell observed, that when he first commenced to preserve timber, he found that no pressure would get the creosote into the timber from the presence of the moisture in the pores, and it became necessary to adopt the system of drying the timber first; and after fourteen days he found that the wood lost 3lb. in weight in every cubic foot; this was by the old process of drying. He then introduced the present drying-house, and in twelve or fourteen hours they lost 8lb. per cubic foot, in Scotch sleepers, and these then absorbed an equal weight of creosote. An average of 11½lb. of creosote per cubic foot was now put into all the Memel timber at Leith Harbour works; it was forced in with a pressure of 180lb. per inch. One piece of creosoted timber had been observed at Lowestoft, which had been half cut through for a mortice, but not filled up again, and a teredo had penetrated a little way into it at that part, and then attempted to turn to the right, and then to the left, and had ultimately quitted the timber without proceeding any further. Young wood was the most porous round the exterior, and consequently absorbed most creosote, which formed a shield to keep off the worm. The creosoted sleepers were better after eight or ten years than when new, because the creosote got consolidated in them and rendered them harder. He had taken the idea originally from the Egyptian mummy; it was exactly the same process; any animal put into a creosote tank assumed the appearance and became in like condition to a mummy. Timber creosoted was now chiefly used in railways, but he believed that if it was introduced into coal-pits it would be found that no timber so used in those places would rot.

Mr. Clift said he had taken up the subject in the present paper with the object of drawing attention to pit timber, and he was satisfied that if the timber used in coal-pits was creosoted, it might, when done with in one situation, be again taken out to use in another place; whereas now, because the dry rot seized the timber so quickly, it was left behind in the workings of the pits.

Mr. Bethell, in answer to questions put by the Chairman, said, that every piece of timber was weighed before it was put into the creosote tank, and again when taken out, and each piece was required to be increased in weight by the process 10lb. per cubic foot; the quantity of oil used always rather exceeded the weight gained in the timber, on account of the loss of weight from the moisture extracted by the exhaustion of the air-pump. Oak only absorbed half as much creosote as Memel timber. Common fir creosoted would last double the time of hard wood creosoted, because it took more creosote. Beech made the best wood, being full of very minute pores, and they could force a greater quantity of creosote into the beech than into any other wood; consequently it took a more uniform colour throughout from the process.—Long pieces of timber were found to require more time to saturate them in proportion to their length, and the creosote appeared to enter at the two ends and be forced up through the whole length of the pores. The progress was known by the quantity of creosote forced into the tank after it was filled, according to the number of cubic feet of timber contained in the tank.

ON THE THEORY OF MECHANICS, AS APPLIED TO WORKS OF CONSTRUCTION.

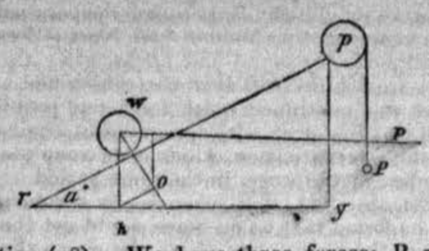
By J. G. B. Marshall, B.A., C.E.

Professor of Mathematics, Surveying, and Civil Engineering, Royal Agricultural College, Cirencester.

Of the Inclined Plane, the Screw, and the Wedge.

The inclined plane is the next mechanic power to which we have to attend. It is a plane as rigid and smooth as possible, intended to offer no resistance by its friction, and to allow bodies to move freely on it. We shall, for the present, suppose it capable of affording these facilities completely, though it may be remarked here, that from the nature of all matter, it cannot be made perfectly so.

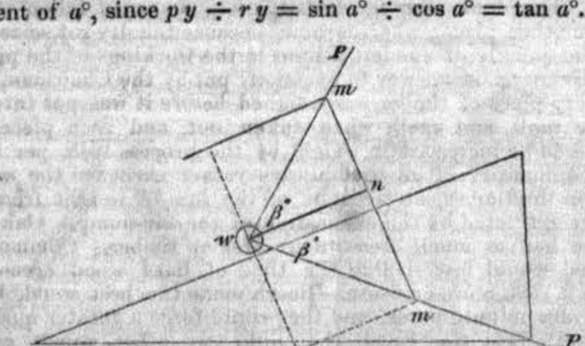
Let the figure represent such a plane in section, with a pulley, over which the power acts by a cord. We wish to determine what power (P) would be required to support a given weight (W) on a



given inclination ($a°$). We have three forces: P, acting in the direction W p, (the tension of the cord is equal throughout); W, acting in a vertical direction of the vertical (W n); and the resistance of the plane, which must be perpendicular to itself. These three forces we suppose to be in equilibrio; they may therefore be represented relatively by three lines forming a triangle when drawn in their directions—such as W n o. Every one can see that this triangle is similar to $r\,p\,y$; wherefore the sides of $r\,p\,y$ also represent the relative magnitudes of the three forces.

Hence W $n : no :: rp : py ::$ W : P $=$ W $\times \frac{py}{rp}$; or the power is to the weight as height of the plane to its length. Now, $\frac{py}{rp} = \frac{\sin a°}{\text{radius}}$; hence this ratio may also be used for calculating. If the angle of inclination be 30°, $\sin a° = \frac{1}{2}$. Let W $=$ 100 lb.; $\therefore$ P $=$ W $\times \frac{\sin 30°}{\text{radius}} = 100$ lb. $\times \frac{1}{2} = 50$ lb., showing that 50 lb. suspended at P would support 100 lb. as at W. In every case the power varies with the sine of the inclination.

If the power P act in a direction (as P′) parallel to the horizon or base of the plane, as is the case with horses drawing, &c., the three forces are perpendicular to the three sides of the triangle $r\,p\,y$; and therefore form a triangle similar to it. Wherefore $p\,y$ represents P; $r\,y$ represents W; and P : W :: the height : the base of the plane; and the ratio between them may be expressed by the tangent of $a°$, since $py \div ry = \sin a° \div \cos a° = \tan a°$.



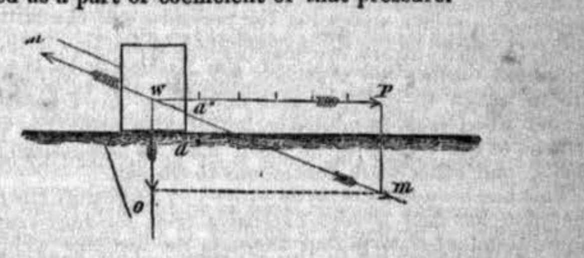
In general, if P act in any direction making an angle ($\beta°$) with the plane, it may be resolved into two other forces, one perpendicular, and one parallel, to the plane,—as $m\,n$ and W n, W m representing P. When W m ($=$ P) is taken as radius, $m\,n$ $= \sin \beta$, and W $n = \cos \beta$; $m\,n$ is equilibrated by the resistance of the plane if P falls in the lower position, so as to cut the plane; and it is lost in pulling W up from the plane if P acts in the upper direction. In any case so much of it is lost, and P . $\cos \beta$ alone remains to pull W up the plane; when P acts parallel to the plane, or when $\beta° = 0°$, $\cos \beta = 1$ and P produces its maximum effect, which has been pointed out in relation to W. Thus it appears that the most advantageous direction for P is parallel to the plane.

This method of calculation admits of a very beautiful application in the consideration of the *limiting angle* of friction, as it is called. There are three kinds of friction: first, the friction of rolling bodies on wheels, cylinders, &c.; second, friction of rest, or that force which prevents one body moving over, or sliding on, another when the force tending to cause it to do so has no effect, being equilibrated by such friction; and third, the friction of motion, or the force which depends on the mutual contact of bodies which actually do move on each other, and which tends to stop or retard such motion.

The first kind of friction scarcely deserves the name: it is a very slight force, and depends chiefly on the mutual cohesion of surfaces in contact, for when a body rolls on another, some part of it is being constantly separated from that other; and this separation, at any point, is instantaneous, and in a direction at right angles to both surfaces. This, therefore, we shall not farther dwell upon.

The friction of rest also depends on the mutual cohesion of surfaces in contact; and it may be of any intensity (always equalling the force tending to produce motion) below a certain limit, which, when attained, permits motion—converts it into the friction of motion, the most important and only one of the three kinds to which we shall allude in detail. If a body rest on a horizontal plane, and some force acting parallel to the surface tends to move it along that plane, and if the force be not sufficient to produce motion, it is clear that it must be equilibrated by some counter-force, which must be equal to itself. However small this force so acting to move the body may be, the counter-force must still be equal and opposite to it; and thus the whole resistance of friction may not be required. Part of it may be latent, so to speak. The case in which it is all required, or called into play, which is the limit between friction of rest and that of motion—the condition bordering on motion—is the one which we shall now consider.

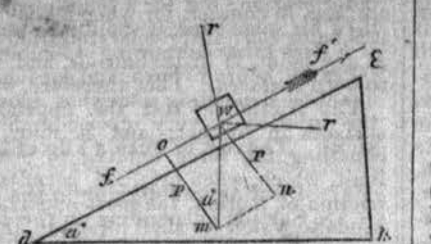
We may premise that friction depends on the nature, extent, and pressure of the surfaces in contact. A rough surface, or a soft and adhesive one, will afford more friction than a smooth and hard one; hence, the greater the extent of surfaces presenting this rough or soft character the greater the amount of friction; and hence, also, the more forcibly they are compressed the greater the amount of friction will be. But for the same surfaces, or for surfaces perfectly hard and smooth, the friction depends on the pressure, and varies with it in a direct ratio. It may, therefore, be expressed as a part or coefficient of that pressure.



For the purpose of finding the value of this coefficient, suppose a body rests on a level, hard, smooth, and horizontal plane, and a force (P) tends to move it along that plane. Let W $=$ the weight of the body, and take as many units of line (W o) as W contains units of weight (lbs. or cwts., &c.); and take as many units (W P) of line as P (the pressure which produces the state bordering on motion) contains units of pressure equal to those of W. Complete the rectangle W P m o; W m is equal and opposite to, or represents in magnitude and direction the resultant of the power (P) and the weight (W). We have now two forces W and P in action; but P cannot equilibrate W, since it is not on the line of its direction. W is equilibrated on the contrary, by the resistance of the plane. There must be some force acting in opposition to P which is equal to it: let us denote it by $f =$ P. It can be no other than the friction.

Thus it appears that W and P produce a resultant represented by W m, and that they are themselves individually counteracted by the resistance of the plane and friction respectively; their resultant must also be equilibrated by the same forces, or which is the same, the plane's resistance and f would produce a resultant (W m') equal and opposite to W m. We have now three forces in equilibrio—namely, P, W, and one equal and opposite to W m. What is the relation that exists between them? Since o W P is a right angle, if $a° = o$ W m, and W $m =$ radius, W $o = \cos a°$, and $om = \sin a°$, the radius being the same for both. But P : W :: W P : P $m = om$: P m $\therefore$ P : W :: $\sin a° : \cos a°$, and P $=$ W $\frac{\sin a°}{\cos a°}$ $=$ W . $\tan a°$ $\therefore f$ varies as $\tan a°$. The fact that the friction is proportional to the pressure (W), and could be connected with it by a coefficient (called the coefficient of friction), has been proved by experiment; but we are not aware that it has been proved before by theory. This coefficient has been shown to be the tangent of the limiting angle of friction, which is $a°$ in our case. It is equal to the angle of inclination of an inclined plane, on which a body would just border on motion in obedience to gravity or its own weight.

Let $d\,e\,h$ represent the section of an inclined plane whose angle $a° =$ the limiting angle of friction, and suppose a weight W placed on it; W acts vertically or along W m. It may be resolved into two forces, one perpendicular to the plane represented by W n, or $o\,m$—call it (P); and one parallel to it represented by W o, or $m\,n$ — call it (f). The angle $e\,d\,h = o\,m$, W $= a°$, and W $o = \sin a°$; and $o\,m = \cos a°$, when W $m =$ radius. Therefore $P : f :: o\,m : W\,o :: \cos a° : \sin a° \therefore f = P \frac{\sin a°}{\cos a°} = P \,.\, \tan a°$. P is the part of W which acts as a pressure on the plane; and f is that part which tends to cause it to slide down. P is resisted by the plane, and f must be equilibrated by the friction, which is therefore equal and opposite to it; and thus the friction equals the pressure multiplied by a coefficient, which we find equal to the tangent of the angle of inclination of the plane. We supposed that this was the limiting angle of friction, or that angle which caused all the forces to be required for maintaing the equilibrium, and no more—that is, that none of the force was lost. f is equal to a force which, acting in an opposite direction (f'), would support W on the plane if it were not capable of offering any resist- in the way of friction. If f' acted in any other direction, as r, or r', it would lend part of its effect to increase or diminish the pressure on the plane, which part might be calculated by a similar resolution of f' into two forces perpendicular and parallel to the plane, the former increasing the pressure, and the latter acting in supporting the body. The coefficient of friction then, or the constant multiplier which connects the friction with the pressure for any given surface and circumstances, is the tangent of the angle contained by the directions of that perpendicular pressure, and the force acting in the direction of the motion. This perpendicular pressure and this force must be deduced by calculation as above.



The Screw may be considered as an inclined plane rolled round a cylinder. The power is applied at the extremities of a handle fixed at right angles to this cylinder. This handle and cylinder resemble the wheel and axle; and the method of estimating the moment at the circumference of the cylinder from that of the power at the circumference described by these extremities, is the same as has been mentioned in the case of that mechanic power. Now, this force or moment, so calculated, acts in a direction parallel to the base of the inclined plane; therefore its ratio to the weight shall be the same as was proved to exist in the case of the inclined plane when the power acted in a direction parallel to the base of the plane—that is, P : W : : h : b, where b is the base, h the height, and P the moment of the power at the circumference of the circle described by its point of application. But the ratio of the height to the base may be expressed by the length of the circumference of the cylinder, divided by the vertical distance between two threads of the screw, since one would be the base, and the other the height of so much of the inclined plane; wherefore P : W : : c : n, where $c =$ circumference of cylinder or screw, and $n =$ the distance between two threads. The screw is composed of such a cylinder, and another hollow one similarly formed inside with wires or *threads* as they are called. The former, or solid cylinder, is called the male, and the hollow one the female screw. A weight is raised or moved by turning the male screw, so that it slides up the threads of the female screw.

The Wedge is a machine used for forcing between two bodies, so as to separate them or raise the one from the other. It may be considered as two inclined planes whose bases are joined. The power acting perpendicularly to the back may be represented by that back, and the weight acting perpendicularly to the two faces may also be represented by them. We shall then have the power to the weight as the back to the sum of the two faces; therefore, when the wedge is isosceles, the weight shall be to the power as twice the length of one face is to the breadth of the back.

New Bridge at Putney.—The proprietors of Putney Bridge have given notice of their intention to apply to parliament for power to erect a new bridge in lieu of the present one, which is sadly inadequate to the public requirements.

NOTES ON CONSTRUCTION.

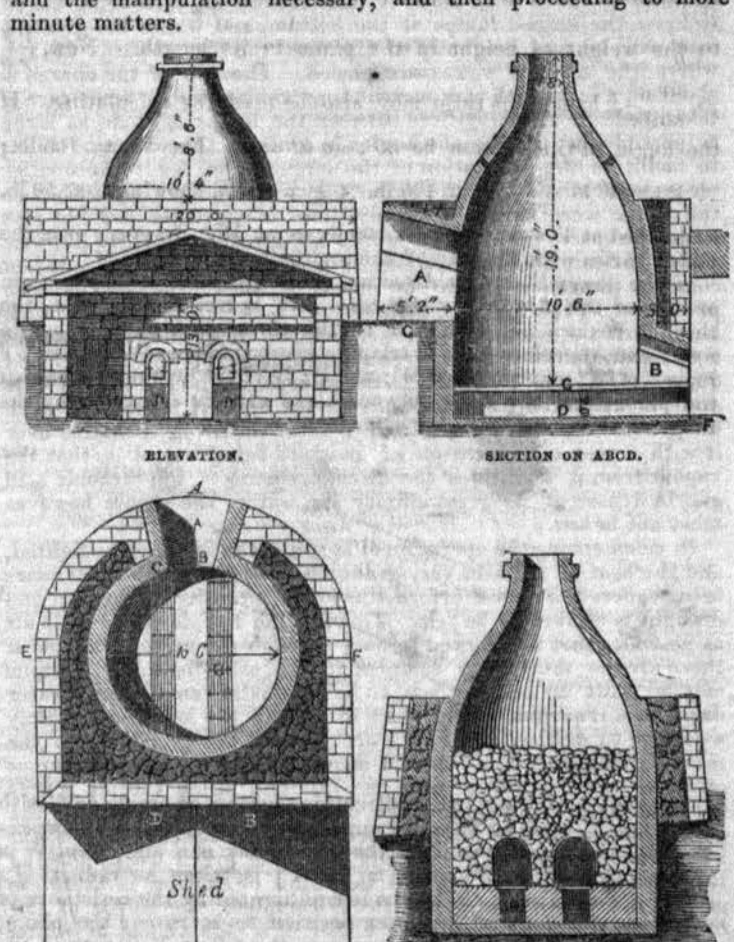
By SAMUEL CLEGG, Jun.

*** These Notes, when completed, will be published in a separate form, as a Hand-Book for the use of the Students at the School of Construction.

On the Burning of Limestones.

IN England the operation of calcination is left almost entirely to the lime-burner, and the engineer receives his material in the state of quicklime, the virtue of which is very generally so well known, that he mixes it up for extensive use without previous trial of its virtues. This, however, would not be the case in new countries, or in those districts removed from spots where lime burning is carried on as a trade: he must then be his own lime-burner, and the knowledge of the best processes followed, both as to fuel and form of kiln, must be studied by him.

The art of lime-burning consists in calcining the greatest quantity of material with the least expenditure of fuel, of time, and of manual labour. To gain this end, the preparation of the limestone, its arrangement in the kiln, the arrangement of the fuel, the regulation of the heat and draught, and the proper cooling of the lime, must be attended to. The general process will probably be more easily understood by first giving the description of a kiln and the manipulation necessary, and then proceeding to more minute matters.



ELEVATION. SECTION ON ABCD.

PLAN. SECTION ON EF.

A, Hatchway.—B, Furnace doors.—C, Grate bars.—D, Ash pit.—E, Rough chalk arches.—F, Level of ground beneath shed.—G, Level of ground at hatchway.

The kiln shown in the woodcut, called a flare or dome kiln, is used by the most extensive lime-burners in Dorking, and is similar to all those used in the vicinity of London, only they are sometimes placed in pairs or three or four together; this arrangement, by exposing a less surface of wall to the cold air, slightly diminishing the expenditure of fuel; but it is probably adopted more with a view of saving labour than fuel, as the fireman has all the fires under his immediate control. The interior of the kiln is of a circular, bottle-shape, the diameter at the bottom being 10 ft. 6 in., the wall is carried up plumb to a height of 7 feet, at which point the dome is commenced, which closes in the kiln, leaving only an opening at the top 1 ft. 8 in. diameter and 2 feet high, as a chimney, the total height from the hearth to the top of the chimney being 19 ft. 6 in. The thickness of the brickwork to a height of 11 feet is 14 inches, which is the level of the top of a surrounding wall of rubble work; from this height to the top the thickness is 9 inches, including the lining of fire-brick. The surrounding wall of rubble is of a horse-shoe form; the circular part 20 feet diameter, and the depth from front to back 19 feet; it is about 18 inches thick, batters about 6 inches, and the space between it and the brickwork of the kiln is filled in with rubbish. At the back of the kiln and 3 ft. 6 in. above the grate bars, a doorway is made 6 ft. 6 in. high, and 4 ft. 8 in. wide, arched over with a 9-inch brick arch, through which the kiln is filled. On the opposite side to this opening are two furnace doors, the grates 1 ft. 6. in. wide, extending to the back of the kiln. The furnace mouths are funnel-shaped, and are 3 ft. 6 in. high above the grates in the inside, this construction making it convenient for turning the rough arches of the limestone when filling the kiln. A shed is built on this side to protect the workmen and the fuel from the weather. In charging the kiln, brushwood is laid over the grates, with a stratum of coals upon it, to form the fire. Large lumps of limestone are then brought in at the doorway, and a rough arch about 3 feet high and 2 feet wide, so firmly built over each grate, that the superincumbent weight of stone may not crush them; the lumps are generally trimmed to shape that they may bed properly. Upon these arches the general mass of stone to be burnt is then thrown in, care being taken to keep the largest lumps at the bottom, and where the greatest heat will be, and gradually to diminish the size towards the top where the smallest pieces are placed. The top of the charge is about on a level with the surrounding rubble wall. Some care is taken to leave the interstices between the lumps of stone as large as possible, by placing the angles in contact: the object of this is to facilitate the calcination of the large lumps, for if the smaller pieces were mixed with the larger they would be *over burnt** before the latter were nearly calcined; there is a greater draught also when the spaces between the stones are greater, and this likewise assists to burn the large lumps as quickly as the small. When compact limestone is to be burnt it should be broken into pieces not exceeding a fist in size. Chalk lumps may be much larger. If the stones are broken into too small pieces, the spaces between them will not give free enough passage to the draught and flame. The stone thrown into the kiln should not be too dry—its state as just taken from the quarry is the best; if it has lost much of its natural moisture by lying by, water should be sprinkled over it with a rose. The reason of moisture being useful is, that the vapour from it facilitates the disengagement of the carbonic acid gas, by reason of its great affinity for water; the stones however must not be *wet*.

In commencing the operation of burning, the fire must be lighted, and the heat of the kiln very gradually raised, from 15 to 20 hours being suffered to elapse before the whole intensity of the fuel and draught is allowed to be felt. To keep the fire down, as little air as possible must be allowed to pass through the grate bars; and if there are no shutters or dampers to the ash-pits, lumps of stone may be built up before them, to be gradually removed as greater draught is required. The effect of raising the heat too suddenly would be to destroy the rough arches over the grates, when the mass above them would fall and smother the fire; also the lumps of stone would splinter, and the splinters filling the air spaces between them would destroy the draught. This attention to the gentle increase of the heat is more especially necessary in a *new* kiln, when the sudden heat would burst the green work; hooping the kiln with iron, to prevent this kind of danger, is therefore practised. When the calcination is complete, the colour of the flame from the chimney will be either of a pale yellow or white, with no smoke; the stone in the kiln will have settled down to the extent of a fifth or a sixth of the entire mass, and the whole will present a glowing red heat, or a whitish rosy tint. The experienced lime-burner will know by these indications that his charge is worked out; but those who have not had much practice should take out a piece of the stone from the kiln, remove the outer coating, and slake the inside portion in water; if no effervescence ensues upon the application of an acid having a stronger affinity for the base than the carbonic acid (nitric or sulphuric for instance), the calcination is complete. When this is ascertained to be the case, the fire may be raked out, and the kiln suffered to cool gradually. If the ash-pits and all vents are closed, the effect will be favourable to the lime, which will be harder, and will keep longer exposed to the air, so that it can be conveyed to greater distances without deterioration; but for a long journey, or if the lime is not to be used for some time, it should be put into tight casks.

A flare kiln, containing 45 cubic yards of Dorking grey chalk, takes 48 hours to burn, and consumes about seven tons of coal, the quantity depending somewhat upon the dryness of the chalk; but the variation is very inconsiderable, never exceeding five or six sacks. The cost of such a kiln of lime is about the following:—

	£	s.	d.
Blasting and digging in the quarry............	0	12	0
Carting (depending on the distance) say* ...	0	10	6
Turning rough arches and filling	0	16	0
Labour for burning	0	18	0
Emptying at 3*d.* per cubic yard.....	0	11	3
	£3	7	9

To this must be added the price of the 7 tons of coal used as fuel, and the value of the land from which the limestone is taken. The price in London per cubic yard for Dorking lime is 10*s.*

A kiln in constant use will not last more than eighteen months or two years without being relined. It is economy, therefore, to use the best Stourbridge bricks, set in fire-clay in the original construction.

* Pure lime is incombustible, and therefore cannot be over burnt; but lime containing the impurities necessary to render it a weather lime, easily fuses and becomes covered with a kind of enamel; it slakes with great difficulty, sometimes it will not slake at all, but becomes reduced to a harsh powder altogether inert, and is called *dead lime*.

* In selecting a position for the kiln, it should be chosen in a spot as near to the quarry as possible, for as the stone loses about ·45 per cent. in burning, it is more economical to move the remaining ·55 per cent. than the original heavy stone. A sloping bank should also be chosen, that the natural ground may be on a level at the back with the bottom of the hatchway, and at the front with the bottom of the ash pits.

EXPERIMENTS ON THE FORM OF SHIPS AND BOATS.

Hints on the Principles which should regulate the Forms of Ships and Boats; derived from original Experiments. By Mr. William Bland, of Sittingbourne, Kent.

(*Continued from page* 539.)

Fifth.—In Experiment 82, the model Q was tested against R. The dimensions of Q are 8 inches in width, 28 inches long, and the weight 5 lb. 1 oz.; and those of R, 11 inches wide, 28 inches long, and weight 5 lb. 1 oz., also. Likewise, it is there shown the model Q beat in speed the model R by 4 oz. extra weight. The stability of Q equalled 24 oz., and that of R 29 oz.

The extra weight of 4 oz. is one-twentieth of 81 oz., and the stability of R exceeded that of Q by 5 oz., which is rather more than one-fifth of 24; and, estimated in ounces, will, in 81 oz., the weight moved, equal 16 oz.; and, minus the 4 oz. extra weight, the measure of the superior speed of Q, leave 12 oz. as the advantage, ultimately, of R over Q. Admitting the above to be correct, then R, under sail, and of equal weight with Q, will beat that, or any other of the same length, but having the beam of less dimensions. The two models Q, and R, sank in the water $\frac{7}{8}$-inch when of the same weight and with the addition of the 4 oz. extra, or total 85 oz.

Sixth.—In Experiment 83, the model Q was tested against T, the dimensions of these two boats being the same in width, length, and weight. The result of their speeds is also denoted—that T beat Q by 32 oz. The stability of T equalled 16 oz., and that of Q 23 oz.

Therefore Q has more stability than T by nearly one-half, being 7 oz., which, if put in ounces, equals $30\frac{1}{2}$ oz. But the extra speed of T was 32 oz.; and, taking $30\frac{1}{2}$ oz., or $32 - 30\frac{1}{2}$, leaves the sum of $1\frac{1}{2}$ oz. on the side of T, which would in consequence, under equal weight and sails proportionate to their stabilities, beat Q by the said extra weight of $1\frac{1}{2}$ oz. The models Q and T sank into the water when of the same weight, thus: Q sank $\frac{13}{16}$-inch, and T sank $1\frac{1}{16}$-inch.

The inference which may be drawn from these calculations is, that Q, if lengthened, would beat R; and R, if made longer than Q, would again beat Q. Moreover, if a model, say S, be made of the same proportional length and breadth of R, before lengthened, meaning the breadth at the midship to be two-fifths of the length, but the length of S to equal the length of R, increased, the breadth of S will then exceed the breadth of R, whose length alone had been added to, and therefore would be beaten by S.

Chapter XV.

It has been seen in the investigations of the preceding Chapter, that when any two of these models were of equal weight and equal length, the one with the greatest breadth of beam beat the other. In the Experiments on Stability numbered 8, and Scale C, it is shown, when the thickness or depth of flotation is varied, the breadth and length being preserved constant, the greatest stability exists at one-fifth of the beam.

Now, it has been before-mentioned in the last chapter relative to the depths of the lines of flotation, that in some instances, as in Experiment 80, in I, it exceeded the one-fifth; and in others, as in Experiments 81, 82, it was less. Upon testing a few of the models between one-fifth and one-fourth for the line of flotation, the following proved to be the case.

Now, with the models I and O, each having their lines of flotation situated between the one-fifth and one-fourth, which in the model I equals $\frac{3}{8}$-inch, and in O equals $1\frac{3}{8}$-inch, at this depth, the weight of I was required to be increased until it altogether equalled 39½ oz; and model O equalled 78 oz.

In the Experiment No. 80, the models I and O, being then of equal weight, the speed of I beat the speed of O by 21 oz. Under the present circumstances, O exceeds the weight of I by 39 oz.; therefore I has the advantage over O of 21 oz. and 39 oz., or together 60 oz. With respect to the stability possessed by these two models, I and O, it was found upon trial that I in stability equalled 2½ oz.; and O equalled 8½ oz., showing O to have 6 oz., or two stabilities above I, which in weight equals 78 oz.; but take away the 60 oz., and there remains 18 oz. in favour of the model O, when under sail.

Likewise, in the same chapter, it is stated of the models O and Q, that when of equal weight, O beat Q by 64 oz. extra weight. Upon causing the model O to sink in the water until its load-line was between one-fifth and one-fourth, it required an increase of its weight, as before given, up to 78 oz.; and Q to equal 152 oz. The stability which each now possessed, was in O 8½ oz., and Q 32 oz. —that is to say, the model Q possesses (let it be granted) two and a-half stabilities above the model O, or in oz. 78 + 78 + 39 = 195. However, from this sum must be taken the extra weight of Q above O, which is 74 oz., together with the 64 oz. the extra weight in speed, and equalling 138 oz.; or 195 — 138 = 57 oz., which number of ounces is on the side of Q, when under sail proportionate to its stability.

Again, with regard to the models Q and R, that when of equal weight Q beat R in speed by 4 oz. extra weight. It has been mentioned before of the model Q, when the line of flotation was made one-fifth and one-fourth of the beam, that it required the whole weight to be 152 oz. The model R to be similarly circumstanced, required its whole weight to amount to 292 oz.; and the stabilities of these two models was in Q, equal to 32 oz.; and in R 42 oz; therefore, in the present instance, R has one-third of a stability above Q, which in ounces equals 152 ÷ 3 = 50; but from this sum the extra weight of R above Q must be deducted. Now the weight of R equals 292 oz., and that of Q 152; then 292 — 152 equals 140 oz., which, with the 4 oz. representing the speed of Q above R, comes to 144 oz. The superior stability of R has been shown to be 50 oz.; therefore, 144 — 50 = 94 oz., by which Q beat R in speed.

From the above result it is clear that for the model R to beat in speed the model Q, it will be necessary to place the line of flotation considerably lower than one-fifth, so as to materially lighten the whole weight of R. But upon taking out 96 oz. from R, thus leaving 196 out of 292 oz., the stability of Q, as before, equals 32 oz.; and that of R equals 34 oz.; and R sank in the water with the reduced weight down to $1\frac{5}{16}$-inch, and Q also to $1\frac{13}{16}$-inch. The difference in the present stabilities is 2 oz. for R, which in ounces = 152 ÷ 32 = $4\frac{2}{3}$ for each ounce; and, therefore, the 2 oz. of greater stablity = 9 oz.; and being taken from 196, or 196 — 9 = 187, and 187 — 152 = 35 oz. of speed against R.

Again, after lightening the model R until it equalled in its whole weight 152 oz., the same as the model Q, the stability of R was now tried, and found to equal 32 oz., equalling that of Q; and R sank only to $1\frac{3}{8}$ inch.

It has been previously mentioned Q beat R in speed when they were of the same weight, by 4 oz.; consequently, their stabilities being now the same, Q will, under sail, again beat R. Before, however, the result was quite contrary, as R by its superior stability beat Q. This being the case, it then appears for R again to beat Q, more weight must be removed out of R; that is to say, until it is of the same precise weight as it was, as in Experiment 83, namely, 81 oz. instead of 152 oz.

When the models Q and T were made to sink down into the water to the depth of between one-fourth and one-fifth of their midship breadth, the weight was required to be increased till it amounted in the total of the model Q, as before given, to = 152 oz.; and that of T to = 140 oz.

In consequence of the above additional weight, the stability of T equalled 18 oz.; and that of Q 32 oz.

It appears then from these stablities, that the model Q has the advantage over T to the amount of three-fourths of a stability and which, if put into ounces equals 105, the stability and weight of T. Q exceeds T in weight by 152 — 140 = 12 oz.; but the extra speed of T over Q = 32 oz., which sum must be deducted also; then Q beats T in speed, when both are under sail, by the number of 105 — 12 — 32 = 61 oz.

I.—TABLE *of the difference of the Speed between the Six Models when Towed through the Water.*

Model.	Shape	Beam.	Weight	Result.
		Inches.	Ounces.	
I	Bird	4	37	O beaten by 21 oz.
O	Bird	5½	37	
O	Bird	5½	52	P beaten by 27 oz.
P	Oblong	5½	52	
P	Oblong	5½	52	Q beaten by 20 oz.
Q	Oblong	8	52	
O	Bird	5½	52	Q beaten by 64 oz.
Q	Oblong	8	52	
Q	Oblong	8	81	R beaten by 4 oz.
R	Bird	11	81	
Q	Oblong	8	70	Q beaten by 32 oz.
T	Bird	8	70	

I is the swiftest, O the second, T the third—all of the bird shape.

II.—TABLE *of the difference of Speed between the Six Models when considered under sail proportional to their Stabilities and carrying a light Load.*

Model	Shape.	Beam.	Weight.	Depth	Stability.	Result.
		Inches.	Ounces.	Inches.	Ounces.	
I	Bird	4	37	0 15 16	2½	I beaten by 62 oz.
O	Bird	5½	37	0 11 16	8	
O	Bird	5½	52	0 15 16	8½	P beaten by 11 oz.
P	Oblong	5½	52	0 6·8	12	
P	Oblong	5½	52	0 6·8	12	P beaten by 19 oz.
Q	Oblong	8	52	0 5·8	21	
O	Bird	5½	52	0 15 16	8½	O beaten by 8 oz.
Q	Oblong	8	52	0 5 8	21	
Q	Oblong	8	81	0 7 8	24	Q beaten by 12 oz.
R	Bird	11	81	0 13 16	29	
Q	Oblong	8	70	0 13 16	23	Q beaten by 1½ oz.
T	Bird	8	70	0 7 8	16	

The model R is the swiftest under sail with the light load, T the second, and Q the third—Q being of oblong form, R and T of the bird shape.

III.—TABLE *of the difference of Speed between the Models when supposed to be under Sail proportionate to their Stabilities, and so Loaded as to draw between one-fourth and one-fifth of their Beams deep in the Water.*

Model.	Shape.	Beam.	Weight.	Depth.	Stability.	Result.
		Inches.	Ounces.	Inches.	Ounces.	
I	Bird	4	39½	0 7-8	2½	I beaten by 18 oz.
O	Bird	5½	78	1 3-8	8½	
O	Bird	5½	78	1 3 8	8½	O beaten by 57 oz.
Q	Oblong	8	152	1 13-16	32	
Q	Oblong	8	152	1 13 16	32	R beaten by 94 oz.
R	Bird	11	292	2 1·2	42	
Q	Oblong	8	152	1 13-16	32	R beaten by 35 oz.
R	Bird	11	196	1 5 8	34	
Q	Oblong	8	152	1 13-16	32	T beaten by 61 oz.
T	Bird	8	140	1 13-16	18	
O	Bird	5½	78	1 3-8	8½	P beaten by 6 oz.
P	Oblong	5½	84	1 3-8	12	

The model Q is the swiftest under sail, when full loaded, and T the second—the oblong, in this instance, being the best.

IV.—TABLE *showing the proportion of the Beam the depth of Flotation ought to be for the greater Speed, with Bottoms quite Flat, and Impelled forward by the Wind on Sails proportioned to their Stability.*

Model.	Shape.	Beam.	Weight	Depth.	Stability	Proportion of Depth to the Beam	Proportion of Beam to the Length.
		Inches.	Ounces.	Inches.	Ounces.		
O	Bird	5½	50	0 7-8	8½	One-Seventh	5
Q	Oblong	8	152	1 13-16	32	One-Fourth	3½
R	Bird	11	81	0 13-16	29	One-Fourtnth	2½
T	Bird	8	70	0 7-8	16	One-Nioth	3½
I	Bird	4	20	0 9-16	2½	One-Seventh	7

Upon a review of these Tables it will be seen, that a maximum of weight and speed is incident to some form of the models, and not to others. This circumstance is most apparent in the long bird or fish-shapes, since their stabilities cease to increase with additional weight, after it amounts to a certain quantity; that quantity, therefore, may be denominated the limit or maximum.

But with the oblong model Q, and the duck-shape model R, any increase of their weight is attended with an increase of their stability also. However, it is seen of the model Q, that with the increased stability, consequent on the additional weight, the speed is not so retarded by it as the model R, and the other models; therefore advantage can be taken of this peculiarity for all ships intended for burthen.

ON THE NATURE AND CHARACTERISTICS OF ART.*

By Samuel Charles Fripp, Architect.

I must premise that little, if any, of the following paper is original, either in form or matter; but I have variously used the expressions of others in every case where the idea corresponded with my opinions, so that a large part of this paper consists of quotations.

It is not my intention to treat of technical details in any branch of art. I propose to consider art in its essence as identical with poetical conception, having the same source and the same object; and then to take a rapid survey of the arts of design historically, indicating the affinity which exists between them, and their evidence of national civilisation and genius; and to conclude with some remarks upon the advancement of architecture and art.

The understanding and the passions are the elements of man's being. The first comprises all mental power; the second includes all the capacities upon which the moral nature of man is founded. Pure science is derived from the understanding alone: applied science is the offspring of the understanding and the passions of man. Art in its various degrees, including natural religion (apart from revelation), is the development of our moral nature.

The universal consent of man in separating art from science and mechanism proves that it has a foundation in our common nature, that it is a subject of our experience and enjoyment; while true philosophy proclaims that the senses are but the instruments of sensation, and that to the faculties of thought and feeling we owe our superiority over all the brute creation.

Nearly four centuries before the revelation of Christianity, Plato embodied the conception of earlier philosophers in his theory of the existence of a spirit in man, receiving impressions by means of sense, yet superior to sense, having a separate and immortal part in our being. This is the true theory of the inspiration of genius—denied, or most imperfectly acknowledged, by Hogarth, Reynolds, and Burke, who place all the beauty perceived in the object; overlooking the sympathies, instincts, and intellect with which the observer invests the object, and which the artist presents in his work.

It is necessary to glance at the purely abstract nature of words, especially those which attempt to distinguish the emotions of our mind and being. We are obliged to speak of the intellect and the social affections as real things, because we are persuaded that man possesses them in the aggregate as states of being, so that we use the words intellect or mind for one part of the intelligence within us, imagination for another, and genius for another—viz., that surprising combination of faculties with which some men are endowed. All such abstract terms represent only conditions of *ourself*. Even the separate existence of organs of mind, if proved by a phrenologist, will not account for mental processes: the organs of the body do not act in a healthy state except at our own desire. The volition—or SELF—must exist independently of the organs.

In philosophy and in experience, ideas of beauty and sublimity, which enter so largely into the principle of art, are tolerably well defined. "The sense of mankind at large has pronounced the human form to be beautiful—by the Greek and by the Esquimaux, by the Circassian and by the Hottentot; from infancy to age. But what is the beauty of childhood or age? It rests neither in form nor colour. It is the appropriate and touching expression which affects our common sympathies. The beauty or the sublime grandeur of inanimate matter are equally derived from our sympathies, and the exercise of our affections and imagination." What is agreeable to the sense of mankind is generally admitted to be beautiful; and what is called the standard of beauty is an artificial distinction, founded partly upon physiognomy in which the intellectual and moral part of our being finds expression, and partly upon the superior physical development of individuals, or of races of mankind. Forms and representations which approach this standard are allowed to be suitable for study and imitation; and the sense of beauty with which man is gifted (by cultivation) becomes *taste*.

Art is the interpretation of Nature—the expression of what is within man applied to objects without: it is the exposition of Nature—revealing the relations that subsist between the external world and the soul, or inmost self of man. This exposition is conveyed by means of language, as in poetry, and by various other means and processes in art, the different mediums of art being more or less suitable for the expression of particular inspirations.

Expression is bestowed upon matter in sculpture and in architecture, and by the painter and engraver; upon sound by the musician; upon the person and look of the mime and actor. The mechanism of art differs in every branch, but each art has its conquests over the hearts and faculties of men: the same sensitiveness and power of imagination and culture of intelligence are (in degree) called into exercise by each, and art to the intelligent is an universal language.

What are the elements of the poet's mind? Observation, sensibility, reflection, judgment, invention, imagination; and, lastly, mechanical or verbial dexterity to give form to his thought. Art, in every branch, is the product of such a poet-mind. "The first efforts of language and of art are simply imitative; but the poet's mind cannot long be confined to such a limit...There is an internal eye constantly stretching its view beyond the bounds of natural vision; and something new, something greater, more beautiful, more excellent, is required to gratify its noble longing...The eye of the mind is the imagination. It peoples the world with new beings; it embodies abstract ideas; it suggests unexpected resemblances; it creates first, and then presides over its creation with absolute sway." Shakspeare has described it well:

> "The poet's eye, with a fine frenzy rolling,
> Doth glance from heaven to earth, from earth to heaven;
> And as Imagination bodies forth
> The form of things unknown, the Poet's pen
> Turns them to shape, and gives to airy nothing
> A local habitation and a name."

Poetry then, in its widest acceptation, is *art*—the power of creating what is beautiful, and of representing it. The great master of our language—Wordsworth—declares in the summary of his poetical theory, that "in works of imagination and sentiment, in proportion as the ideas and feelings are true, elevated, and valuable, whether the composition be in prose or in verse, they require and exact one and the same language......Metre is but adventitious to composition; and the phraseology for which that passport is necessary, even where it may be graceful, will be little valued by the judicious."

The highest, most varied powers are required to form the artist or poet—*maker*, according to the Greek original. The powers "to collect, combine, and animate," accorded to genius, are born in the man: with these he breathes upon his works the impress of his own spirit, his life, his sensibility. He is the poet who, from the depths of his own nature, draws to himself, and raises towards his own level, the spirits of his fellow men. The "words that breathe" are but exponents of the "thoughts that burn." The sculptured marble and the living canvas are but the medium by which we are elevated to sympathies kindred to the artist's thought.

Few are the men so highly endowed by Nature and by education as to be makers—artists of the highest class; but something of the sensibility of genius, and something of its power, resides in mankind generally, as is proved by their experience of an aptitude—an appreciating, feeling power within them. How many noblest faculties of man are daily lost to the world, being destitute of culture and opportunity?

> "Full many a gem of purest ray serene,
> The dark unfathomed caves of ocean bear;
> Full many a rose is born to blush unseen,
> And waste its sweetness on the desert air."

This sensibility is the element from which arises the enjoyment of literary culture and of art, as distinguished from science or knowledge, and mechanical efforts. It is the link that connects the first efforts of barbarian art with the noblest products of human genius. None can appreciate a work of art without possessing a measure of the artist's faculty and study and exercise.

"What (says Jeffrey) is done in the highest degree by the highest genius is done by all of ourselves in lesser degree and unconsciously, at every moment, in our intercourse with one another. To this sympathy, without which there can be neither poetry nor philosophy, are necessary a largeness of heart which willingly yields itself to conceive the feelings and states of others whose character is utterly unlike its own." And Goethe writes, that men are "too inclined to content themselves with what is commonest. ......The spirit and the sense so easily grow dead to the impression

* Paper read before the Bristol Society of Architects.

of the beautiful and the perfect, that every one should study to nourish in his mind the faculty of feeling these things, by every means in his power;—one ought every day to hear a little song, to read a good poem, see a fine picture, and, if it were possible, speak a few reasonable words."

Art then is the realisation of man's intellectual and imaginative powers: it exhibits itself in every production that calls into exercise our sensibility, whether it be a touching memory or thought, description or representation. In its higher walks it is poetical conception embodied in some noblest form; in lower walks it is the expression of taste and fancy bestowed on the object: is is content to reside in a graceful use of words, and to bestow itself in the adornment of the simplest fabric; but if it rises not above the *sensuous* gratification of taste, it is only an elegant refinement of civilisation. In every work, great or little, its true interest depends upon the conception.

"The ideal subsists in thought as the archetype and pattern of supreme and perfect beauty—the absolute sum and unity of that beauty which clothes the universe......This ideal is unapproachable by the artist; but the more perfect the ideal which kindles his enthusiasm and animates his fancy, the higher will his efforts tend—the nobler will be the energy of his art."

The beauty or grandeur of any work is to be measured by the spritual essence with which the artist is gifted to bestow upon it. The most perfect "imitation" of Nature must be a failure; but the representation of Nature, conceived and created afresh, is the work of a true artist. It is the image of a likeness animated by his mind.

Poetical conception, then, has its birth in the inspiration of the artist, and comes to maturity in various forms of art suitable for its expression. And art is two-fold, having its essence in the conception and treatment of the artist, and its language or mechanism (expressive of its power and intention) as the medium of its development.

A poem may be suggested, nay, wrought out, to the mind's eye, by picture and sculpture, and mimetic action; but it can be described only by means of language, and the method of expression by words is technically called the art of poetry. So skill in the manipulation of sculpture and painting gives rise to the terms "art of sculpture," &c.; but in this sense the word *art* should be strictly confined to mean acquaintance with the means of representation.

The beauties and refinements of language convey the most minute and varying modes of thought and feeling. Horace, in his 'Art of Poetry,' truly describes the adoption of an old word, rendered in a new sense by skilful construction with other words, as entitling the poet to the praise of original diction. The same will be granted to the judicious adoption of ideas in art. The style of authorship, or the choice of expression, is the greatest charm of most authors. This is clearly derived from personal idiosyncracy; and the same personality influences every touch of the painter or sculptor, every gesture and inflection of voice in the orator. Thought born again in the breast assumes a poetical shape, or at least, an individual impress from the author and artist.

Having indicated the broad foundation of art as poetical conception, it appears that the fine arts are intimately related, and that painting, sculpture, architecture, poetry, oratory, music, dancing, and the drama, are branches of art having different forms of representation; but appealing to the universal sympathies and imaginations of men, and historically bearing the artistic peculiarities observable in every parallel stage or cotemporary existence of their sister arts.

As various schools of art have risen from the wonderful influences of individual minds, so national styles of art testify the peculiar qualities of different races of men, and their religious and social condition.

The fine arts are coeval with earliest civilisation of man. Philosophy, art, and religion found expression in poetry, in architecture, and sculpture. From their remains we know much of the spirit which dwelt in the most celebrated nations of antiquity.

"On the walls of the temples of Egypt may be traced the history of its kings and potentates for a period of nearly fifteen hundred years. On every side are sculptured and painted representations of the rites of religious worship, of proceedings in agriculture and the arts, and of the Supreme Being symbolised by the emblems of his qualities." The style of these monuments is represented by all travellers to be sublime in the highest degree. One temple at Thebes appears to have been one thousand years receiving the sculptured histories which covers its surface; "and it is certain that nearly all the arts which give zest to life were advanced to nearly their present state of mechanical perfection four thousand years ago."

The genius that first conceived these wonderful structures is worthy of our highest admiration. We know that in its early history Egypt was the cradle of knowledge: it was the academy of young Greece. Sir William Jones has proved, I think, that at a still earlier period, Iran, now the Persian empire, was the true centre of population and language, of knowledge and of the arts; but in Egypt we find demonstration of its former life. The stupendous outlines and solemn shades of the rock-hewn or rock-built temple once doubtless symbolised some great idea of religion; but their temple outlines never received a corresponding decoration. The primal symbols of deity, and the deified animals which superstition adored are repeated upon all their monuments for two thousand years. The few primitive types never developed themselves in higher form than as they were conceived by the greater and earlier artists. There was no progress in art. How could it be otherwise while despotism and priestcraft held the populace in the bondage of slavish fear and degraded superstition? Such have stamped themselves imperishably upon these sculptured legends.

"In the heroic ages of Homer, and in the priestly theories and influences which are developed in Hesiod, we see the sources of the philosophy of the Greeks and the speculative idealism of their religion."

"The worship of the powers of Nature which clouded the Egyptian imagination with hideous shapes, in Greece assumed a mild and dignified form, the human body being spiritualised to a glorious transfiguration symbolical of mental perfection."

"Superstition cherished the arts by which it was adorned; its idols became models of ideal beauty. The gods of Phidias (says Pliny) gave a new motive to religion; the type of majesty was born in him, and he embodied it in several statues of Jupiter. The character and form of the deities of his sculpture fulfilled the types of Grecian mythology. Mercury was then recognised without his wand or his purse; Apollo without either bow or lyre."

The first age of Grecian art and poetry was devoted almost exclusively to religious purposes; the second developed all the elements of philosophy and art; the third lasted in its greatest brightness only fifty years, but in great splendour for still another century. In these epochs may be found a striking analogy between the progress of sculpture and poetry, as exemplified in the severe and sublime dramas of Æschylus, and the ideal of archaic sculpture; in the more impassioned writing of Sophocles, and in the sculptured Niobe and Laocoon; in the elegant pathos of Euripides, and the sensuous beauty of the Venus.

Grecian architecture of this latter period exhibits the greatest symmetry of form, material of greatest beauty, and sculptured decoration in exquisite profusion—the most simple, noble, and refined style of architecture that the world has seen.

The exquisite taste of the Greeks is shown in every article of luxury and domestic use, wonderfully preserved to us. "The fame of her arts might be sustained by the beauty of her gems alone; they are memorials of forgotten skill and vanished beauty."

"The best specimens of Roman architecture, and the coins of the early emperors, are considered to have been the design and workmanship of Greek artists, who, for a thousand years after their national subjugation, retained an aptitude and skill in all matters of art, which distinguishes that nation from all the people who have inhabited this earth." It is impossible to estimate the amount of Grecian thought and feeling embodied in their literature and poetry, sculpture and architecture, which have been transfused into all subsequent culture and civilisation of the human race.

The history of architecture points chronologically to the development of styles founded upon national character. The Lombard, the Saracenic, the Romanesque, the Norman, and the national varieties of Gothic architecture, display the universal aptitude for art and the expression of popular religious feeling. These, doubtless, arose from new wants and habits, new forms of religion and peculiarities of climate, which have developed creative power in every branch of art; in varieties complete in themselves, wrought out with extreme finish and perfection. The finest specimens of Gothic art abound in England, Normandy, and Germany; all having a general similarity, but as markedly different, and as easily distinguished as the literature of these nations is to this day.

With much of rude and inferior art, they have left most admirable specimens: sculpture, embodying sentiment and expression, faith and devotion; spirit-stirring ballads, calling for an open heart in the listener; and architecture, marvellous for science and fancy. Look at Cologne, that builded poem; surely it exhibits harmonious relation of parts and magic light and shade—beautiful and grand alike in sunshine and storm—by daylight and moonlight—the creation of a spirit kin to the greatest of northern poets. Hundreds of Gothic buildings attest the prodigality of the genius of their makers, and the variety and universality of the art; and no one can doubt that in the so-called dark ages, the spirit of beauty condescended to inspire many devoted followers of every branch of art.

The Early Italian school of painting had many of the characteristics observable in the designs of the structures devoted to religion—refined idealism, united freqently, to imperfect powers of representation.

The modern arts of painting and sculpture rose with the decline of Gothic art; and almost immediately, through the powers of two men, attained a limit not yet passed. The Sistine Chapel and the Vatican proclaim the yet unrivalled majesty of Michael Angelo, and the splendour of the genius of Raffaelle.

Architecture from the sixteenth century has made many efforts, and great minds have employed themselves in bending antique forms to the requirements of modern customs and northern climates, but our imitations have not as yet succeeded.

In this country, architecture, like literature, has become almost entirely scientific and economical; and where opportunities have opened for new artistic efforts, architects are met by a stern requirement only to copy, or at best to apply the design of a bygone day to a work intended for the present day. While I heartily admire ancient Gothic art, as well as Grecian art, the revival of both has, I think, hitherto been of little service; and if the profession is to be restricted, as at present, to a minute copying of forms and details, we may bid farewell to architecture as an art.

I am satisfied that if broader views were generally entertained of the nature and condition of art, our resources of wealth and skill would be applied to the production of a higher style of art than now prevails. In this country sculpture is decidedly ascendant, because our sculptors study antiquity and nature for their study, and not for mere imitation. Our painters, who work for fame, must be contented with moderate success; while those who surprise the public by marvellous exhibitions of colour and handling, have their immediate reward. The musician likewise is paid for his dexterity, but not for his art. Even the literature of our day is made up of the fragments of old learning. I hope to see the day when our public buildings shall exhibit their object in their forms, and their uses in the decorations applied.

If the requirements of plan, and construction, and use of a building, and the consideration of its site, and the climate in which it is placed, be not sufficient motive for an artistic piece of design, let us but build well and plainly, and leave for the sculptor's and the painter's arts the sums which are now laid out in conventional imitations of ancient works or in decorations of unmeaning *bizarre*.

Why should not representations of sacred history range the friezes and galleries of our churches, and enliven our bare walls and imitation windows? Our sculptors and painters might well be employed upon such works, acquainted as they are with the art of the Greeks and with nature, and, as they should be ennobled, purified by their Christian profession and office. Surely such a plain building so decorated would be preferable to a repetition of the most gorgeous Gothic ornaments or loftiest spires,—to the pedantry of emblems and the affectations of mediævalism,—to absurd copies of Greek temples and classical forms and ornaments, now meaningless. The artist and critic of the present day must seek to recognise whatever is beautiful under every form and modification, and to re-create the same when opportunity offers. It is common to claim for art too great a power as a civiliser; it is, in fact—like printing—a great instrument, which may be exercised for advancing the social happiness of man. In its highest walk it springs from the holiest influences of our nature; but we may not claim for it a power to enforce virtue, or to redeem sensuality.

Royal Scottish Academy of Painting, Sculpture, and Architecture.—At the annual meeting on the 12th, held in Edinburgh, the office bearers were elected, and the council declared for the ensuing year, as follows:—Sir J. W. Gordon, R.A., President; D. O. Hill, Secretary; W. B. Johnstone, Treasurer; J. A. Houston and Charles Lees, Auditors; Council, J. Noel Paton, K. Macleay, H. Macculloch, J. Faed, Patric Park, and J. Lyme; Visitors of the Life Academy, J. E. Lauder, J. Faed, and Patric Park.

THE ARCHITECTURAL EXHIBITION.

If the Architectural Association had done nothing more than the establishment of the Architectural Exhibition, it would have fully deserved the heartiest thanks of the profession. The establishment of the Architectural Exhibition will hereafter be looked upon as an era in the history of the art in this country, and it is operating at a like time with the enfranchisement of the art from fiscal regulations, and no less heavy shackles of the cant of schools. We do not know whether we ought to treat the so-called Architectural Room at the Royal Academy as a farce, because we believe its arrangements are part of a design or conspiracy for turning architects out of the Academy. Be this as it may, the Architectural Exhibition opens a home for our works, as the Institute and Association constitute rallying points for our professional organisation; and as the several colleges afford us places for the acquirement of scholastic knowledge. Thus we no longer want their exhibition room, nor their school, nor their paltry representation of our art; we make no claim on the common funds for our scholars, and it is really not worth while to make any on the charity funds. Separation from the Academy is needful for the enfranchisement of architects from a degrading alliance, by which we have been deluded. Let the Royal Academy of Portrait Painters accomplish its mission, and when architecture is independently constituted an appeal can fairly be made for the requisite government aid to our exertions.

It is particularly gratifying to us to see, that in the next Exhibition the committee propose to introduce several new features, because in the pages of this *Journal* they were first suggested. Amendments have been demanded of the Academy constantly, and have met with no attention; but the Architectural Association have shown the greatest readiness to introduce every improvement which could be brought to bear. What is now proposed to be done is particularly important, because while we shall get rid of the narrow basis of the Royal Academy, we shall gain strength in the connection with allied interests. The association of exhibitors of objects employed for architectural purposes will be in every way beneficial. A larger number of persons will have a permanent interest in maintaining the Exhibition; there will be more for the public to see, more for the profession to study; and while the Exhibition assumes a more important character it will have the greatest advantages for the profession, because it will put employers in mind that the details in many cases intrusted to workmen properly belong to the domain of the architect. On the manufacturer the effect will be very great; the enlightened and enterprising man will see that he can submit his productions to a competent tribunal, and that he will have credit for originality and fitness of design, and the inferior manufacturer will find out that he must give up mangling foreign or English patterns, or cramming the public with his own balderdash.

What has been shown at the Society of Arts and at the Great Exhibition, in examples of our decorative manufactures, has excited the greatest interest, and the competition of foreigners at the World's Fair has given us a keen desire to develope the energies of our English producers. This object nothing is so well calculated to foster as the Architectural Exhibition. It will at once be acknowledged that one great class in the Crystal Palace—that of furniture—belongs strictly to us, and it will be found the greater part of the hardware class owes the same allegiance. Then those large classes of paperhangings and stained-glass come likewise within our domain, while there is scarcely a class which does not afford extensive contributions.

The Great Exhibition rendered essential services to the manufacturers in the exhibition of Sheffield grates and Birmingham chandeliers, but the Architectural Exhibition will do much more. Hereafter the manufacturers will vie to exhibit the new patterns which are to become those of the season, and they will know that they exhibit them to those who have the control of the orders. A closer union will take place between the manufacturer and artist, to the benefit of both. The leading professional man will gain co-operators on whom he can depend for the proper execution of details, the young man will obtain employment in preparing or superintending designs for the manufactory. The position which the engineer is taking in the manufacturing world as the adviser for mechanical and chemical operations, will be open to the young architect for the artistic department.

The alliance now being formed will elevate manufactures without depressing art; but on the contrary, extending its influence, and in nothing more than educating the public eye. People in the habit of buying trash for furnishing their rooms, are content with houses on which the architect has not been employed, and the decoration of which is not placed under his care; but with a general appreciation of art there will be a greater demand for it. When people find that it is not a matter of fancy whether they shall use particular forms, or mix certain colours, when their eyes are opened to the barbarisms which are being perpetrated by ignorance, they will place the greater confidence in professional assistance.

The influence which architecture has exercised upon manufactures was exemplified in the Great Exhibition, but what it is capable of doing is infinitely more, and we look therefore with the greatest interest to the prosecution of the proposed plan for extending the Architectural Exhibition.

IMPROVED SCREW PROPELLERS.

A PATENT has been granted to Captain Carpenter, R.N., of Toft Manks, Norfolk, for "Improvements in the construction of ships or vessels, and in machinery or apparatus for propelling and directing the same."—Patent dated May 13, 1851.

The invention consists of four improvements: the first is for constructing in that portion of the hull of a vessel where the rudder, stern-post, and keel usually are, a framework which has an arched roof. This extends from the stern as far as the centre of the vessel; at this point it unites with the regular keel. The framing branches off from this point towards the stern, and forms two keels, a starboard and port keel. The arched covering between the two keels diminishes in height from the stern to the centre, and forms a water-way. To each of the branch keels a rudder is attached; the two may be worked together by one machine or singly as may be required.—The second claim is for placing in the two keels just described, and working in the water-space between the two keels, two propellers, or other submerged principle of propulsion, one a little in advance of the other; they may be worked together or singly. The inventor considers from experiments that he has made, that this arrangement is more advantageous than the single screw. There are four disadvantages attached to the single screw: first, the slip is very great; second, in consequence of the vessel having passed over the water in which it works, it renders the water disturbed, and therefore the propeller does not work to its greatest advantage; third, the single screw has a tendency to turn the vessel one way, the rudder having to overcome this tendency absorbs a large portion of the power; fourth, that when the vessel is pitching, the shaft being placed amidships, the screw is frequently revolving without doing any work. The inventor considers that a large body of still water will be brought to the screw through the framed water spaces passing through the centre of the vessel; consequently, less power will be required, and the vessel be more easily turned, stopped, or backed; will not roll so much, and will scud better.—The third claim is for a propeller constructed of metal, wood, or other suitable material, and the blades of which have a flat and curved surface.—The fourth claim is for lifting the propellers, without the shaft, out of the water; or, in other words, feathering the blades.

The invention can be applied with advantage as an auxiliary power to line-of-battle ships, and also to steam-tugs.

INSTITUTION OF CIVIL ENGINEERS.

Nov. 18.—Sir WILLIAM CUBITT, President, in the Chair.

THE paper read was "*A Description of a new Metallic Manometer, and other Instruments for measuring Pressures and Temperatures.*" By M. EUGENE BOURDON, of Paris.

In the course of manufacturing a coiled copper worm for a still, one side becoming flattened by accident, internal pressure by a force pump was applied, to restore the cylindrical form, and to the astonishment of the author, as the pressure increased, the coiled tube unwound itself, until it became nearly straight. This induced further experiments, which resulted in the production of the various instruments described in the paper, and exhibited to the meeting.

The transverse section of the coil was that of a flattened tube, which when acted upon internally by the pressure of steam, or any other fluid, had a tendency to uncoil itself, as the density increased, and to return to its original form, on the pressure being removed. If it was exposed to external pressure, or a partial vacuum was created within it, the tendency of the tube was to coil itself up into a smaller diameter. In the former case, as the tube uncoiled itself, its sides became more convex, and its capacity became greater; and, in the latter instance, the capacity diminished as the sides collapsed and approached each other. It was on this relation, between the capacity of the tube, or the amount of convexity of the sides, and the diameter of the coil, that the action of the instrument depended. If a flat band of metal was bent round a circle, its transverse form remained unaltered, but if a semi-cylindrical, or gutter-shaped band, was bent into a circular coil, its convexity was diminished; and if the circle formed by it was of small diameter the band became almost flat in the transverse direction. It being then a law of general application that a surface which was curved in two directions could not have its curvature increased in one direction without its curvature being diminished in the other direction, and *vice versâ*, the action of the instruments in measuring pressure or temperature was easily understood.

The variation in thickness or capacity of a curved flattened tube was shown by filling the tube with a liquid, and attaching to the centre of its external periphery a small glass tube, when every change of curvature produced a corresponding motion in the liquid in the tube; for as the tube was straightened its capacity increased, and as it curled up again it diminished.

The change in the thickness or capacity of the tube being proportional to the variation of its radius or curvature, it was found, by experiment, that the motion of the extremities of the tube was in proportion to the pressure applied, so that the indications were equal for equal increments of pressure; this fact greatly facilitated the construction of the indicating instruments.

The simplest form exhibited was that of the steam-pressure gauge, in which rather more than one convolution of flattened tube was employed, one end being attached to a stop-cock in connection with the boiler, and the other extremity carrying an index pointer, which traversed a scale graduated to given pressures per square inch; on the steam being admitted the tube uncoiled, and the pointer indicated the amount of pressure to which it was subjected.

When a greater range of motion was required, the lever, instead of being placed on the axis of the index, carried a toothed segment which, working into a pinion on the spindle of the index, increased the extent of indication. This arrangement was adapted for barometers, in the construction of which the air was exhausted from the flattened tube, which was then hermetically sealed. The pressure of the atmosphere acted on the exterior, and was balanced by the elasticity of the tube, which varied in curvature with every variation on the pressure of the atmosphere.

Many ingenious modifications of the principle, and adaptation of it to various purposes were described. The construction of thermometers, by a spiral flattened tube, was extremely novel and good; that, also, of a pyrometer for measuring high temperatures was equally clever. The Steam Engine Indicator became a very simple instrument, avoiding the error which was to be allowed for the friction of the piston of the ordinary instrument.

The instruments were stated to be generally adopted in France, where the government inspectors of steam-engines used pressure gauges on this principle, in verifying the accuracy of all the other instruments they found attached to the engines under their inspection. At the French Exposition of 1849, M. Bourdon received a gold medal, and at the Great Exhibition in Hyde Park, he was rewarded by a Council medal.

Mr. POLE, A.I.C.E., exhibited and explained an instrument of his invention, called the "Prismatic Clinometer," for measuring angles of elevation and depression. It was an application to vertical angles, of the principle of Captain Kater's Prismatic Compass, in which the angle is read by a prism, at the same time that the sights are directed to the object. The advantages of Mr. Pole's instrument were, its portability, it being only about 3 inches diameter and ¾-inch thick; its simplicity, durability, and safety in carriage; the convenience and facility with which it could be used, and its accuracy. The various applications of the instrument were explained, and also a modification of its construction, by which it could be combined with the Prismatic Compass, and a new compound instrument thereby produced, which would be exceedingly useful in topographical investigations.

Mr. C. MAY, C.E., directed the attention of the meeting to some specimens of iron ore, now being extensively raised, in the neighbourhood of Middlesbro'-on-Tees, by which, as great a revolution would probably be caused in the iron trade of the North of England, as the discovery of the black band ore in Scotland had produced some years since. This ore was found in a bed of 15 feet to 18 feet in thickness, close to the surface, amidst cheap fuel, and within a few miles of a seaport, and as it contained from 33 to 35 per cent. of iron, its advantages were already so fully estimated by the proprietors of some iron works, where there were eleven blast furnaces, that they had ceased working their former mines, and conveyed this ore a distance of 55 miles by railway, with advantage to the quantity and quality of the iron produced.

Royal Institute of British Architects.—The first ordinary meeting of this season was held on the 17th, at the Society's Rooms, Mr. Fowler, V.P., in the chair. Mr. J. W. Papworth read an interesting paper upon "Some of the Productions connected with Architecture exhibited in the Great Exhibition." Professor Donaldson gave an account of the foreign architects who in the recess had visited this country, and their impressions of the peculiarities of English architecture. The chairman in opening the session spoke in terms of regret of the loss the Institute had sustained by the deaths of the Earl of Liverpool and Mr. Beazley.

THE EMPLOYMENT OF IRON IN ARCHITECTURE.

At the present time the subject here indicated is, on one hand and another, pronounced to be perhaps the most interesting of all practical questions for the study of the architect. It is a weighty fact with us that it has come to this; old things are most effectually passing away,—Precedent and the ancients, and Orders and styles, are most assuredly being bidden adieu,—intellect and invention demanded—and no more instinct and routine,—when it has come to this. There stood no Crystal Palace on the old Acropolis; no Victoria Regia grew in the gloomy gardens of the monks, to demand cage-room by the acre; Inigo Jones, Sir William Chambers, Soane, or even Wilkins, never dreamt of such things, any more than of steam-engines rushing across the island in a night, or electric speech passing under the sea.

It is with the professional architect as with all other hard-working men of business,—he is but a poor friend of improvement, he clings to routine. But it has, of late, been strongly urged that the architect is, rather more than most other men, disposed to let well-enough alone: if so, he must soon be stirring. The uninitiated, the mere multitude, who know not the Orders from so many apple-trees, nor the Seven Lamps or the Seven Periods from the seven heavens or the seven voyages of Sinbad the sailor,—these are taking up the cry that architecture must be reformed. It is not merely that the nations have stood still in admiration before an architectural idea of the Duke of Devonshire's gardener; there has been, so far, quite as much of ignorance as of knowledge in the comparisons drawn by the sovereign public, to the prejudice of our craft. But there is more than this. In the reviews, the newspapers, the penny journals, there is this unwonted cry. Architecture, they declare, must make a move: they hear of Precedent with wonder and amusement,—they demand common-sense, progress, novelty,—they name the name of *Iron*,—and they point to engineers and builders and a landscape gardener, and call upon architects, like bill-stickers, to beware.

In associating with the idea of the necessity for reform and novelty in architectural style and the abandonment of Precedent, the idea of iron as a new building material, there is, however, an essential error—at least, in some degree. It is true that architects, in their almost total neglect and misapplication of the new building material of the age, may have to blame their educational prejudice for their fault; but that educational prejudice has much more to answer for than this,—and the overthrow of the strange government of Precedent, by which we do as our forefathers did, is of higher importance in the art than merely as it regards the adoption or not of the use of iron. Moreover as it may be said, without hesitation, that iron can never supplant stone and timber in general building, so the new style of architecture, which, as the public think, will no doubt make its appearance among other excellencies of the good time that is coming, may safely be looked upon as quite distinct from the mere question of the use of iron as a building material. Stone and timber work must still be in vogue; and it will be seen, nevertheless, that there is abundant room for extensive alteration and radical reform.

Having thus placed our subject in its proper position in this respect (of some importance to the architect), the question in hand may be more precisely defined—That as the application of iron in building is likely to be much extended, how are we to govern its use architecturally?

The terms in which the question is here put, no doubt suggest to the reader the idea that a distinction is drawn between the application of the material constructively and its management architecturally. And so it is: the distinction is that which exists between the science of him who is constructor only, and the art of him who is architect. The latter is the subject in hand. It embraces the former within its province, in so far that the science is of necessity the first basis of the art; and the character of architect embraces that of constructor, in so far that building is of necessity the first basis of architecture. Accordingly, in discussing the architectural question, the constructional question must first be disposed of; and then, our subject being the treatment of iron-work *architecturally*, it will be necessary also to consider the subject of the uses of iron *constructively*, as a primary question.

Another word on this point. Construction is the science of *building;* architecture is the art of *beautifying* building. Construction has certain indubitable principles and irrefragable laws, springing from the very laws of matter; architecture is the system by which this construction is to be made beautiful; not by doing violence to its principles and laws—for constructive truth and fitness are themselves primary beauty, and can never be dispensed with—but by a fusion of other principles and laws with these, equally indisputable and irrefragable, but of another part of nature. By such fusion, the work which construction would have made simply stable is now made by architecture both stable and beautiful.

In looking, then, at the question of the constructive uses of iron, it is at once to be seen that these have not, by any means, been yet reduced to a system; and we are therefore, at present, necessitated to look at the subject in the light of the mere details of the position of the present employment of iron in building.

In railing-work and gates, in the first place, the material has been employed from early times; and we may say that perhaps its employment, so far, has seldom if ever exhibited inconsistency with its nature, except occasionally in more modern times, when the principles of copyism of form, and disguise of material, have been carried to such extreme lengths as to defy control.

In girders and beams, again, we have one of the services to which we have been most accustomed to turn the material. With the help of the engineer, we have here aimed at a considerable amount of science. The form and proportionate dimensions of rib and flanges, and the swell of the depth, and so on, have been somewhat carefully adjusted; and the question of the greatest strength with the least material and weight has been pretty well disposed of, in both theory and practice. Story-posts, also, we have had made of iron, and columns generally, with the full amount of constructional advantage; and here the question of hollow against solid, and the scientific calculations of diameter and thickness, have been sufficiently disposed of likewise. But do not forget, as of considerable moment presently, that we have shown large ingenuity in such matters as casing out our girders (where deemed advisable for better effect) to make timbers of them, or clothing them in cradling, lath, and plaster, to show as mighty stone beams from the quarries of the giants; and, with regard to our columns, in making them of the largest diameter with the smallest thickness, to keep up, with the aid of four coats plain, the standard surface of stone and proportions of the beloved Orders,—or in inshrouding them, like the girders, in glued-up and blocked casings, with the same end,—or in painting them in our shop windows of invisible green, or incasing them in mirror or drapery to keep them out of sight altogether, and let the superstructure to all appearance float in mid-air, or stand upon a basement of small sash-bars. And here let us remark—for the opportunity is a good one—that in so far as regards science and skill, of the best and keenest, in trimming and contriving disguise and fraud and hollow semblance, architects of modern times have displayed an amount of genius in overcoming difficulties which may encourage us to hope for great results of a better sort when their ingenuity shall be turned into a better channel; and that, moreover, if half that perseverance which has been so misapplied in the cultivation of deception had been employed in the pursuit of truth, our art would not now have to go begging to a landscape gardener, because something out of the common way was wanted.

It is strictly, of course, a question of architecture, as it has been above explained, to refer for a moment to the works of engineers in the employment of iron in bridges. And here we have a good deal to admire. The great tubes of Conway and Menai we may in the meantime pass by, pertaining, as they stand, more to the mere machinist than the engineer-architect—tremendous productions of the common boiler-maker rather than structures of the more refined builder. But in the ordinary girder or rib-bridges of the last and present generations, we have structures which come perfectly under our category, and which can generally claim to take a very high rank as regards constructive merit. In suspension bridges, again, we have works which, so far as their ironwork goes, it is perhaps best in the meantime, with their tubular brethren, to lay aside. Ships, of course, we have nothing to do with; and iron lighthouses (as at present constructed), and other similar merely utilitarian engineering works, need not be made to incumber our investigation.

We come, then, to a class of structures in which we have the nearest approximation to complete house-building among the works of the age in iron. Various conservatories have of late been constructed almost entirely, as regards their skeleton, of this material; and, instead of forming hollow wooden mockeries of the Orders, and lath-and-plaster semblances of heavy stonework generally, to incase withal their ironwork, the builders have left the straightforward construction to speak for itself—unadorned, but truthful. And, at last, on the occasion of a vast shelter being required in a vast hurry for the great exposition of human handicraft just concluded, a gentleman, no better than a first-rate gardener, but one whose boldness of conception and energy of conduct cannot be too highly admired, comes forward with an amplification of the principle which he had before successfully employed in his own department, and an edifice in iron is run-up with almost magical rapidity, and (with all its faults) with signal success as regards efficiency, covering ground by the acre with nothing more complicated than castings run by the hundred at the other end of the kingdom and fitting together like a toy. And this brings us to the climax of iron house-building as it at present stands. It is from this point that the public are looking down upon us architects with no small amount of deserved and undeserved scorn, pointing to the man whose pupilage was that of a gardener's boy, as the Columbus of a new world of art, and the leader in whose train must now be content to follow, humbly and abashed, old architects and professors of mysteries—whose profession, they say, is detected quackery, and their mysteries the folly of a child.

It is hard to have to record such criticisms on one's own craft; but if any of our readers doubt the accuracy of our report, they can have paid but very superficial attention to the public sayings and writings about this Crystal Palace of 1851. It seems as if, hitherto, architecture had been to the uninitiated so much an impenetrable subject—a thing so wrapped-up in inexplicable system-mongering—that it is with a satisfaction not to be disguised that they now see so bold and slashing an animal rush into this sublimated china-shop, and make such short work of its wire-drawn forms and fragile fabrics, so tenderly nursed in their brittleness lest a breath of air should shatter them or the very eye of inquiring men wither and shrivel up their fine elements. It may be a very great pity, indeed, but it certainly would seem to be a very great fact, that the public of this country, and Sir Joseph Paxton at their head, at this moment hold architecture extremely cheap, and look upon architects as men of exceedingly much cry and exceedingly little wool.

But much as we are bound on many accounts to deplore the shortcomings of the craft, the case is not so bad as this; and, however justly the main body of the public may bear us a grudge for that impenetrability which our system has thrown around our art, their uncompromising contempt of us on the strength of this same Crystal Palace is the offspring of what it is best to designate ignorance at once, and their delight in that stupendous work a vulgar admiration of its majesty of magnitude and novelty of character, much more than a critical perception of anything like extraordinary excellence of design, or even an ordinary comprehension of those common merits which it really possesses.

The supreme public have not only cast contempt upon all architects, and weighed them in derision in the balance against the Duke of Devonshire's gardener, but when the architects, feeling aggrieved, have meekly remonstrated against all this, the just remonstrance has been most unjustly met with this very vulgar argument—that of course such great merit and success as Paxton's must needs provoke envy, malice, and wickedness, especially in those whose incapacity his merit has brought to light. It is therefore worth while to inquire with some care—even if it did not otherwise lie in our way as it does—into the merits of this celebrated structure.

The merit of the idea of applying the principle of the Victoria Regia-conservatory to the Exhibition building was, in any case, a very considerable merit, if not a very great. The moral courage of the man in venturing to broach the idea, and in such circumstances of hurry, is a very considerable merit, certainly; and his boldness in positively pressing his opinion, crude as it must have been in his own mind, against a committee of men eminent in such matters—matters of which his own knowledge was necessarily small—savours more of Yankee assurance than of the modesty of our own nation. All this merit we should candidly award to the conductor, if the building had been half the size and the period for thinking over it double the time: so much the greater, then, is the praise to be bestowed upon his energy, with the work so vast and the time so short. His *energy*, we have said—not his artistic taste though, nor even his constructive skill: these are matters, probably, far beyond the reach of his mind, or at any rate out of the range of his education. If Sir Joseph Paxton is to be a worthy knight in England's intellectual chivalry, let it be for his chivalrous display in a strait of the true English hardihood of mind; but if the English public fancy that in architectural design he has outstripped all architects, and in constructive skill made building hide its head, then the English public are only once more in error, according to their not unusual habit in such matters; and if our foreign guests have departed with the impression that this is the summit of our attainments in architectural conception, then are they, we should hope, equally wide of the mark.

The faults of the Crystal Palace are these: clumsiness and flimsiness of construction,—positive inefficiency for a permanent and substantial building in several minor details,—a decided act of common architectural counterfeit in the wooden intermediates between the iron supports of the structure,—an almost entire want of what we have called architectural beauty of form,—and excessive crudeness in respect of all ornamentation. With the single exception of the matter of the wooden intermediates in disguise, all these faults may be laid at the door of the great haste in which the preparations had to be made by an inexperienced person; and they may, therefore, be set down more as misfortunes than as faults. The merits of the Crystal Palace (as a structure), on the other hand, are these: an illustration of the capabilities of iron construction on the largest scale, and a good example, although a very crude one, of the fact that iron construction may be made architectural without the casing and cradling, lath and plaster, and all the rest of our pseudo-architectonic system of disguise.

The next subject to which we have to refer in this review of the present condition of iron construction is that of the very scientific and constructionally-pleasing light iron roof-frames, now so common in our railway sheds and warehouses, &c. These are mostly the work of engineers, no doubt—if, indeed, the credit be not properly their due for all that is really praiseworthy in the employment of iron in building. However, it will now be the part of the architect to adopt the skilful construction of the engineer, and throw into it the artistic beauty of elegance and grace.

The last matter for mention now is the introduction of sheet-iron, zinc, &c., for roof coverings, and even for wall screens; and the fact in connection with this, that iron houses for exportation have been advertised to some extent of late years, although probably they are but of small constructive merit, if we may judge from examples.

With this we may close our catalogue of the uses made of iron in construction at present: it remains for us to investigate upon this basis the question of the architectural or artistic employment of iron—the infusion into, or together with, its principles of scientific construction the principles of tasteful form and ornamentation, to make good building beautiful.

DRAINAGE OF WHITTLESEY MERE.

THE *Cambridge* press gives an account of this important undertaking, by the formal opening on November 12th of the magnificent steam-engine, erected by Messrs. Easton and Amos, of London, for W. Wells, Esq. "The engine is one of Wolfe's, with modifications and improvements by Mr. Amos, and is of 25-horse power. It was selected after much investigation and examination, by Mr. J. Hinman and Mr. J. Laurence. The mode of raising the water is by means of the centrifugal pump invented by Mr. Appold, and which was such a source of attraction at the Great Exhibition. There seems to have been great prejudice against the centrifugal mode of discharging the water; but the experiments witnessed in the Mere fully satisfied the most doubtful that the invention ranks amongst the most valuable for drainage, and elicited the warmest expressions of satisfaction and approval. The wheel from which the pump derives its name is 4 ft. 6 in. in diameter, and is constructed to lift 73 tons of water 5 feet high per minute, with a consumption of only one-half the quantity of fuel required by ordinary engines. This quantity is equivalent to about a square acre of water $\frac{3}{4}$-inch deep; but though 73 tons is stated as the average, the engineers are fully satisfied that if required, 100 tons per minute might be lifted 5 feet high. The calculations of Mr. Amos were verified by practical gentlemen on the spot, during the working of the engine, and it was proved that 16,520 gallons of water were discharged per minute, at the above named height. Nothing could exceed the success of the trial: it equalled, and probably surpassed, the expectations of the most sanguine. The novelty of the invention—the smallness of the wheel, so opposite to a fenman's notion of what is necessary for a superior drainage—the simplicity of its construction, the neatness of the engine, and the amazing quantity of water discharged, did not, and could not, fail to strike the beholders with admiration at the triumph of engineering skill displayed before their wondering eyes."—[It would add very much to the interest of the undertaking if we were favoured with the quantity of fuel actually consumed in eight hours, the number of cubic feet of water evaporated, and the number of pounds of water lifted one foot high in that period. ED. C.E. & A. *Journal*.]

INSTITUTION OF CIVIL ENGINEERS.

Nov. 25.—Sir WILLIAM CUBITT, President, in the Chair.

THE paper read was "*On the Application of Machinery to the Manufacture of Rotating Chambered-Breech Fire-Arms, and the Peculiarities of those Arms.*" By COLONEL SAMUEL COLT, U. S. America.

The communication commenced with an historical account of such rotating chamber fire-arms as had been discovered by the author in his researches after specimens of the early efforts of armorers for the construction of repeating weapons, the necessity for which appears to have been long ago admitted; and with the attention of such an intelligent class, devoted to the subject, it is certainly remarkable that during so long a period so little was really effected towards the production of serviceable and trustworthy weapons of this class.

The collections in the Tower of London, the United Service Museum, the Rotunda at Woolwich, Warwick Castle, the Musée d'Artillerie, and the Hotel Cluny, at Paris, as well as some ancient Eastern arms, brought from India, by Lord William Bentinck, demonstrated the early efforts that been made to produce arms capable of rapidly firing several times, consecutively, without the delay of loading after each discharge. Drawings of these specimens were exhibited, comprising the match-lock, the pyrites wheel-lock, the flint-lock, down to the percussion lock, as adapted by the author.

Among the match-lock guns some had as many as eight chambers rotating by hand; and the length of the chambers, as well as the thinness of the barrel, showed the bad quality of the gunpowder at the period of their construction.

Some of the pyrites wheel-lock guns had also as many as eight chambers, and rotated by hand; one of them, made in the 17th century, had the peculiarity of igniting the charge close behind the bullet, burning backwards towards the breech; an arrangement identical in principle with that of the modern Prussian "Needle Gun," for which great merit has been claimed.

The flint-locks induced more determined efforts, but all were abortive, as the magazines for priming, and the pan covers, were continually blown off on the explosion of the charge. Indeed, from the earliest match-lock down to the present time, the premature explosion of several chambers, owing to the simultaneous ignition of the charges from the spreading of the fire at their mouths, had been the great source of difficulty. In some of the most ancient specimens, orifices were provided in the butt of the barrel for the escape of the bullets in case of explosion, whilst others had evidently been destroyed by this action. In a brass model of a pistol of the time of Charles II., from the United Service Museum, there was an ingenious attempt to cause the chamber to rotate, by mechanical action, in some degree similar, but more complicated, than the arms constructed by the author.

The "Coolidge" and the "Collier" guns, both flint-guns of comparatively modern manufacture, exhibited the same radical defects, of liability to premature explosion.

The invention of Nock's patent breech, and the Rev. Mr. Forsyth's introduction of the detonating, or percussion-guns, which latter principle, with the necessary mechanical arrangements for the caps, was essential to the safe construction of repeating fire-arms, constituted a new era in these weapons; and the author recognising the peculiar wants in a country whose inhabitants were constantly moving onwards towards new settlements, where the pioneers were required to protect themselves and families, by their personal prowess, frequently against fearful inequality of numbers, from the attacks of the aboriginal Indians, whose peculiar mode of warfare could only be coped with by rapid and repeated firing, it was natural that attention should be directed to the production of self-acting repeating arms.

The author being fully cognisant of these wants, but entirely unaware of any previous attempts to produce such weapons, made a series of experiments on skeleton fire-arms, which were very successful; but subsequently he fell into many of the errors of his predecessors, for, by covering the breech and the mouths of the chambers, simultaneous explosion of several charges constantly occurred. This induced the restoration of the arms nearly to their original skeleton form, and the result was the production of the present perfect arm, which has been so univerally adopted in America, that the author's large manufactory has proved quite insufficient to supply the demand.

The means for manufacturing these arms on so large a scale, was the main point of the paper; for, unlike the system adopted in England and on the Continent, of making fire-arms almost entirely by manual labour, the several parts comprising these weapons, are forged, planed, shaped, slotted, drilled tapped, bored, rifled, and even engraved by machinery, to such an extent that 10 per cent. only of the value of the arm was for hand labour in finishing and ornamenting; 90 per cent. being executed by automaton machines, guided by women and children, whose labour was represented by 10 per cent., leaving 80 per cent. for the machinery.

The action of these machines was described; and it appeared that though, like a cotton or flax mill, the manufactory, at first sight, appeared intricate, yet that each part travelled independently through its course, until at length the finishing workmen had only to put the several parts together, almost indiscriminately, and the uniformity was so precise, that little or no fitting was required beyond removing the "burr," or rough edge left by the machines. This was a point of great importance, especially in a country of such extent as America, where the necessity for sending arms from one district to another for repair, might be attended with the most serious consequences.

The arms now manufactured by the author, and of which numerous specimens were exhibited, were of the simplest construction; the lock consisted of only five working parts contained in a lock-frame cut out from the solid metal, into which the breech arbor was firmly inserted, and by it rigidly attached to the barrel in such a manner as to regulate, with the greatest precision, the contact between the end of the barrel and the mouths of the cylinders, so as to prevent any serious escape of lateral fire.

The rotating of the cylinder was accomplished by a self-acting lever, to which motion was given by the act of drawing back the hammer; at half-cock the cylinder was free to rotate in one direction, for the purpose of loading and putting the caps on the nipples, the former operation being rapidly accomplished by the conversion of the ramrod into a jointed lever attached to the barrel, by which means the bullets were rammed home so securely, that no patch or wadding was required. The grooves in the barrel were of a peculiar spiral, commencing almost straight near the breech end, and terminating at the muzzle in a curve of small radius. The bullets were either cylindrical or conical shape; and from some diagrams of several practice targets sent from Woolwich, by Colonel Chalmers, R.A., for exhibition at the meeting, it appeared, that even by men unaccustomed to the use of this particular arm, great precision of firing could be attained, as with a small revolving belt-pistol, at a distance of 50 yards, out of forty-eight shots, twenty-five bullets took effect within a space of 1 foot square, and of them, thirteen hit the bull's-eye, which was only 6 inches in diameter—the whole number of shots striking the target.

This was the first American communication that had been brought before the Institution, and it was received with acclamation; and in the discussion which ensued, in which the Honourable Abbott Lawrence (United States Minister), Captain Sir Thomas Hastings, R.N., Captain Sir Edward Belcher, R.N., Captain Riddell, R.A., Mr. Richards, Mr. Miles, and the members of the council, took part, the most flattering testimony was given of the efficiency of the Colt revolvers in active service, and the strongest opinions as to the necessity of their use in all frontier warfare; and that without this arm it was almost impossible, except with an overwhelming force of troops, to cope with savage tribes.

From the diagrams on the wall, and the ancient arms exhibited, it appeared that the necessity for the principle of repeating arms had been admitted from the earliest period of the use of gunpowder; but all the attempts at constructing them usefully had been frustrated by certain mechanical deficiencies, which Colonel Colt had, after long trials and experience, succeeded in remedying, and had eventually produced by machinery an arm which, for simplicity of construction, uniformity of its parts, and efficiency of action, was unequalled.

The President announced that the discussion on this subject would be renewed at the next meeting, Tuesday, December 2nd, when the mechanical construction of the arm would be more particularly entered into.

New Dock at Southampton.—A new dock, having an area of about ten acres, is to be opened next week, the preliminary step of gradually letting in the water commenced on the 25th. This dock, which has been partially excavated for many years, adjoins the tidal basin, which has hitherto been the only dock accommodation, and which has been found to be inadequate for the increasing commerce of the port. In consequence of the additional room required for the larger steam-ships preparing for the mail-packet service by the West India and Peninsular and Oriental Steam Navigation Companies, the directors determined to complete without delay a new dock. The area is estimated at ten acres; the entrance from the tidal basin is 46 feet wide, and is furnished with one pair of gates (no lock), the height of water inside being regulated, as regards the incoming tide, by a sluice through the seabank; the depth of water over the sill will be 25 feet at springs, and 21 feet at neap tides, and these depths will be maintained inside, varying only with the difference of rise between the springs and neaps. The entrance is crossed by means of a running bridge, which upon being opened disappears beneath a vertebrated platform, leaving neither gap nor projection when shut. The bridge has a line of rails, a cart-road, and footways over it; is very simple in its construction, and is altogether a new invention. The dock has stone walls on two sides only, the remaining sides being merely sloping banks, against which vessels lying-up will be moored. The length of quay wall, including the entrance, is 1700 feet. The quays are furnished with Fairbairn's patent tubular cranes, and have lines of railway running so close to them that coals and merchandise can be whipped from the vessels into the wagons. The whole of the new works have been carried out by Mr. Alfred Giles, the company's engineer, without a contract, and the cost is supposed to be very moderate, the dock alone without warehouses having cost about 1800*l.*, the dock-walls, 25 feet in height from the coping, costing only 6*l.* 10*s.* per lineal foot.

ON THE THEORY OF MECHANICS, AS APPLIED TO WORKS OF CONSTRUCTION.

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VI. APPLICATION OF THE PRINCIPLES OF STATICS TO THE CALCULATIONS INVOLVED IN ESTIMATING THE STRENGTH OF MATERIALS USED BY THE CIVIL ENGINEER AND ARCHITECT.

THE description of the mechanic powers which has been given, was chiefly intended for the illustration of the laws and principles of Statics, or the science of Equilibrium, which had previously been established. To give in minute detail all the combinations of these machines would be to write a history and description of all that pertains to the mechanical engineer A much more important exemplification of the application of these laws in the science and practice of civil engineering and architecture, is afforded by the consideration of the nature, properties, and modes of action of those materials which, when combined together on these statical principles, give stability and strength, or, in scientific parlance, afford stable equilibrium to fabrics. We shall therefore merely name one or two combinations of the mechanic powers (*entre deux*), with another principle (that of virtual velocities) which has been used in estimating their effect, and then proceed to this vaster subject. It may here be remarked, that many other mechanic powers are now used—the fly-wheel for example; but they generally belong to dynamical effect.

A combination of wheels and axles, in which the teeth formed round the circumference of the first wheel act on the second axle, whose wheel again acts similarly on the axle of the next, &c.; and where the power is applied by a cord, capstan levers, or otherwise, to the first axle, and the weight is attached to the cord passing round the last wheel, may be multiplied to any extent. The increase of force gained may be estimated in the same manner as has been already pointed out in the case of the compound lever. The capstan is a combination of the lever with the wheel and axle. A wheel and axle, furnished with a wince-handle placed at the top of an inclined plane, furnishes a most powerful machine for raising bodies up them; or, fixed on any plane, may be used with immense advantage of force to draw bodies along it. To go into details of all these arrangements would involve us (as we have said) in a treatise on machinery. The student had better refer for this to Willis or Moseley, as it is not our design to furnish it; nor would this be the place to do it. In every case we have seen that gain of power was accompanied by loss of velocity. Even in the case of equilibrium, where no motion is supposed, this principle may assist the calculator.

We shall now proceed to consider some properties of materials by which they are suited to establish, maintain, and communicate the conditions of equilibrium, which is the grand object of the designer and executor of works of construction.

These materials are stone, timber, metals, &c.; and their properties to which we refer, hardness, or the resistance to forces which tend to compress them; elasticity, or their resistance to forces tending to separate or pull asunder their cohering parts; and some other qualities, very similar to these, which are described under different names, according to the peculiarities of their resistance to the forces: ductility, for example, is a name for a form of elasticity which is used when the matter resisting becomes extended under the influence of the force without immediate rupture.

All the strength of materials might be included under two heads—namely, their indisposition to be *compressed* into a *smaller*, or *drawn* or *twisted* into a *larger*, or *different* shape. Forces acting in different directions tend to cause different sets of these effects; and, as different substances having distinct properties, afford peculiar adaptations for resisting each force, so the skill of the constructor must select what material appears best suited for the sustaining of a pressure, &c., which he has to resist.

Every fabric built upon the earth presses its foundations and points of support, in obedience to the law of gravitation. This pressure is proportional to the weight—nay, equal to it. Now, as stone, brick, &c., are very strong in resisting compressing forces, they may be used with great advantage in such cases: indeed, this is their principal use. As the structure increases in size, the weight increases; hence the quantity of material must be increased in proportion. The principal element of this weight is the stone itself which forms the walls, &c.

The weight of limestone may be taken as a mean for other stones, and it is a very commonly used building material itself: it weighs from 162 to 175 lb. per cubic foot; hence may be found the weight of any wall, pillar, &c. But it has been found from the experiments of numerous accurate and scientific inquirers—including Vicat, Hodgkinson, Rondelet, &c.—that the following may be taken as mean resistances to compression in lbs. per square inch of surface (the surface being supposed to be perpendicular to the directions of the forces, for if it be not so, the tendency will be—wholly or in part—to cause sliding motion along that surface, and then comes under the case of friction, which we have noticed): granite (Scotch), 10,804; ditto, 8184; granite (Cornwall), 6292; sandstone (Dundee), 6490; sandstone (Derby), 3110; white marble, 9583; limestone (Portland), 6550; brick (Stourbridge), 1695. These are the principal materials used for building. Quartz or flint, and greenstone, whinstone, or basalt, are too hard to be economically prepared for edifices. In stone, it is found in all experiments that when the length in the direction of the compressing force is more than six times the smallest dimensions (lateral) at right angles to that direction, the piece is not completely *crushed*, but partly broken across. Moreover, Hodgkinson has shown, that when the length is under this ratio to the breadth, the fracture is at an angle to the direction of the force which is constant for the same substance. Similar conditions maintain, also, in the case of any other material as well as stone. In the case of pieces which are not *crushed*, but broken across by the effect of superincumbent weight or pressure, the following formula is used for finding the strength of resistance of stone: $b = \frac{a\,d^4}{l^2}$ where b = the crushing weight, or that pressure in lbs. which would break the piece; d = the shortest line, *in inches*, across it at right angles to the direction of such force or pressure; l = the length, *in feet*, of the piece in the direction of the pressure; and a is a constant coefficient, which has different values in different materials, and is found by experiment to be 25,000 in granite, 15,000 in fine sandstone, 24,000 in marble, &c.

Example.—To determine the least diameter of a sandstone pillar which shall sustain a weight of 10 tons at a height of 12 feet from its base:

$$22{,}400 \text{ lb.} \;(= 10 \text{ tons}) = \frac{15{,}000 \times d^4}{12 \times 12} \quad \therefore d = 3\tfrac{4}{5} \text{ inches nearly.}$$

Of course, no engineer or architect would trust this dimension; but it shows the limit below which we must not go. Practical men have a rule—and, indeed, it is set down even in theoretical works on the subject—that only one-half the breaking weight can be trusted to. Hence the pillar should be made two or three times greater than this.

Stone is seldom used in situations where tension alone is to be resisted, its tensile strength—depending on the cohesion of its particles—being small in comparison to its resistance to forces of compression. Its resistance to tension is, however, frequently called into action in conjunction with that of compression, as will be seen from the nature of strains considered in relation to timber and metal. It was this difference in the nature of stone as a building material which suggested the idea of the arch, in which the strength is dependent on the resistance to compression. For though the Romans did not know systematically and scientifically this property, yet experience operated even among barbarians and Pagans in suggesting improvements, and new modes of securing darling objects. Indeed, it is only by experiment that we know the fact, but knowing it we must seek means of obviating it; and, therefore, wherever stone is submitted to tension, ties of iron or wood are introduced. The following are the weights which just break the materials named, according to the average of many careful investigations. [It should perhaps be premised, that the resistance must be proportional to the quantity of matter resisting, or to the area of the section perpendicular to the direction of the strain. Hence, knowing what one unit of section (a square inch) sustains, the power of any other may be found.]

	lbs. per square inch.	Compression.
Portland limestone......	857	6550
Fine sandstone	215	6490
Brick	275 to 300.........	1695
Hydraulic lime (mean)	100 to 150.........	—
Common lime	43	—

It appears from this comparison that bricks resist tensile forces much the same as stone; while they are crushed by much smaller weights.

Many examples might be stated of the application of these results. For example, when a stone is raised by placing wedges in a hole cut for the purpose, what forces act, and when do the wedges break the hole? &c. But we must not delay with these. It may be remarked, however, that a close study, and more general diffusion among the mass of building and designing operatives and foremen, might prevent much mischief. For example, if men really considered that stone bore just a certain weight under given circumstances, and could not sustain more, they would be cautious in overloading it. A fearful accident has just been recorded in the leading journals, the real cause of which sprung from ignorance or inattention to this fact.

Roads.

One very important application of stone is its use in forming common roads, in which the qualities of that material are not precisely similar to those required by other structures. Since railways have become the channels of commercial intercourse, this subject has fallen somewhat out of notice and into desuetude. Still road-making is of vast importance, and people generally must keep its principles in mind, and even study them more carefully. Their construction now must fall into the hands of the many, and especially of those interested in land. Few grand, leading country roads will now be undertaken; yet still, roads on the small scale must everywhere be changed, new formed, and repaired. Hence the necessity of instructing the mass in these principles, since individuals will form their own, and the attention of the scientific and general engineer will be omitted or abstracted from them by weightier matters. It is only within the current century that the true principles of constructing roads were recognised in this country; for though the Romans and other nations had formed capital thoroughfares even in Britain, we all know what the state of these indispensable requisites to every civilised community was even so late as a century and a-half ago; and we find elaborate reports of parliamentary committees on the subject only fifty years old, in which eminent engineers (such as Hughes and Telford) gave conflicting opinions regarding their foundations. It has been pretty generally admitted since the days of Macadam, that broken stones are *the materials* for forming the surface; and, of course, each locality will use its own produce in this way. It is therefore only with the foundation that we have to deal. The height of perfection to be aimed at in forming a road is to make it as enduring as possible, and to present as little resistance to motion along its surface as the circumstances admit.

For these purposes the road should be as hard, as smooth, as dry, and as level as it can be made under the conditions which limit it, and which are, its position and cost; these again being influenced by its objects, either of serving a number of people or only a private individual.

The hardness and smoothness depend principally on the surface materials. Flint makes a good surface, but should be covered with some soft material, such as chalk, to prevent its cutting the wheels of vehicles. It fortunately happens, that where flint is found chalk generally occurs in abundance. Chalk of itself is too soft, and wasting away entails an immense expense in repairing; but the two together make good roads. It is seldom that flint is found in sufficient quantity for roads; and hence we find granite,* &c., imported for this purpose into chalk countries, such as London and its environs. Basalt, sandstone, limestone, &c., make excellent roads. All these materials are broken, so as to pass through a ring $2\frac{1}{2}$ inches in diameter, more or less. These should be laid on the prepared bed, in a layer about six inches in depth; and when this layer has been worn for a time, and kept low by raking in and filling up the ruts, a second layer of three inches should be added, and similarly dressed, till perfectly bonded. As ruts then form by subsequent wear, new materials should be laid on; and it is surprising how small a quantity will be required if regular attention is paid to this rule—namely, that no rut should be allowed to remain. Many reasons prove the folly of passing over this: 1st, a rut collects water, and hence, being softer, wears more rapidly; 2nd, a wheel coming into a rut acts not by pressure in wearing the bottom of it as well as the wheel itself, but by impact acquired in the descent; and 3rd, loss of power required to pull the vehicle out of it, &c. Steep inclinations must be avoided. The fewer and the more gentle these are the better will be the road. In hills, not only the friction from necessarily imperfect hardness and smoothness, but also the raising of the load through a certain space, must be overcome. A reference to the principles of the inclined plane will enable any one to calculate the amount of this element Up an inclination of one in twenty, an additional horse-power would be required to move 15 tons 20 feet in a minute (for it must be raised one foot, and it is 33,600lb.) to what would draw the same along the road if it were horizontal; and a similar calculation shows the required increase of strength for any other loads, inclinations, and velocities—*e. g.* three miles an hour on an inclination of one in one hundred. Care must therefore be taken to select the levellest route possible; and sometimes cuttings and embankments may be advantageously adopted. Once made they entail no expense, while their absence may cause continually recurring expenditure for horse keep and additional strength of machinery. In many cases a slight deviation from the direct course along the sides of hills, &c., will present a ready means of avoiding too steep inclinations. For important turnpike roads near towns, &c., the law prescribes certain limits beyond which rates of inclinations must not be introduced—such as one in thirty, &c.

* Granite might be obtain d at a much cheaper rate for London roads if an enterprising man tried it.

The breadth of roads may here be noticed. In no case should a road be too narrow to allow two vehicles to pass each other—say 16 feet for farm roads. Near towns, &c., roads must, by law, be 60 feet wide. Between those limits, or above the latter, the circumstances of the case must decide.

Note.—We have practised a method of draining a peat bog, for the purpose of consolidating it so as to carry a railway, which might, in many marshy places, be introduced with success. The line of railway having been chosen, and the level having been pretty nearly formed, a drain was cut along each side, of the required width. The drains were therefore about 30 feet apart, 4 feet wide at top, and about 4 to 6 feet deep. At the distance of about 20 feet, cross drains (not quite so large or deep) were formed, so as to empty themselves into the longitudinal ones, which again were made to discharge at a lower level. The peat from all these was thrown up, and dried for three or four months in summer. When once dried, peat never becomes quite soft again by the absorption or action of water; hence it suits well for drainage, where it is abundant. When the drains had thus stood for a sufficient time to allow their sides to harden, and the masses of peat which were to form the foundation of the railway to become tolerably dry and hard, pipes of wood were formed by nailing or *pegging* together four boards, about 3 inches broad and an inch thick; precautions being taken to make openings in them so as to admit the water. These pipes were laid along the entire drains described, the end of each being made to fit into that of the one which succeeded it, commencing at the highest point. The dried peat was then thrown in, and some wicker-work constructed (like hurdles warped with twigs) for the purpose, covered the surface. On these the ballast-engine could at once enter and deposit the gravel, which, when spread, formed the bed for the sleepers and rails. It is found to last quite firm and enduring: not a sign of failure has ever been observed in it. What folly, therefore, it would appear to be to imitate the practice of some engineers, who build with heavy timber pipes, whose dimensions are feet to our inches, in similar situations. In truth, it too frequently appears to have been an object with the engineer to invest the maximum of capital, and finish the minimum of enduring work.

Granite v. *Whinstone Causeway.*—A report by the inspector to the Edinburgh Paving Board has been read, on the comparative expense of granite and Whinstone causeway, from which it appeared that while six roods of whinstone from Ratho quarry (the stone at present used) would cost 64*l.* 2*s.* 6*d.*, six roods of Aberdeen granite, laid with concrete and grouted, would cost 151*l.* 8*s.* 6*d.*, Argylshire granite, 140*l.* 12*s.* 6*d.*, Barnton granite, 113*l.* 12*s.* 6*d.*; the difference in each being 97*l.* 6*s.*, 76*l.* 10*s.*, and 49*l.* 10*s.* respectively

French Public Works.—For the grand public works of 1852, a sum of 1,133,091*l.* has been demanded. The following are the most important items:—New roads in Corsica, 9843*l.*; Canal of the Marne to the Rhine, 1,116,000*l.*; branch canal to the Garonne, 52,000*l.*; railway from Paris to Hommarting, 640,000*l.*; Hommarting to Strasburg, 36,000*l.*; Avignon to Marseilles, 28,000*l.*; Tours to Bordeaux, 640,000*l.*; Chateauroux to Limoges, 80,000*l.*; Vierzon to Chateauroux, 400*l.*; Vierzon to Bec d'Allier, 20,000*l.*; Bec d'Allier to Clermont, with branch to Nevers, 130,000*l.*; Chartres to Rennes, 220,000*l.*; Paris to Orsay, 4000*l.*; isolating the Louvre, and prolonging the Rue de Rivoli, 64,000*l.*; completing the grand court of the Louvre and its four porticoes, and establishing gates for entering, 8200*l.*

Old English Wrought Ironwork.

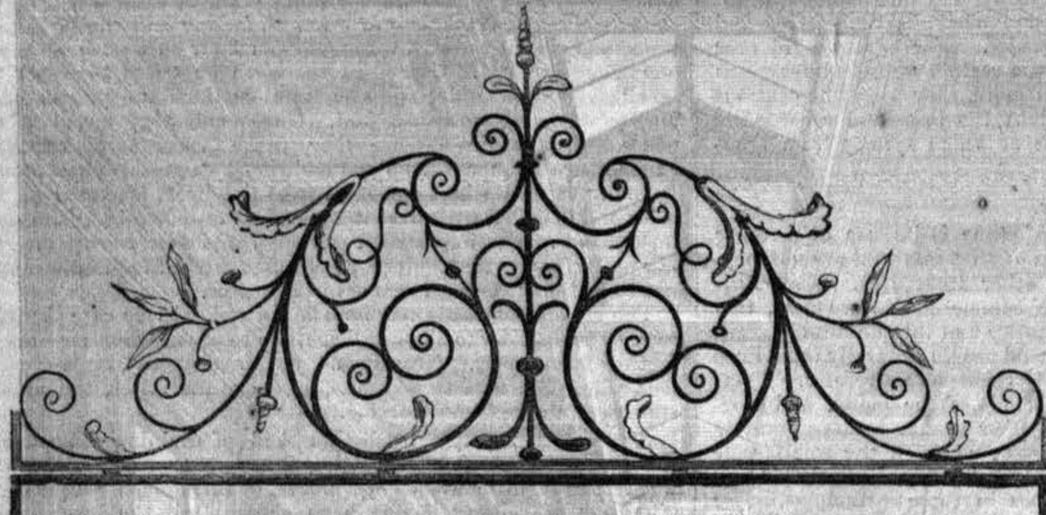


Fig. 1.

Fig. 2.

Fig. 3.

F

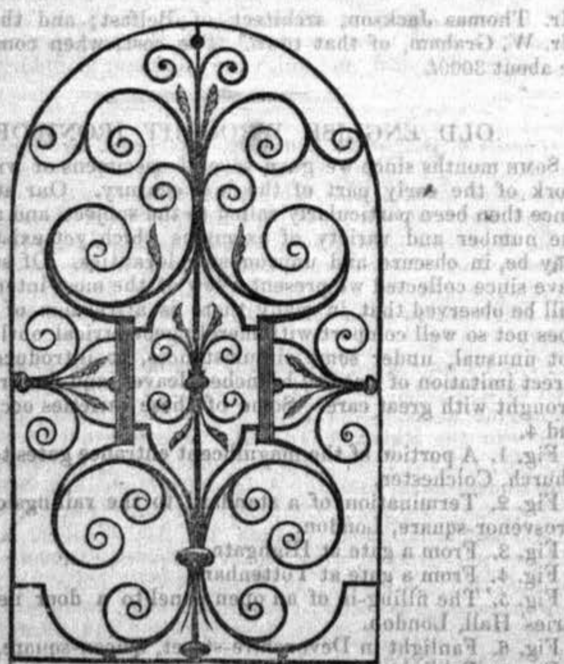


Fig. 5.

Fig. 6.

Fig. 7.

CORN EXCHANGE, BELFAST.—T. JACKSON, Esq., Architect.

THE CORN EXCHANGE, BELFAST.

THIS building is situated at the northern extremity of Victoria-street, having its principal front towards that street, and its end facing Corporation-street, in such a manner, that from the angle at which the streets meet, both fronts are seen in perspective to great advantage from Corporation-street. The exterior of the building is executed of a superior description of Glasgow stone. The lower floor is intended to be appropriated to four commodious shops or counting-houses, the ceilings of which are formed of brick arches on metal beams, and form also the fire-proof floor of the Exchange Room, which is immediately over. The latter is to be approached from the street, through a recessed portico with columns of the Ionic order, and from it the visitor ascends by a commodious cut stone stair of easy ascent to the Exchange Room, which will be upwards of 60 feet long, 32 feet wide, and 27 feet in height. This room will present a very tasteful appearance from the style of decoration which has been adopted, and which will be enhanced by an ornamental coffered ceiling, lighted by roof lights glazed with rough plate, the area of which taken together will be about equal to 440 square feet. From the main room will be entered two or three smaller apartments, to which the merchants can retire to write or transact private business. Under the same roof are apartments for a housekeeper, and other conveniences.

In consequence of the regulations of the town council, the structure had to be raised to a corresponding height with the adjoining houses, and is being built upon a piled foundation. It was designed by, and is being erected under the direction of, Mr. Thomas Jackson, architect, of Belfast; and the builder is Mr. W. Graham, of that town. The cost, when completed, will be about 3000*l*.

OLD ENGLISH WROUGHT IRONWORK.

SOME months since we gave several specimens of wrought iron-work of the early part of the last century. Our attention has since then been particularly called to the subject, and attracted by the number and variety of examples which yet exist, though, it may be, in obscure and unpromising localities. Of some that we have since collected we present a few of the most interesting. It will be observed that in many there is a freedom of form which does not so well comport with merely geometrical outline. It was not unusual, under some circumstances, to introduce an almost direct imitation of natural branches, leaves, and flowers, which are wrought with great care. Some of these varieties occur in figs. 1, and 4.

Fig. 1. A portion of the magnificent entrance gates to St. Peter's Church, Colchester.

Fig. 2. Termination of a standard to the railings of houses in Grosvenor-square, London.

Fig. 3. From a gate at Highgate.

Fig. 4. From a gate at Tottenham.

Fig. 5. The filling-in of an open panel to a door near Apothecaries' Hall, London.

Fig. 6. Fanlight in Devonshire-street, Queen-square, London.

Fig. 7. Fanlight at Bury St. Edmunds.

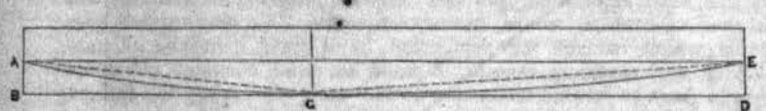
EXPERIMENTS ON THE FORM OF SHIPS AND BOATS.

Hints on the Principles which should regulate the Forms of Ships and Boats; derived from original Experiments. By Mr. William Bland, of Sittingbourne, Kent.

(*Concluded from page* 605.)

Chapter XVI.

The six models just treated of were all with flat bottoms, and this for the sake of convenience. The forms calculated for service must have the curve along the bottom, as shown to be so necessary in Experiments 33 to 36. They must have, likewise, the keel deeper towards and at the stern than towards and at the stem (see Experiment 5); again, the space between the curve along the bottom and the keel must be filled up at both stem and stern, and so constructed as to offer at the bows, from the cutwater to the midship, the least resistance possible to the water; and from the midship to the stern post, to afford the easiest and most direct passage for the water, that it may act to the best advantage against the sides of the rudder.



Upon an inspection of the accompanying diagram it will be seen, that the part cut off the flat bottom by the curve A C E, equals nearly the triangles A B C, and C D E; but since a portion of the triangles will be made up by the sharp bows and body situated between the keel and the line of curvature along the bottom, it will occupy the space of about half the cubic parallelogram: therefore a quarter part only will be necessary to add to the depth at the midship section for the load-line of flotation. Upon testing the above by two models, one with a flat bottom, the other curved and yet left filled up, as required between the curve and the keel, the displacement in the water gave a quarter part as the exact difference. This proportion of a quarter part to be added to the depth at midship, applies to all the six models, from their similarity in flatness; therefore, the depth at their midship section for their load water-line should be increased by one-quarter part of their draught, when having a flat bottom at midship.

On turning back to those experiments which relate to the depths of keels, commencing with No. 44, it will be seen that the flat bottomed model (No. 2) required no keel; likewise the triangular midship model No. 3; but to the forms Nos. 1 and 4, keels were necessary.

Before deciding upon the midship section best calculated for service, it will be right to criticise those sections which have been already tested. To this end, it will be advisable to review the Experiment 41, where it appears of the triangular model No. 3, that its speed equalled Nos. 2 and 4, the latter having been previously made elliptic. In lateral resistance, No. 3 possessed the same as No. 2, Experiment 54. In stability, No. 3 proved the worst of the four (see Experiment and Table, &c., after No. 43). Lastly, in depth or draught, No. 3 again exceeds all the others. The conclusion to be drawn from the preceding facts are of such a nature as to justify the rejection of the triangular form of midship.

The semicircular form of midship (No. 1), possessed speed as one good quality; but which advantage is counterbalanced, first, by its circular outline being conducive to rolling; next, the depth at which it floats; and third, its deficiency in stability. These evils, it must be admitted, are highly objectionable, and warrant the rejection of the semicircular midship section, except where speed only is sought, when the employment of iron or lead ballast can be had recourse to as a corrective of its instability.

There remains to be considered the flat bottomed model No. 2, and the elliptic one No. 4.

The model 2, (as shown in Experiment 41), is inferior in speed to No. 1; but as regards all other qualities, so essential to every ship, particularly for burthen, very far the superior,—1st, in floating depth (see Experiment 43); 2nd, in not rolling; 3rd, in lateral resistance (see Experiment 44); 4th, in stability, the means of speed (see Table, after Experiment 43).

The elliptic midship model (No. 4), as stated in the several experiments before adduced, is equal in speed to No. 2, but is slightly inferior to the same model,—1st, in depth of flotation; 2nd, by rolling more; 3rd, by having less lateral resistance; 4th, by possessing less stability.

The next point to be considered, before finally deciding upon the midship section, is, that part of a ship's midship which is above the load water-line—meaning the sides; whether they should be continued up perpendicularly, or slightly inclined outwards, so as to present at the lee-side a larger bearing on the water, to operate in an increasing ratio against the force of the wind upon the sails.

The Experiment 63, shows that the stability of the model (No. 1) having right-angled sides, equalled the stability of the model No. 2, with its sides inclining outward; and when both were lightened, the influence of the sides which inclined outwards became apparent in the stability remaining unaltered; whereas, in No. 1, the stability was improved to the amount of half-an-ounce; consequently, there appears no good reason for giving a preference to the bevelling-out sides, over those carried up perpendicular.

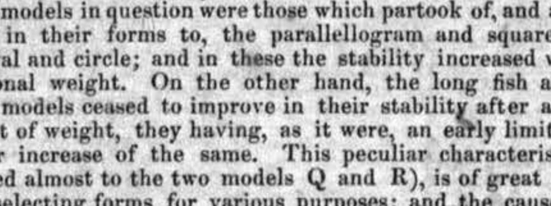
From what has been elicited, it appears that any approach to the triangular midship section has its stability improved materially by ballast, or weight; for, in fact, it is indispensable, since it possesses none without ballast.

Chapter XVII.

The criticism of the four models of midship section being concluded, the inference to be drawn from it is, that (No. 2) the flat bottom, exceeded all the others in the essential qualities for a ship of burthen. But since speed is now become so essential a quality in a ship, those curves must be adopted which have been proved so advantageous in Experiments 33, &c. Chapter VIII.; and in consequence, the flat bottom can only be preserved entire at midships; thus making the addition of a keel absolutely necessary, both before and after that point. No. 4, the elliptic form, comes next. When carrying out the experiments undertaken, with the object of ascertaining the effects of additional weight, for the purpose of gaining an increased depth of flotation in the six models, it came out that a certain few of the models were influenced in their stabilities differently from the others.

The models in question were those which partook of, and approximated in their forms to, the parallellogram and square, and of the oval and circle; and in these the stability increased with the additional weight. On the other hand, the long fish and bird-shape models ceased to improve in their stability after a certain amount of weight, they having, as it were, an early limit to any further increase of the same. This peculiar characteristic (and confined almost to the two models Q and R), is of great moment when selecting forms for various purposes; and the cause of the same must be looked for in the narrowness or sharpness of such craft, particularly towards their head and stern.

The Experiment No. 8 and Table C, exhibits No. 2, with one-fifth of the base or beam for the depth of flotation, as possessing the greatest stability. Now, admitting the depth of flotation to be one-fifth at the midship, then the depth from the midship towards both head and stern must be greater than one-fifth; indeed, be in an increasing ratio as the distance nears those extremities; consequently, the stability diminishes proportionally, as shown in the same Table C, in No. 5, being inversely to the length. Thus throwing the support of such parts upon the superior stability about the midship section; which, therefore, must necessarily be reduced. The annexed diagram will explain the meaning.



Let A B C D be the model, and B D the midship section. Take any point in the sides B C and D C, as F, and draw the line F G, parallel to B D; likewise, draw F H, and G I, parallel to A C, cutting B D in H and I. Now, it is well-known, that the straight line F G equals the straight line H I, which is part of the line B D. H I is less than B D; so also must be its equal F G.

From hence it follows, that since B D, is greater than F G, then is one-fifth of B D likewise greater than one-fifth of F G; consequently the stability is proportionally less. The same can be shown of every line that may be drawn parallel to B D, between B D and the extremities A and C.

Chapter XVIII.

Presuming thus far as correct, the difficulty then almost vanishes in relating to models or forms of ships for particular services.

To begin with boats intended for speed, and to be impelled forward by the oar. Now it has been seen in Table No. 1, of the difference in speed beween the six models when towed through the water, that the model I proved the swiftest. This model, in its proportion of length to breadth, is seven times the breadth. If greater speed be required, then eight, ten, or more times the breadth may be selected, the midship section being semicircular, and to be situated at the middle of the length (see Experiment 75), or from that to an ellipse; but the utmost care will be requisite to prevent upsetting from its deficiency in stability.

For a steam vessel upon rivers, and without the aid of sails, seven times the beam or breadth as the length will be found to answer very well, with the midship section semicircular, and at the mid-length (see Experiment 75), or nearly so. Here iron and lead as ballast will greatly improve the stability; but then it will act as an extra load to carry.

When boats and steam-vessels are to have the assistance of sails, the length should be about five times the breadth, as the model O.

For yachts, which are vessels for speed only, and impelled forward by sail, and in consequence great stability required, then the model R, or between R and T, is the one most applicable for the purpose. The floating depth, according to Table 4, must be very shallow, yet the keel with the bottom tapered should be made to descend down into the water sufficient to obtain the requisite lateral resistance, having the lower spaces filled with iron ballast, to further improve the stability for racing purposes; the masts, &c., being made proportionally strong.

Sea fishing-boats should closely resemble the model R also, because, although required for burthen rather than speed, great stability is absolutely necessary for the sake of safety, since such craft rarely have decks. Besides this, the cubic capacity of the form R is great, and at little cost, which is a consideration with fishermen. The sides also should be carried up high, both for safety and burthen.

The model Q presents the best form and requisites for the merchant service, which is made evident in Table No. 3. The proportion of its length to breadth is three and a-half the breadth. In the same Table (No. 3), it appears, that when the oblong form of model, as P, is in length five times the beam, and possessing, as is there noted, greater stability than the model O, yet the model O beat P, and with less surface of sail, which is an advantage as requiring less weight of masts and yards.

Lastly, for ships of war, the model Q is here again pre-eminent for this purpose, particularly for the largest rates; because, in the first place, the stability increases in a degree with the load; and in the second place, of the greater bearing on the water at and towards both head and stern; and in the third, of the almost parallel sides, which afford every facility for the carrying of guns with space to work them; but draught in the water should on no account be great, because speed is too essential a quality to be dispensed with in a man-of-war.

Chapter XIX.—The Positions of the Centre of Gravity, of the Centre of Lateral Resistance, and the Centre of Force of the Sails.

The position of the centre of gravity in a ship, with regard to its height above the keel, should not exceed when loaded, the line of the surface of the water (see Experiment 8, Table C); otherwise it will lose stability and become top-heavy. If situated much lower than the water-line, the stability will certainly be improved; at the same time, a greater strain than needful will ensue upon the vessel, and thus endanger the breaking of the masts and yards, if they be not of sufficient dimensions to meet it. When the axis of the centre of gravity, considered lengthwise of a ship, exactly corresponds with the surface of the water, the rolling will be easy as far as the height of the said gravity is concerned; but the form of the midship section has very great influence in checking or increasing such motion. The distance from the head and stern in a ship at which the position of the centre of gravity had best be fixed, requires no small degree of reflection, and must be decided before the laying down of the keel, because the circumstance involves both the places of the centre of lateral resistance, and the centre of force of the sails.

The sole fish has the centre of gravity in the widest part of its breadth, and which, therefore, is its centre of motion. The distance of this point from each extremity of the fish is just two-fifths of its length from the head, and three-fifths from the tail; consequently, gives one-fifth as the excess of leverage at the tail over that at the head. In a fish this is most essential, because it derives its power of locomotion chiefly from the rapid, lateral, and curved movements of the tail.

A ship, which is a body impelled forward by sails, could by no means answer if constructed altogether upon the principle of the sole fish; and chiefly on account of the centre of gravity being so forward, as stated. The consequence in practice, from the great distance apart of the centres of gravity and lateral resistance, would be a perpetual conflict against each other for the centre of motion, at the positive disparagement of the speed; for, first, the influence of gravity would place the centre of motion at two-fifths of the length from the cut-water; second, the lateral resistance would operate to carry back the centre of motion towards the centre of length; and third, the centre of the force of the sails, if not situated well a-head by means of a long bowsprit, would be perpetually causing the ship's head to fly up into the wind. From all that has been stated, it appears in every way impolitic to have the centre of gravity situated too far forward.

In Experiments 73, &c., of the six models, it is shown that their centres of gravity taken in the solid state of the models themselves, previous to their being hollowed out—and, therefore, their true centres being likewise centres of displacement with regard to length—are situated forward and a trifle more than their mid-length. Now, if the centre of lateral resistance be influenced by the head resistance, the two centres, namely, of gravity and lateral resistance, would merely coincide. To accomplish this point, which insures the perfection, in a great measure, of easy sailing and steering vessels, it must be done through attention being given to lateral resistance at the time of making the design; as by well slanting the cut-water, without however losing a good foot-hold, and deepening the keel towards and at the stern—whose post should be perpendicular, for length of keel operates with the best effect in improving lateral resistance, whereas the deepening of it acts to overturn, and thus lessens the resistance (see Chapter XI.),—by this means, the two centres of gravity and lateral resistance will be made to approximate very closely, or quite unite. Nothing now will remain to make perfect the sailing and steering, but to place the centre of the effort of the sails perpendicularly over the two centres before-named. If this be not effected, then whichever way the preponderance of the power of the sails operates, it will, if towards the stern, cause the head to fly up into the wind; and if towards the head, cause it to fly from the wind. The helm, which is the tell-tale, will counteract in part these propensities; likewise the reduction of sail at either stern or head, but that must be at the expense of speed.

If what has been stated be admitted to be correct, the three centres then ought to coincide as nearly as practicable, when the steerage will be easy, and only require the motion of the rudder to overturn the equilibrium to alter the course.

Again, the centre of gravity, though situated correctly as to its height, may yet be extremely injurious to easy motion of pitching and scudding, if the heaviest weights be stowed very fore or aft. Instead of which, they ought to be placed at or near the position of the centre of gravity, the object being the rendering the vibration like a scale-beam, easy and without plunging. To fix the exact plan of stowage is out of the question; but it is best completed at sea, correcting any evils that may be found expedient.

The place of the centre of gravity between the head and stern, is ascertained pretty correctly by the surface of the water coinciding with the load water-line, obtained and laid down from a correct model. But the axis of its height is extremely difficult of detection; and the readiest mode which presents itself would be, the placing of three or more cups or open vessels filled with water, upon separate yet moveable shelves, a few inches or more perpendicularly above each other, at the centre of the ship's width and centre of gravity, taken lengthwise. This being done, a lateral rolling motion communicated to the ship artificially, or the taking advantage of a light wind upon smooth water, and observing particularly the surfaces of the water in the cups; then if the water in any one of them be seen merely to rise up first on one side, afterwards on the other, but in the remaining cups if the motion of the water be more rapid, even to overflowing—that first cup, wherever situated, cannot be far from the axis of lateral motion. Should any doubt on this question arise, just shift the said cup a trifle higher or lower, until the due quietude of its water surface be obtained.

Chapter XX.—Conclusion.

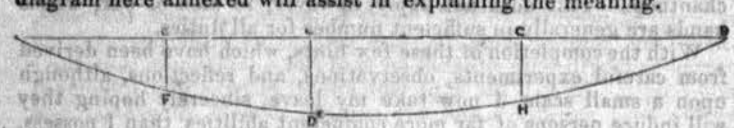
Since curves must be substituted for the straight line in the forms of the bottoms of all vessels of speed, as proved (see Experiments 33, &c., Chapter VIII.), and in consequence a keel is indispensable, the midship section, but particularly the parts fore and aft of the same, will partake more or less of the elliptic and angle shape.

From experiments made subsequent to those already given in

Chapter XI., but not entered, and for the purpose of determining the perpendicular depth of the under-part of the keel at midships, from the load water-line of models with curved bottoms, it appeared that the depth to cause the greatest lateral resistance should not exceed the average breadth of half the beam measured at the points of equal distance between the midship and either end; unless the centre of gravity by means of heavy ballast, as lead, be made to descend proportionally with any addition to the depth of the keel.

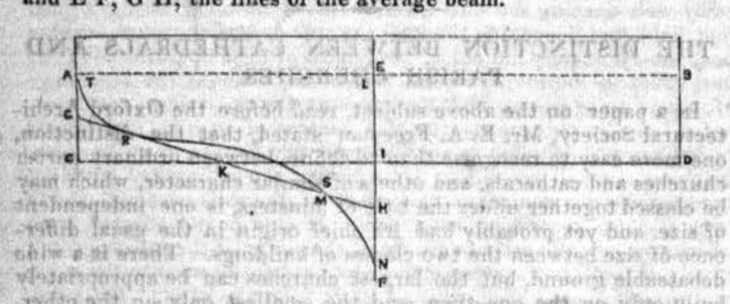
Again, as the above average depth is requisite for lateral resistance, then the midship form, and likewise the sections towards both head and stern, must be moulded into those shapes which will meet the object desired, with the least increase of displacement beyond the true one the vessel ought to possess when required for speed, as in Table 4, Chapter XV.

Let the above be exemplified in the models O, Q, and R, and the diagram here annexed will assist in explaining the meaning.



No. 1. The Model O.—Scale, ½-inch to 1 inch.

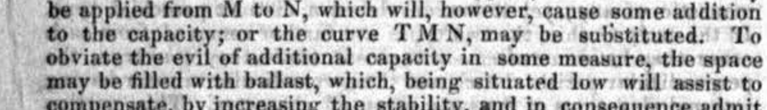
A C B D represents the half part of the horizontal section of the model O, taken at the load water-line; C D being the midship, and E F, G H, the lines of the average beam.



No. 2. Midship Section of Model O.—Scale, 1 inch to 1 inch.

Let A B D C be the midship section of the model O, when with the flat bottom; L I the depth as stated in Table 4, Chapter XV. Now, in order to give speed to the model, the curved form must be applied to the bottom, which will cause the model to sink deeper into the water than before, by a one-fourth part of L I (see Chapter XVI.), or to the dotted line A E B.

Again, let E F equal the average breadth of beam, and F the bottom of the keel; but as every increase of the displacement beyond A B D C, will retard speed; yet the part of the dead wood and keel from I to F, require support; it can only be carried into practice by transferring a portion of the capacity, or displacement at and about C, to between I and F. To this end, let K bisect the straight line C I, and G bisect A C from G, and draw through K the straight line G K H. By Euclid, the triangles G C K, K I H, are equal, therefore their displacements are equal. But since the keel from H to F, will likewise need support, a curved brace may be applied from M to N, which will, however, cause some addition to the capacity; or the curve T M N, may be substituted. To obviate the evil of additional capacity in some measure, the space may be filled with ballast, which, being situated low will assist to compensate, by increasing the stability, and in consequence admit of an addition being made to the sail sufficient for the wind to impel forward the extra weight with nearly undiminished speed. The angle at G may be rounded off or not, but as it is, the original stability will be diminished by the removing of the triangle G C K, to the triangle K I H, because it is sufficiently evident on inspection that the assumed centre of the triangle K I H, from the perpendicular line E F, is less than R, the centre of the triangle G C K; therefore the power of buoyancy to aid stability is proportionally reduced, and which will not be altogether met by the ballast in the triangles K I H, and M H N; the stability will again be lessened also, if the angle at G is rounded off.



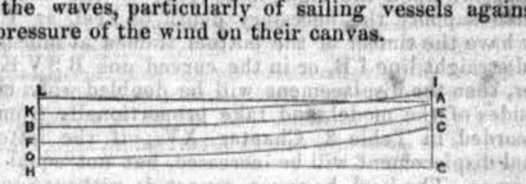
No. 3. Bottom Curves of Model O.—Scale, ½-inch to 1 inch.

In this diagram (No. 3), A C is the load water-line, A B, B C, the bottom curves, and D E, E F, their union with the keel G H.

Here is represented the part of the model situated between the head and the midship. A L the load water-line, A B the curve

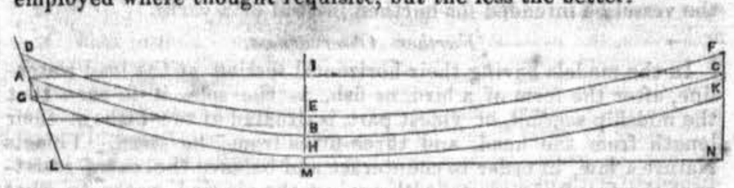
No. 4. Model O, from Head to Midship.—Scale, ½ inch to 1 inch.

as A B in No. 3, B being the depth of E I in No. 2, and I K the curve at the depth of A G in No. 2, and C D the curve uniting with the keel G H. The curves I K, A B, C D, and the dotted one E F, are all parallel to each other, and which must be carried out along the bottom of the ship in planes perpendicular to the horizon, and parallel to the ship's longitudinal axis. With regard to the lines E M, C N, &c., they must be drawn parallel to the load water-line to form a wedge of the bows, as repeated experiments, not entered, have determined this point over the bow curved alone; yet the outline of the said curve should be preserved wherever the lines touch, and made to take the concave form, with the express view of promoting speed, by assisting the raising of the bows over the waves, particularly of sailing vessels against the downward pressure of the wind on their canvas.



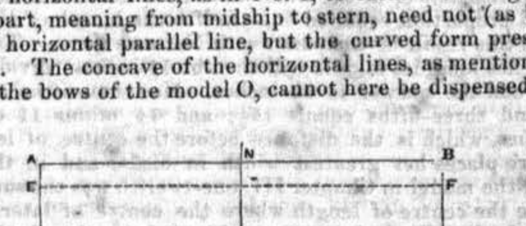
No. 4, *continued*.—Model O, from Midship Section to Stern.—Scale, ½-inch to 1 inch.

Let L A be the load water-line, B A, F E, D C, the curves, and D C the one uniting with the dead wood and keel. In this part of a ship no lines parallel with the load water-line are necessary, indeed they would be hindrances to speed, as has been shown already in the experiments. But in order to strengthen the dead wood and keel, short braces placed at the angle of 45° may be employed where thought requisite, but the less the better.



No. 5. Midship Section of Model Q.—Scale, ½ inch to 1 inch.

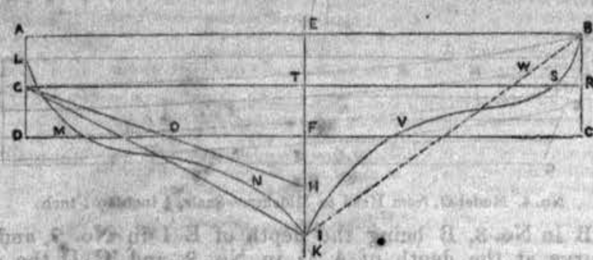
A I C is the load water-line, A B, B C, D E, E F, are the bottom curves, and G H, H K, the union with the keel L N; A R, G S, are parallel horizontal lines, as in No. 4, to form the wedge bow. The stern part, meaning from midship to stern, need not (as before stated) the horizontal parallel line, but the curved form preserved throughout. The concave of the horizontal lines, as mentioned in treating of the bows of the model O, cannot here be dispensed with.



No. 6. Model Q.—Scale, ½-inch to 1 inch.

Let A B D C be the midship section of the model Q, A B the load water-line, the depth being increased from E F, to A B, as in diagram No. 2. N K the depth equal to the average breadth of half the beam of the model Q, taken as in the model O. It is seen in this instance, that the depth from I to K, is less than in No. 2; therefore the bottom may be preserved flat at the midship, with a straight or curved bracket, as it were, to support the keel, and continued fore and aft; or it may at once take the form as shown in the diagram by the letters H Y X, X D being taken equal to I H, when the triangles H I Y, X D Y, will be equal. Instead, however, of either of these, the outline may be as the curve G L M H.

A B the load water-line, E T the depth of flotation, as in Table 4, Chapter XV., with the addition of one-fourth part of the



No. 7. Midship Section of the Model R.—Scale, $\frac{1}{2}$ inch to 1 inch.

$\frac{1}{12}$ths, in consequence of the curved bottom, making the total or one inch; which, according to the scale above is half-an-inch, or B R; therefore, A B R G represents the true displacement. E K is the half part of the average beam (see diagram R, in Experiment 83), in which the straight lines A B, D F, denote them; but they being drawn on the scale of $\frac{1}{8}$-inch to 1 inch, the average of the two, when doubled, will make it in the $\frac{1}{4}$-inch scale, as the diagram above, equal to E K, K being the bottom of the keel.

It appears upon the right-hand part of the diagram, that in order to support the necessary depth of keel, as T K, it must either have the timber of the bottom framed at midship, as in the dotted straight line I B, or in the curved one B S V K. If in the former, then the displacement will be doubled when completed on both sides of the model, and take proportionally from the speed, as recorded in Table 3, Chapter XV.; if the latter, still the original displacement will be increased, but not equal in degree to the former. The keel, however, cannot do without support; therefore, of the two evils, the latter must be preferred whenever speed is to be gained.

The form on the left-hand side of the diagram, comprehended and denoted by the curve L M N I, is graceful and effectual with regard to the keel; but then the displacement, even on inspection, exceeds more than double (it must be admitted) the true displacement required, and therefore will take too much from the speed, as evidenced in Table 3, Chapter XV., but would answer well if the vessel be intended for burthen instead of a yacht.

Further Observations.

In the models having their horizontal section at the load water-line, after the form of a bird, or fish, as the sole, it is seen that the midship section, or widest part, is situated at two-fifths of their length from the head, and three-fifths from the stern. This is Nature's law, in order to counteract and balance the extra resistance the fore-body meets with against the air and water to what the aft-body is subject. In Chapter III. it is seen, when treating upon the law of lateral resistance, that when the model was drawn forward through the water, as well as sideways, the centre of lateral resistance, at the time, moved forward also; and the estimated proportion equalled one-twelfth the length of the model.

Let this result be compared with Nature's form. Take a model 28 inches long, its middle will then be 14 inches; divide 28 inches by 5, and the answer is $5\frac{1}{2}$ inches. Now two-fifths of 28 equals 11; and three-fifths equals $16\frac{1}{2}$; and 14 minus 11 equals 3, or 3 inches, which is the distance before the centre of length where Nature places her greatest width in birds, and in the sole fish. With the model in Chapter III. one-twelfth was the supposed place before the centre of length where the centre of lateral resistance resided when the body was moved both forward and sideways. The proportion of one-twelfth will be found to equal $2\frac{1}{3}$ inches, and rather more; being certainly less than 3 inches. It was stated, however, that increase of the speed of the model would cause the centre of lateral resistance to move still more forward. If granted, the average, allowing for mistakes, will be somewhere not far short of Nature's distance of 3 inches.

If the above statement be admitted near the truth, it follows, that whenever the line of greatest breadth of beam in a ship be situated aft the two-fifths of length, so as to destroy the balance of three-fifths of stern length, the evil must be compensated for, giving an equivalent in extra depth of keel towards and at the stern. Hence, the further aft the midship section be placed, the deeper must the keel be made, to preserve the due proportions of perpendicular surface of the two-fifths and three-fifths between the body before the midship and the body aft of the midship. Now, great depth of keel towards and at the stern is a serious evil in all ships destined for shallow waters; and is objectionable, in another point of view, as in respect of lee-way, on account of the greater power, from increased leverage, to overturn.

The forms of ships as regards beam to length, especially those for merchandise, should be regulated in a measure by the nature of the climate and sea in which they are destined to navigate. For if to encounter stormy winds and seas, whose average continuance is above that in other climates and seas, their breadth of beam and angle projections ought to be strongly kept in view, and acted upon by the builders, to assist the stability. If, on the other hand, the winds and seas are comparatively moderate, less beam will be requisite, or greater length of vessel, and all angles dispensed with. Moreover, ships requiring much sail, in consequence of the breadth of beam, will need hands in proportion, to manage the same; which circumstance, being an item of increased expenditure, will ever have its weight with the owners of merchantmen. This does not apply, however, to men-of-war, whose hands are generally in sufficient number for all duties.

With the completion of these few hints, which have been derived from careful experiments, observations, and reflections, although upon a small scale, I now take my leave, sincerely hoping they will induce persons of far more competent abilities than I possess, to engage in making investigations upon a large scale, that the true principles of shipbuilding may no longer continue a mystery.

WILLIAM BLAND.

THE DISTINCTION BETWEEN CATHEDRALS AND PARISH CHURCHES.

IN a paper on the above subject, read before the Oxford Architectural Society, Mr. E. A. Freeman stated, that the distinction, one more easy to recognise than to define, between ordinary parish churches and catherals, and others of similar character, which may be classed together under the title of minsters, is one independent of size, and yet probably had its chief origin in the usual difference of size between the two classes of buildings. There is a wide debateable ground, but the largest churches can be appropriately built only on the one type, and the smallest only on the other. Anterior to the distinction between minsters and parish churches, another may be drawn between those whose beauty is derived from mere picturesque effect, and those which are really works of architectural design. Of parish churches, those of Pembrokeshire may be taken as the best specimens of the former; the finer churches of Somersetshire of the latter. This latter superior type of parish church is a certain advance in the cathedral direction over the other, but is still very far removed from it. The developed cross form, and the predominant central tower—the combination of a clerestory and a high roof—the presence of a regular western front, as at Gatton and Crewkerne, were all great steps in the same direction. Numerous churches were cited which exhibit approximations, more or less remote, to the cathedral outline, without fully realising it, as Leonard Stanley, Brecon Priors, Gatton, Wimborne Minster, &c.

In considering interiors, the question becomes more implicated with the historical sequence of styles. Romanesque is the most monastic of any; yet it has developed a distinct parochial type. In the early Gothic, the two types are further removed from each other than before or after—in the continuous, they converge; the perpendicular parish church and the perpendicular minster having internal elevations of the same essential character. This portion of the subject was illustrated by various examples, as St. Wollos, Newport, Buildwas Abbey, Rothwell, Berkeley, Llandaff, Southwell, and various churches in Somerset. Of the numerous parish churches, not one can be allowed to present the cathedral type in its fulness, except possibly St. Mary Redcliffe, and even there the position of the tower is a great drawback. On the other hand, many cathedral, conventual, and collegiate buildings, approach more or less to the parochial type, as at Dorchester, Manchester, and even Christ Church in Hampshire. This tendency is especially common in Wales, as in Llandaff Cathedral, Monckton Priory, and other less important examples. The author wished the whole of his remarks to be understood as referring exclusively to South Britain. The paper was illustrated by drawings of most of the buildings referred to.

Tyne Docks.—The docks on the Tyne, south side at Jarrow, will go before parliament. On the north side, there are to be docks at Hayhole, estimated at 150,000*l.* The Tyne Commissioners are debating whether they shall be made by them or the coal owners.

Paris.—The statue of the Marne, since represented in a masculine form, has just been placed on the coping of the Hotel de Ville. It is a similar statue to that of the Seine. They have been executed in a stone of great hardness, by M. Cavalier.

Poplar Trees.—An edict has been issued from the Department of Public Works, Berlin, by virtue of which all the *allees* of poplars along the public roads are gradually to be removed, and replaced by trees of another kind. The reason alleged is the damage the poplars do to the neighbouring fields.

Incorporated Society for Promoting the Building and Repairing of Churches and Chapels.—The first meeting of this society for the present session, was held on the 17th. Grants were made in aid of the erection of additional churches at Limehouse; Metheane, near Truro; Cwm Rhondda, near Pont-y-Pridd, Glamorganshire; and Norwood; also towards rebuilding the church at Llanfaerpwll-gwyngyll, near Bangor; and towards enlarging the churches of Cheveley, near Newmarket; Cranworth, near Shepdham, Norfolk; Hurley, near Marlow; Stanford, near Brandon; St. Thomas by Launceston; Combmartin, near Ilfracombe; and Catfield, near Statham, Norfolk.

Improved Lighthouses.—Various ingenious lighthouses have been proposed by Mr. Wells, of the Admiralty, and are under consideration. He objects to coloured lights, which in dense atmospheres are subject to optical illusions as to colour as in ordinary lights and reflectors there is, in general, too much similarity, and the towers are usually too high, deceiving as to distance. It is proposed that there should be openings in the tower below the lantern, fitted with plate glass, and shaped so as to allow initial letters or other distinctive marks to appear, the light also, where practicable, to be more on the level with the eye from a ship's deck.

Local Intelligence.—A great commotion has been created at Worcester, by a bill of nearly 2000*l.*, for plans, sections, work, and labour done, sent in to the Town Council by Mr. E. L. Williams, the surveyor under the Local Board of Health. Mr. Williams had accepted the office subject to such salary as the council might think fit, but owing to an agitation against sanitary measures got up by the owners of small tenements and others, the salary offered to him was so obviously inadequate that, after many months had been spent in useless negotiation, Mr. Williams has at length made his professional charges and put the whole affair in litigation.——The fine old church at Northam, on the north coast of Devonshire, whose lofty tower serves as a beacon to mariners traversing the dangerous navigation of the Bristol Channel, has just been completely renovated. New Gothic windows adorn the sacred edifice, and the internal improvements are creditable alike to the designer and accomplisher of the work.——Lydbrook new church, in the Forest of Dean district, which has been built after the designs and plans of Mr. Woodyer, architect, of Guildford, is now completed. It is a spacious fabric, and is situated in a most picturesque valley on the borders of East and West Dean, and in the parishes of English Bicknor and Ruardean.——The foundation-stone of a new church has been laid at Banbury. A site was purchased for 600*l.*, and a design in the Early Decorated style, by Benjamin Ferrey, Esq., architect, has been selected, The church which will be built of range-work from the neighbouring quarries, with Bath stone dressings, is to be called Christ Church, and will consist of a nave, two aisles, a chancel, and a tower, terminating, if sufficient funds can be raised, with a spire. It will be capable of accommodating 1000 persons, and the seats will be open. Cost, 3000*l.* The execution of the work has been confided to Mr. Hope, of Oxford.

LIST OF NEW PATENTS

GRANTED IN ENGLAND FROM OCTOBER 16, TO NOVEMBER 20, 1851.

Six Months allowed for Enrolment unless otherwise expressed.

Richard Roberts, of Manchester, engineer, for improvements in machinery or apparatus for regulating and measuring the flow of fluids; also for pumping, forcing, agitating and evaporating fluids; and for obtaining motive-power from fluids.—October 17.

Ephraim Hallum, of Stockport, Chester, cotton spinner, for certain improvements in preparing and spinning cotton and other fibrous substances.—October 22

John Ramsbottom, of New Mills, Derby, engraver, for certain improvements in machinery or apparatus for measuring and registering the flow of water and other fluids or vapours; which machinery or apparatus is also applicable to registering the speed of, and distance run by, vessels in motion; and for obtaining motive-power and other similar purposes.—October 22.

Joseph Beattie, of Lawn place, Lambeth, engineer, for improvements in the construction of railways, in locomotive-engines, and other carriages to be used thereon; and in the machinery by which some of the improvements are effected.—October 22.

William Boggett, of St. Martin's lane, gentleman, and John Holworthy Palmer, of Westbourne Villas, Paddington, civil engineer, for improvements in obtaining and applying heat and light.—October 22.

John Platt, and Christian Schiele, both of Oldham, Lancaster, machinists, for certain improvements in machinery or apparatus for the preparation and manufacture of fibrous materials; which improvements, or parts thereof, are also applicable for the transmission of fluids and aeriform bodies.—October 22.

Donald Henderson, of Glasgow, ironmonger, for an improved apparatus for generating gas; which apparatus may be used for heating, and other similar useful purposes; and other apparatus for heating and ventilating.—October 23.

John Henry Pape, of Paris, in the Republic of France, for improvements in ploughs.—October 23.

Jonathan Sparks, of Conduit-street, Bond-street, Middlesex, surgical bandage-maker, for improvements in, or substitutes for laced stockings or bandages for the legs.—October 23.

Henry Adcock, of Northumberland-street, Strand, Middlesex, civil engineer, for improvements in the manufacture of pipes, chimney pots, and hollow vessels; also bricks, tiles, copings, columns, and other articles used in building houses and other structures.—October 23.

Moses Poole, of the Patent Bill Office, London, gentleman for improvements in axle-boxes for railway carriages. (A communication.)—October 23.

Allen Searell, of Tanybwlch, Merioneth, engineer, for improvements in sawing machinery.—October 23.

William Adolphus Biddell, of St. John's square Clerkenwell, Middlesex, founder, and Thomas Green, of No. 4, Trafalgar-square, for certain improvements in moulding, casting, ornamenting, and finishing articles and surfaces.—October 29.

Frederick Grace Calvert, of Manchester, professor of chemistry and analytical chemist, for improvements in the manufacture of iron, and in manufacturing and purifying coke.—October 30.

Michael Scott, of John-street, Adelphi, civil engineer, for improvements in punching, rivetting, bending, and shearing metals, and in building and constructing ships and vessels.—October 30.

Thomas Greenwood, machinist, and James Warburton, worsted spinner, both of Leeds, Yorkshire, for certain improvements in machinery for drawing and combing wool, silk, flax, hemp, and tow.—November 3.

George Fergusson Wilson, manager of Price's Patent Candle Company, Vauxhall; David Wilson, of Wandsworth, Esq.; James Childs, of Putney, Esq.; and John Jackson, of Vauxhall, aforesaid, gentleman; for improvements in presses and matting, and in the process of, and apparatus for, treating fatty and oily matters, and in the manufacture of candles and night-lights.—November 3.

Francois Marie ...anoa, of Paris, for improvements in apparatus for holding and drawing off aerated liquors, and in machinery for filling vessels with aerated liquors.—November 3.

Henry Vigurs, of Camden-town, Middlesex, engineer, for improvements in buffers, grease-boxes, axle-boxes, and springs, and in appendages to railway engines and carriages.—November 4.

Jules Francois Dorey, of Havre, in the Republic of France, gentleman, for improvements in illuminating the dials of clocks and other instruments in which dials are employed.—November 4.

Theodore Kosmann, o Cranbourne-street, Middlesex, for improvements in brooches and other dress fastenings.—November 4.

Henry Hussey Vivian, of Llangollen, Glamorgan, Esq., for improvements in obtaining nickel and cobalt.—November 4.

Joseph Robinson, of the Ebbw Vale Iron Company, and Charles May, civil engineer, of Great George-street, Westminster, and William Thomas Doyere, civil engineer, of Euston square station, for improvements in the permanent way of railways.—November 6.

George Dismore, of Clerkenwell-green, Middlesex, jeweller, for improvements in locks.—November 6.

Robert Beswick, of Tunstall, Stafford, builder, for certain improvements in the making or manufacturing brick and tiles, or quarries, and in constructing ovens or kilns for burning or firing bricks, tiles, and quarries, and other articles of pottery and earthenware.—November 6.

Alexander Doull, of Greenwich, Kent, civil engineer, for certain improvements in railway construction.—November 6.

Michael Leopold Parnell, of 32, Little Queen-street, Holborn, Middlesex, ironmonger, for certain improvements in locks.—November 6.

William Thomas, of Exeter, Devonshire, engineer, for certain improvements in the construction of apparatus and machinery for economising fuel, and in the generation of steam, and in machinery for propelling on land and water.—November 6.

William Sinclair, of Manchester, Lancaster, engineer, for improvements in locks.—November 13.

Julian Bernard, of Green-street, Grosvenor-square, Middlesex, gentleman, for improvements in the manufacture of leather or dressed skins, and of materials to be used in lieu thereof, and in the machinery or apparatus to be employed in such manufacture.—November 13.

William Smith, of Derby; William Dickinson, also of Derby; and Thomas Peake, also of Derby, for certain improvements in the manufacture of chenille and other plied fabrics.—November 13.

George Sheppard, of Stuckton Iron Works, Fording Bridge, Hants, engineer, for improvements in the construction of apparatus for grinding grain and other substances.—November 13.

Hugh Bowlsby Wilson, of the York Hotel, Blackfriars, in the City of London, Esq., for improvements in the construction of rails for railways.—November 12.

William Charles Scott, of Camberwell, gentleman, for certain improvements in the construction of omnibuses and other public and private carriages.—November 15.

James Lott, of Whitchurch, Southampton, saddler, for improvements in harness and fastenings.—November 15.

Charles Ewing, of Bodorgan, Anglesea, steward and gardener, for an improved method or methods of construction applicable to architectural and horticultural purposes.—November 15.

Claude François Tachet, of Paris, mathematical instrument maker, for improvements in preparing wood to prevent its warping or shrinking.—November 15.

Pierre Erard, of Great Marlborough-street, Middlesex, piano-forte maker, for improvements in piano-fortes.—November 15.

Antoine Dominique Lisco, of Slough, for improvements in the manufacture of chains, and in combining iron with other metal applicable to such and other manufactures.—November 15.

William Hamer, of Manchester, for certain improvements in weaving textile fabrics.—November 15.

Henry Bessemer, of Baxter House, St. Pancras, for improvements in producing ornamental surfaces on woven fabrics and leather, and rendering the same applicable to bookbinding and other uses.—November 19.

Frederick Joseph Bramwell, of Millwall, engineer, for improvements in working the valves of steam-engines for marine and other purposes, and in paddle-wheels.—November 20.

Thomas Statham, of Sidney-street, City-road, piano forte maker, for certain improvements in piano-fortes.—November 20.

Joseph Sharp Bailey, of No. 3 Victoria-terrace, Keighley, York, machine wool-comber, and Isaac Bailey, of Victoria-street, Bradford, York, book keeper, for certain improvements in preparing, combing, and spinning wool, alpaca, mohair, and other fibrous materials.—November 20.

PROFESSIONAL QUALIFICATION.

The works that have been executed by engineers and by architects in this country, have sufficient scientific merit to entitle the designers to take their stand as members of a profession. Such structures as harbours, docks, lighthouses, railways, large bridges, cathedrals, huge roofs, have not been constructed by rule of thumb, nor the dimensions and detail obtained from works that have preceded them, and pronounced successful because they have stood. Statical and dynamical laws were investigated, by men who were philosophers and practical mathematicians, when the tubes for the Britannia and Conway bridges were designed, and their dimensions sought to be adjusted in perfect proportion one part to another, so that were a single ton of metal taken away or added, they would be weaker; so were they when the Hungerford-bridge, Chester-bridge, London-bridge, Liverpool landing-pier, &c., were worked-out in detail. The laws which govern tides, ocean currents, and winds and waves, are studied by scientific men when the sites of our harbours and breakwaters are determined upon, and their forms made suitable. Pneumatics and chemistry are not put aside when our water and gas works are projected; and natural laws are fully understood when the mechanical engineer puts together his gigantic steam-engine. The men who do these things are not mere children of good luck, ignorant of natural and mechanical philosophy, but possessing a knack of getting at a dimension that will be great enough. No man is rash enough to say they are; and all who think at all must be aware of the deep thought, sound learning, and great labour necessary to constitute an engineer or an architect. Are then, it is asked, such men qualified to be members of a profession? The answer will be, "YES."

The next question must be, what constitutes a *profession*, as that term is usually understood? Is it not made up of learned men, who, having submitted to a course of study first, and to examination afterwards, have been admitted into its ranks, and separated from the quacks? The surgeon, the parson, the sailor, the soldier, all have to undergo examinations before they can become entitled to diplomas, licenses, or commissions; but the engineer or architect may practice without a diploma, and it is therefore difficult to separate the sound man from the ignorant—nay, almost impossible, until he be tried by his performances, and then the knowledge comes too late. The surgeon has life or death often in his hand, and his diploma guarantees, to a great extent, his efficiency; at all events, it secures to his patient the certainty that he is under the care of a man regularly educated for surgery. The engineer and architect have the lives of their fellow creatures frequently, perhaps almost always, dependent upon the stability of their works: they do not touch life so nearly as the surgeon, but indirectly they have charge of it in a more wholesale manner; therefore they, also, should hold diplomas before being permitted to practice. The engineer and architect have the control over large sums of money, which, by judgment or the contrary, may be fairly expended, or foolishly wasted; another reason why they should be qualified to practice by a recognised education. If a patient dies under the hands of a quack doctor, the quack is liable to be tried for manslaughter; and if an edifice falls, and destroys life, such edifice having been built by a person not holding a diploma, he also should be held responsible to the same extent. It is not intended to be argued, that the mere holding of a diploma of practice will insure an engineer or architect being competent, for their professions are practical as well as theoretical—perhaps practice going further to insure competency than theory, but which, nevertheless, must always maintain its high value; and it is to *theory* that the education of a young man, intended for either profession, should be chiefly directed. There is such a thing as *practical theory*, although the expression may sound anomalous; but by it is meant the sciences as applied to works of construction, such theories as will enable him to arrive at dimensions with facility and certainty.

If the diploma did no further good, it would prevent the profession being filled by persons totally unqualified. A great outcry was raised a little time ago, that the Royal Engineers were employed upon the Ordnance and many other surveys, to the exclusion of civil surveyors As the ranks of this branch of engineering are at present filled, government did perfectly right, for what security had they against error and fraud? It is true, they might employ their own officers to plot from the field books of the civil surveyors; but this would entail a great amount of trouble and expense, and only partially remove the evil, for field books can be "fudged" as well as plottings, and discontent would still remain. Government employ the Royal Engineers on their surveys, because they know that they are having their work done by men educated for such work. Who can say that the names of Dennison, Frome, McKerlie, and Yolland, are not a sufficient guarantee for honesty and accuracy? Brunel, Cubitt, Rendel, Macneill, and many other civil engineers are unimpeachable, their names are well-known and justly esteemed—no one would ever dream of questioning their capabilites. But it is not such men as these who come into opposition with the Royal Engineers; it is the men whose capabilities *may be* questionable, because they can show perhaps no proof that they may be trusted. Would not a diploma go far to remove such unpleasant collisions? There might be diplomas of two degrees, one for a civil engineer, another for a surveyor.

There is another evil from the want of diplomas. Some half-dozen great engineers monopolise all the work in the kingdom, and the small fry pick up the crumbs which fall from their tables. Government, or a company, or an individual, require work to be done: "Who is to do it?" they ask—why one of the half-dozen men who do all. Now great practice, and talents equally great to direct that practice, make these men perhaps the best that employers could choose for large works; but there are smaller men quite as well qualified to execute smaller works, and there is no doubt if engineers were constituted as a body, by a recognised qualification, they would get some of these. One step towards the qualification of an engineer has been gained, by the council of the Institution refusing to admit men as *members* who cannot show that they have been articled, and that they have practised a certain number of years. Thus a member may fairly be presumed to be qualified—by *practice*, at all events; still a *theoretical* education is wanting. Cannot something be done to make the council of the Institution the fountain head from whence diplomas may issue? If the diploma scheme be practicable—and no reasoning on earth can prove it otherwise—why should it not be carried into effect? Let all engineers who honour their profession strive together to get it done.

W.

NOTES ON CONSTRUCTION.

By Samuel Clegg, Jun.

*** These Notes, when completed, will be published in a separate form, as a Hand-Book for the use of the Students at the School of Construction.

Lime Burning (*continued*).

Wood is seldom or never used in Great Britain for burning lime; but in new countries, or those abounding in timber, it would most probably be the cheapest fuel. The method of burning with wood will consequently be explained. The kilns may be the same as those used for coal, or "field kilns" may be erected; their construction is expeditious and economical, but somewhat precarious.

Above an oven-shaped vault a circular tower of limestone is built, which is inclosed by a wall of beaten earth, supported externally by coarse wattling, in which care is taken to leave an opening, to introduce the fire beneath the vault. No grate-bars are necessary. The charge rests upon one or two rough arches, turned with the materials of the charge itself, as in the flare-kiln described before. Under these arches a small fire is made with faggots or logs, which is gradually increased as the draught establishes itself and gains force. All the precautions before enumerated in burning the lime hold good in this case also. The proportion of wood-fuel to lime is taken from some French kilns mentioned by M. Vicat. A "field kiln" at the Monsieur Canal consumed 1·64 cubic yards of oak billets, for each cubic yard of lime burnt. At the bridge of Souillac, a cylindrical kiln, surmounted by a cone, consumed 1·70 cubic yard of oak billets per cubic yard of lime. When faggots are used, their cubic measure is of course much greater than cord wood for the same value of fuel, and a cubic yard of lime will require from 22·34 to 30 cubic yards of such faggots. It is the practice in some places where wood-fuel is used, and the form of the kiln is that of a cylinder or an inverted cone, to interlay the lime and fuel in the charge, first placing a layer of billets or faggots, then about 12 or 15 inches of limestone, and so on, keeping the due proportion of each; but the practice is not a safe one, as, supposing the limestone not to be perfectly calcined, the charge must be emptied, and the kiln refilled, which is expensive and unsatisfactory.

Peat is also available as fuel, and so is coke, the treatment of the kiln being with them much the same as with coal. The value of turf and peat as fuel is liable to much variation, and depends partly upon their density and partly upon their freedom from earthy impurities; the quantity required to calcine 1 cubic yard of limestone varies from 2 to 11 cubic yards. 10 bushels of coke or cinders to 18 bushels of coal dust, the whole thoroughly moistened, will burn rapidly 112 bushels of limestone. The stone for the hydraulic mortar used at the Liverpool and Birkenhead docks is obtained from the Halkin mountain, near Holywell, Flintshire. When the stone is required to be burnt quickly, coke is used, at 16*s.* per ton; when not required quickly, coal is used, at 8*s.* 6*d.* per ton. The stone can be burnt quickly for as little money with coke as it can be burnt slowly with coal; but it is expensive to burn quickly with coal, or slowly with coke. The proportion of coke is generally one bushel to six bushels of stone.

Cost of Burning the Limestone.

tons.	cwt.			s	d.		£	s.	d.
4	10	Limestone	@	7	3	per ton ...	1	12	7½
		Labour on ditto......	@	1	6	,, ...	0	6	9
1	10	Coke	@	11	0	,, ...	0	16	6
							2	15	10½
		Produce: Lime, 3 tons @ 18*s.* 7½*d.* per ton					2	15	10½

The quantity of any quick-lime required for mixing with the other substances to form mortar, should be determined by measure, and not by weight, as the latter varies according to the length of time the lime has been burnt or exposed to the air, or to the quantity of core it contains; and, although these changes affect the quality in the measure, the results will be found more accurate than by weight.*

The measures employed are yards or bushels. The yard measure is a strong square box, without top or bottom, measuring 3 feet in height and width, and containing, therefore, 27 cubic feet. A yard is occasionally called a "measure," or a hundred of lime: a single cart load is equal to one yard. A bushel is $\frac{1}{45}$th of a-yard; and a barrow contains about three bushels.

* Gen. Pasley says, that *weight* affords a more accurate estimate of the quantity of lime than *measurement*, but this is not correct; besides, the practical difficulties in the way of weighing lime for large works would be insurmountable.

HOLYHEAD HARBOUR.

We extract from the *Liverpool Albion* the following account of what has been done since the passing of the act for the formation of the above harbour, and what is the present condition of the works:—

"The act was obtained on the evidence given that a harbour of refuge would be one of great public utility, and that it could be completed in seven years for the sum of 628,083*l.*

"Mr. Rendel divided the estimate of the cost into two distinct parts. First, for the rough breakwaters, or rubble-stone work, and, secondly, for the dressed masonry necessary for encasing the rubble-stone work. The former he calculated could be completed in three or four summers, at an expense of—

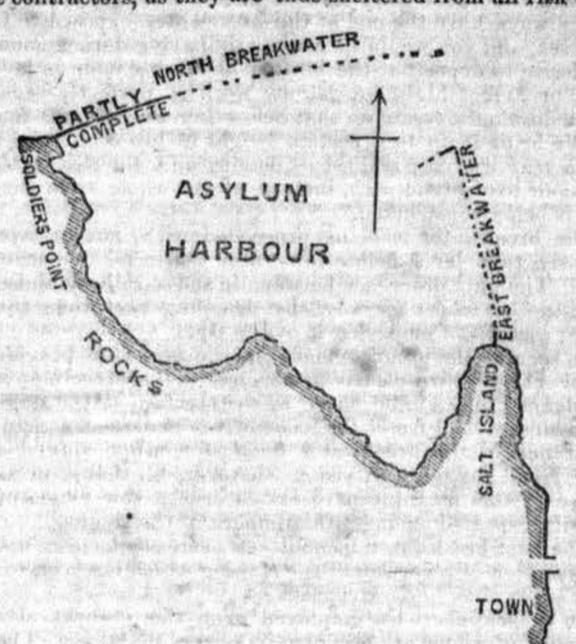
	£	s	d.	£	s.	d.
For North Breakwater, rubb'e stone	174 335	5	0			
Contingencies, superintendence, &c., at 15 per cent.	25,823	15	0			
				200,159	0	0
For East Breakwater, rubblestone	38,639	8	0			
Contingencies, superintendence, &c., at 15 per cent.	5,795	17	0			
				44,435	5	0
Total expense of rough breakwaters.........				£244,594	5	0

"For the completion of the masonry for encasing these breakwaters, Mr. Rendel calculated that a further sum of 383,488*l.* 15*s.* would be required. He proposed to build the whole extent of the rough breakwaters continuously up to a certain height, until they reached low-water level; and when this was effected, in, as Mr. Rendel calculated, three or four years, he purposed to commence building the masonry for facing them, which further work he expected to complete in three years more; in all seven years.

"The act having been obtained, the Admiralty seem, in the first place, to have been impressed with the idea that the estimate of Messrs. Ackroyd and Co. was not sufficiently moderate, and in order to satisfy themselves on this point, they arrived at the conclusion that it would be more advisable to offer the contract for public competition. Messrs. Ackroyd and Co. tendered for the whole of the works, at 604,994*l.* The Admiralty, however, for some reason or other which is not intelligible, without explanation, determined, in the first instance, to receive tenders only for a portion of the works.

"It will be observed, at the time when the act was passed, the bay which it was proposed to enclose was in a state of nature. In order to convey the mountain into the sea, from the respective points of Soldiers' Point and Salt Island, it was necessary that a road should be made to each of them from the intended quarry. The Admiralty advertised for tenders for constructing these roads round the bay; but, for some reasons which are still more inexplicable, they coupled with these roads a portion of the masonry which was to unite the landward end of the East Breakwater with Salt Island. This masonry was to be of ashlar stone, and it is understood that several contractors tendered for it, amongst others, Messrs. Ackroyd and Co., and Messrs. Rigby and Co. The tender given by the latter, for the masonry and roads, is supposed to have been the lowest, and amounted to the sum of 90,000*l.* Messrs. Rigby and Co., proceeded with and completed the roads, but as yet no part of the masonry contracted for at the East Breakwater has been commenced. Why, therefore, it was tendered for at so early a period it is difficult to imagine.

"The roads having been completed, the Admiralty next proceeded with the north breakwater. No more tenders, however, were advertised for; and it is understood, that this great portion of the work is being proceeded with upon some private arrangement existing between the Admiralty and Messrs. Rigby and Co., by which the contractors are paid at a certain rate for every ton of stone which is deposited in the sea: an excellent arrangement for the contractors, as they are thus sheltered from all risk of loss.



[The accompanying engraving is a rough sketch of the proposed Harbour of Refuge, the works in progress being indicated thus ———; works not yet commenced: thus - - - - - - .]

"At present the only portion of the work in progress is the north breakwater, which is carried out in the following manner:—A railway is formed from the quarry to the extreme end of Soldiers' Point. Beyond this, a wooden staging has been run out into the sea, not for the whole length of the breakwater, as at first proposed by Mr. Rendel, but for about a third part only of the distance. The top of the staging is considerably above high-water mark. The depth of the sea at low-water, in the line of the breakwater, varies from 30 to 50 feet; the tide rising, on an average, to a further height of 17 feet in spring tides and 7 feet in neaps. Along the top of the staging are railways capable of sustaining the weight of a locomotive engine and a number of trucks. The rough breakwater is formed by rubble-stone, brought from the mountain and dropped, through the staging, into the sea. The operation is exceedingly simple: the rubble-stone is tumbled into the water, and is then left to be dealt with by the sea, which arranges the deposit in the manner best suited to form a consolidated mass; and it is calculated that, when a sufficient portion of the mountain has been dropped into the sea, there will be formed a breakwater which will have an average base of some 600 feet, and a top surface of about 50 feet in width. The slopes, it is understood, will be faced with dressed stone to a certain extent, similar to the fine specimen which has been executed for about 100 yards at the seaward side of Soldiers' Point. When the whole is complete, protected by batteries, and ornamented by lighthouses, observatories, and telegraphs, it will no doubt present a very interesting, if not a useful, monument of industry and perseverance.

"It must not be supposed that this method of forming a breakwater is unscientific: it is quite the reverse. That a breakwater of any magnitude could not be constructed by man without the natural forces of the sea, was discovered by the French, in their attempts to form the great breakwater at Cherbourg. They tried, in the first instance, to inclose that famous harbour by sinking truncated cones of wood, filled with rock, at certain distances from each other; but the sea soon washed these contrivances to pieces, and recourse was then had to depositing stone, and when, by the action of the sea, this had become sufficiently arranged and consolidated, it was then cased with dressed masonry. This mode of procedure was first proposed by Monsieur Cachin, the celebrated French engineer. He says 'If man be strong enough to heap together rocks in the midst of the ocean, the action of the sea alone can dispose them in the manner most likely to insure their stability.' Mr. Rendel, therefore, in the present instance, is acting upon experience in the mode of operation which he is now pursuing.

"It has been stated that Mr. Rendel originally intended to proceed with the rough breakwaters continuously and simultaneously, that is, to construct the entirety of the works under water before he commenced the superincumbent masonry. He says, in his evidence. 'Dropping in stone in the way of an embankment for a railway would be very bad engineering indeed; because you would always have the end of the breakwater exposed to the beat of the sea, and you would be constantly having derangements; but if we begin to deposit at the bottom and bring it up in layers, say 10, 15, or 20 feet high, we get our work so perfectly secure that the sea does not operate on that below low water, so as to damage it. We bring it up to a certain height in low water and finish it off in a year or a year and a-half, having only the risk of that year and a-half to contend with, instead of the whole time the breakwater is being constructed.'

"The breakwater is being proceeded with, not in layers continuously, to a level below low-water mark, but as an embankment. The only difference between it and a railway embankment being, in the *modus operandi*, by dropping the stone through a staging instead of emptying it over a tip.

"As regards the progress made in the works, it is evident that only about one-third part is in a course of construction, and this is evidenced to the mind, more by the erection of the staging, and the passing to and fro of the locomotives and trucks than by any appearance of the breakwater itself; for, when viewed at high-water, from any point of vision whatever, all that is presented to the eye of this magnificent breakwater is a few ridges of rubble rocks interspersed amongst the timbers of the staging.

"The east breakwater has not yet been commenced upon, with the exception of a portion of the staging which has been run out as far to seaward as low-water mark.

"At present there are employed upon these works about 1500 men, most of whom are occupied in quarrying stone. They work in relays, night and day. They are assisted by four locomotive engines. This mass of mind and matter is able every day to accomplish a removal into the sea of about 2000 tons weight of the mountain; and so the work proceeds, 'dragging its slow length along.'"

RENNIE ON HARBOURS.*

It will be noticed with gratification, that the first volume of this great work has been completed. We wish we could say *national* work, because an undertaking so important to the profession and the country ought not to rest on the exertions of an individual, but be promoted from the public funds. A work of this kind is so essential for the practice of hydraulic engineering, that those who see this volume will hardly believe it was possible to pursue the profession without such assistance; and the production will materially influence future practice. Indeed, it is most welcome at the present period, when the effect of railways is to produce a modification in harbour engineering. By the operation of railways in distributing goods throughout the country, warehouses are now less essential for goods imported; while the facilities for loading coal are such that the extent of accommodation is pretty well limited to basins, quay-walls, and drops. Whatever may be the nature of the dock or basin—from the largest government yard down to a fishing port—all the practical materials for preparing a design are to be found in Sir John Rennie's work. The plates are generally full of details, so crowded that some may complain; but this is a defect on the right side, because plates are sometimes little better than sheets of paper. We have before enumerated the class of designs included in the scope of this undertaking, and, though necessarily some of them can be only partially illustrated, yet there is quite a sufficient series of complete and copious examples of many kinds to afford sufficient variety. Indeed, there is hardly a branch of the subject on which full information will not be found in these pages, or in the engravings. Sir John Rennie has depended more on his drawing than on his writing; and this, again, is a point which will be most welcome to professional readers.

Sir John, having fully described all the dockyards of England, thus sums up his conclusions:—

"First, as regards the harbours — the Thames, Medway, Portsmouth, Southampton Water and the channel between the Isle of Wight and the main; Plymouth, including the Sound, Hamoaze, and Catwater; Milford Haven, and Cork—we seldom find ports better situated, or possessing greater natural advantages of protection, of depth, holding-ground, capacity, facility of access and departure, than they do; and if these had been duly considered and turned to the proper account when the naval arsenals or dockyards had been respectively established, they would have been in a great measure, if not wholly, overlooked.

"Secondly, the lee, instead of the weather shores of the respective ports, have been selected; thus great inconvenience in the access and departure, as well as increased expense and delay in fitting out vessels of war, has arisen.

"Thirdly, the dockyards having been established at a period when the navy of England was in its infancy, the importance of arranging the different departments according to the order in which the operations ought to be carried on, was not considered or even understood: they were consequently distributed according to the particular circumstances at the time, without reference to one general well-organised system; and although their defects and the remedies for them have been long known and acknowledged, and more particularly pointed out in the report of the late Mr. Rennie, on the proposed naval establishment at Northfleet, in 1806 (given at page 51) still (although some improvements have been made) nothing effectual has been done towards obviating these serious evils. It may possibly be urged as an excuse, that in order to effect this, it would have been necessary to have remodelled the whole existing establishments. This is certainly true to a certain extent; but if the matter had been seriously entertained and pursued steadily and systematically, in proportion as the old works required repairs or extension, in a very few years the desired result would have been obtained, and the dockyards by this time would have been in a tolerably perfect condition, and the means expended in bringing them to that desirable state would have been amply repaid. It is not, however, too late, and it is to be hoped that the desired improvements will still be effected."

Sir John objects, too, that the dockyards are too numerous, and suggests that Woolwich and Deptford in particular should be abolished. He thinks, too, that the government can, in case of any emergency, as well rely on the private establishments of this country as the foreign states who have had war-steamers constructed here.

* Theory, Formation, and Construction of British and Foreign Harbours. By Sir John Rennie, C.E. London: Weale.

ON NEW ARCHITECTURE.—DECORATIVE FACINGS

In our former remarks upon the new style of architecture which the recent removal of fiscal obstructions would give rise to, we endeavoured to direct the attention of our readers to the facilities now afforded for the better planning of offices and dwellings, in order to increase the comfort of the inmates, and to the economy which such alterations in the ground-plan and distribution of apartments would allow of being effected in various branches of household expenditure. We also alluded to the fact, that the abolition of these duties—the brick-tax and window-tax—would go far to place English architects on an equal footing with their continental brethren, and give scope to exercise their artistic genius in designing and erecting blocks of buildings to contain several suites of offices or apartments on the different floors. But we felt that they would still labour under a great difficulty, as regards the external appearance of their works, from being obliged to employ materials that, as yet, have never been made to wear a pleasing and agreeable aspect, except at a great and constantly-recurring expense.

The English architect has hitherto had only brick or stucco placed at his disposal to produce an ornamental surface, or to heighten the effect of his design. For it would be manifestly absurd to take into consideration, when speaking of the architectural appearance of the metropolis, the rare and exceptional cases where stone has been employed. Of late years, the government, some few public companies, and the corporation of London, have been impressed with the idea that some architectural embellishments were necessary to relieve the dull monotony of our streets and squares; and they have accordingly allowed their architect to increase his estimate, so as to include the cost of a stone facing or dressing. But even in many of these instances the amount has been so limited that, beyond a facing, literally nothing was practicable, as may be seen in the British Museum, with its brick and unadorned sides thrusting themselves into view, as if to convince the beholder that the pretentious façade is but a sham after all. For the purposes of street architecture, therefore, stone is out of the question. The remoteness of the quarries from London, the cost of carriage, and the expense of dressing the material, all contribute to render its employment a luxury which even the majority of our wealthy clubs and nobility cannot afford, as witnessed by the huge, dingy mansions in the neighbourhood of Pall-Mall, Piccadilly, Belgrave-square, and other fashionable localities. To a native, the absolute ugliness of the abodes of many whose fortunes are large enough to excite the envy of more than one European potentate, is so familiar that it fails to create surprise; but to a provincial or foreigner the circumstance is amazing. They gaze with a degree of incredulity which to us may, perhaps, appear uncalled for, upon the dwellings of the magnates of our aristocracy or of our merchant princes. However disagreeable it may be to hear this fact asserted, it is not possible to gainsay it. Let any one, who desires to judge for himself, walk from one end of London to the other, and what aspect will the shops and dwelling-houses have?—cheerless and dingy, sure enough; or, where the sameness of dirty brick fronts is broken by a range of stuccoed houses, he will be sure to find many of the latter of different colours—varying degrees of dinginess; and this is rendered the more displeasing to the eye when the whole range has been designed by the architect to form one façade, as in Regent-street for instance, where the portions of what appears to be but one building are not only of different and graduated hues, but one is sometimes as gay and clean-looking as successive coats of paint can make it, while the next is begrimed with three years' soot and dirt. How often may half a column be seen with its capital and base freshly painted, and the other half of that almost indescribable colour which, for want of a better term, we must designate as *noir de Londres*? Alas! how does the poor architect's reputation suffer from this parti-coloured appearance of his façade, upon which he has probably expended so much time and skill in elaborate ornamentation.

Hitherto, the rapid and easy discolouration of the materials were evils which no artistic efforts on his part could overcome. The incubus of the brick duties, and absurd limitation as to size, both tended to retard improvements in the mere ornamental appearance of bricks; for it is clear, that so long as the manufacturer was fettered to the legal brick, 9 inches by 3 inches—that curious sample of tax-makers' wisdom—he could not afford to bestow the necessary time to mould or otherwise decorate, separately, the external surface of so small a fraction of an architectural ornament—a column, for instance—as was required.

The removal of these restrictive duties, it was felt, would afford scope to the inventive genius of our countrymen to improve the character of an article in such general and constant use as bricks; nor have these anticipations failed to be realised, for within the last week, the specification of a patent for certain improvements in dwelling-houses, was enrolled by Mr. Tate, among which is one that has for its especial object the facile and economical decoration of buildings by the employment of bricks, blocks, tiles, or slabs, faced with china clay or porcelain, painted in imitation of marbles or other expensive building materials, and glazed.

We have now the pleasure of submitting the details of this important invention to the consideration of our readers, and have no doubt but that the professional portion of them will speedily avail themselves of the means thus placed at their command for the artistic, and, if required, polychromatic decoration of their designs.

"Another of the improvements comprehended under this part of my invention relates to the manufacture of corrugated bricks, tiles, or slabs, moulded or ornamented, and faced and glazed, in manner hereafter described, to be fitted to each other, so as to be adapted for ornamenting buildings in an economical manner. The clay of which the basis of the bricks, tiles, or slabs is to be composed is selected according to the locality in which the manufacture is to be carried on, preference being given to that description of clay which is the most conveniently worked, the cheapest, the hardest, the most durable after burning, and not liable to fusion during the after process. The clay, after being broken down and prepared in the ordinary way by being subjected to the action of machinery well known and in general use (combined or not with breeze or any other suitable material), is moulded by machinery or hand into bricks, blocks, tiles, or slabs, of the required form or size. I prefer that the bricks or blocks should be made hollow, for the sake of lightness and economy of material. The tiles or slabs are corrugated on the back surfaces, in order to enable them to obtain a firm hold of the mortar by means of which they are attached to the faces of walls, &c., or they may be made with projections at the back to admit of their bonding. The external surfaces of the bricks, blocks, tiles, or slabs, may also have the form or configuration of architectural ornaments, or of portions of architectural ornaments, such as mouldings, pediments, columns, pillars, pilasters, capitals, balustrades, terminals, &c., given to them by means of suitable moulds. And in such ornaments where undercutting is required to be imitated—the capital of a Corinthian column, for instance—I mould what I term the body of the capital and pieces separately, and subsequently unite them, when they have been sufficiently dried, by means of a thin paste known in the trade as 'slip,' taking care to smooth the seams off with a wet sponge. When the bricks, blocks, tiles, or slabs come from the moulder's hands, they are put aside to dry and stiffen, after which the intended external surfaces are dressed and sponged, and coated with china or potters' clay, which may be applied in a state of powder by rubbing it into the surface, or in any other convenient manner. The articles are now ready for firing, which may be effected in the usual kilns or muffles. When this is achieved, the fire is gradually slackened, and the bricks, blocks, tiles, slabs, &c. cooled down. They are next removed, and the design in colours applied by printing or by any of the modes employed by potters or porcelain manufacturers. The ornamental surfaces are subsequently glazed by immersion in, or by brushing them over with glaze, and again subjected to the firing process. The tiles or slabs may be made with bevelled edges and with projecting pieces, instead of corrugations at the back, when they are to be built up with the structure.

"By the manufacture of building materials just described, bricks, blocks, slabs, or tiles composed of brick earth, moulded with flat or curved exterior surfaces, or with surfaces in basso or alto relievo, or formed into any ornamental architectural shape or configuration, may be faced with a finer kind of clay or porcelain earth, which is capable of being printed on, or painted, or otherwise coloured, in imitation of expensive building stones, marbles, serpentine, porphyry, granite, lapis lazuli, or other costly material, so as to be adapted for the external facing and ornamenting of buildings."

Our readers will be better able to imagine than we are to describe the great and radical revolution which Mr. Tate's invention promises to effect in the character of future buildings, and in the external appearance of our streets and squares, if applied (as it seems fully capable of being) to existing structures.

Let them picture in their mind's eye what would be the effect of the whole of Regent-street so decorated. Instead of dirty and fresh-painted strips of stucco jumbled together, we should have ranges of buildings palatial in their design, and unsurpassed in the magnificence, the apparent costliness, and the polychromatic decorative character of the materials employed. Basements of porphyry, serpentine, dark-coloured marbles, or polished granites; flat surfaces of white marble, delicately veined with lines of the purest blue; pediments, architraves, columns, pilasters of verd-antique, and the smaller architectural decorations of lapis lazuli—balustrades, for instance, of this pure deep blue, entwined with the white and graceful convolvolus. Nor need the architect be limited to these materials: marbles and stones of the rarest and most expensive natures are, by this invention, all pressed into his service,—sienna, black and gold, &c.; and the colours of the materials employed, or their combinations, may be made to vary in every block or group, as much as do the designs.

Fancy this gorgeous vision realised, and what city in the world could vie with London for architectural beauty? Not Paris, with its Tuileries, Louvre, Madeleine, Place Vendome, Boulevarts, Chambre des Deputés, and hotels of the vielle noblesse in the Faubourg St. Germain, and their rivals in the Chaussée d'Antin, for they lack the rich and pleasing effect of polychromatic decoration. Nor Venice, for "the Hun is in her palaces," which marked the blending of oriental imagination with northern energy: they are desolate and degraded, and tell more eloquently than words, of the subjugation of the once proud Queen of the Adriatic, and of the thraldom of her sons. Scarcely Rome, with her classic temples, her magnificent Vatican, and her palazzi; for *there* there is neither liberty, nor progress, nor life: her beauty is the beauty of the tomb. Were this vision realised, London, the largest city in the world—the abode of two and a-half millions of energetic, liberty-loving Anglo-Saxons, imbued with a vitality unequalled—occupying a larger area than any other city for every thousand of the population—with streets and squares unsurpassed for their size and magnificence—with churches, schools, and hospitals, endowed with immense wealth—the residence of the monarch of the greatest empire the world ever saw, and of the wealthiest court and aristocracy in Europe, as well also of merchants who are princely by their fortunes and their tastes;—it might then be said, "This London, into whose teeming lap is poured the rich commerce of the world, has at last clothed herself in a garb of loveliness befitting her high station among the cities of the world, her colossal dimensions, and her intellectual beauty: *Esto perpetua.*"

Lest any of our readers should imagine the vision we have endeavoured to indicate rather than to describe, too difficult and expensive to be realised, we purpose to consider what Mr. Tate really proposes to effect: to manufacture slabs composed of common clay capable of resisting the high temperatures to which it would have to be subjected in the after processes of baking and glazing;—to coat the intended external surfaces of these slabs with a thin layer of china clay or porcelain, which is to be printed or painted with the required designs in the usual manner, and afterwards to glaze them. Where is the difficulty or impracticability of any one of these processes? Why, there is not a workman, the dullest of comprehension in the Potteries, who would not readily understand and achieve the manufacture.

We are, of course, well aware that glazed bricks have been used, and that some were exhibited in the Crystal Palace—by Ridgway we believe—with an imitation of marble underneath the glaze. But in this case the imitation was very poor and imperfect, from the fact that the main colour of the imitation marble was the same as the clay of which the brick was composed, a not over bright or pleasing yellow, so that no variations were practicable—that is to say, they must all be of the same main colour as the brick clay; while the surface, although the glaze was smooth enough, had a very rough and uneven appearance, certainly as much unlike marble as anything we ever saw. Nor is it possible to obtain with common clay that necessary evenness of surface, to say nothing of variety of colour. Upon china clay or porcelain only is it possible, we believe, to effect these desiderata. And it is coating slabs of common fire or other suitable clay with porcelain, in order to render them capable of being properly painted and glazed, and adapted to the architectural decoration of houses, that constitutes the chief feature of novelty of this part of Mr. Tate's invention.

The Chinese have, from time immemorial, used porcelain to face their buildings with, especially those which they were anxious to preserve from the decaying influence of the atmosphere, and to which they desired to give an enduring monumental character, such as their towers. Certes, porcelain tiles or slabs would be far too costly a material to employ for like purposes in England: but porcelain-faced slabs are very different things. Probably the material contained in a dozen plates would be more than sufficient to face the slabs for a moderate-sized house.

The manner of applying them to buildings already erected is necessarily much the same as the one adopted for fixing china plates in butchers' shops, and simple enough. The face of the house or other structure would have to be coated with a good adhesive mortar, and the slabs applied, which, by reason of the longitudinal corrugations at the back, would hold firm. In the case of building them up with the house, the operations would be simplified and the expenses reduced, in consequence of less mortar being required to be used. When a slab has to be cut smaller, the workman will only have to cut the glaze with a diamond, and the part that is not wanted may be easily cut away with a trowel, or a cutter such as slaters use.

As regards expense, we can see no just reason why, in a short time, when the invention is got into working order, as it were, the cost of facing a house with these slabs should exceed what it would be to do so with stucco, including the first nine coats of paint. Indeed, we have every cause to think, from the statement laid before us, that the expense will be considerably less even at the first going off, independently of the important saving that would be effected every four years, or thereabouts, by its not requiring to be repainted. We omit the not unimportant item of washing down every spring. This washing and repainting must, in the course of twenty or thirty years, make the cost of a stucco front very considerable—almost as much as stone. Whereas a house once fronted with Mr. Tate's marbled porcelain-faced slabs will require no further care or attention. Their smooth and highly-polished surfaces will afford no hold for the collection of dirt. Whatever few particles may by chance happen to lodge upon projecting portions will be washed away by the first shower. No rain or damp will be able to penetrate the glaze, so that none can be absorbed by the inner bricks, and transmitted to the walls of the dwelling apartments, which will materially increase the durability of the structure, as well also as the comfort, health, and general well being of the inmates.

More lasting than stone or granite, the porcelain-faced slabs will, unless the glaze be purposely broken off, withstand the ravages of time for ages; neither rain, nor soot, nor dirt, will fade the brightness of their colours, nor tarnish the brilliancy of their appearance.

NOTES OF A TOUR AMONG THE CATHEDRALS AND CHURCHES OF BRITTANY AND NORMANDY.

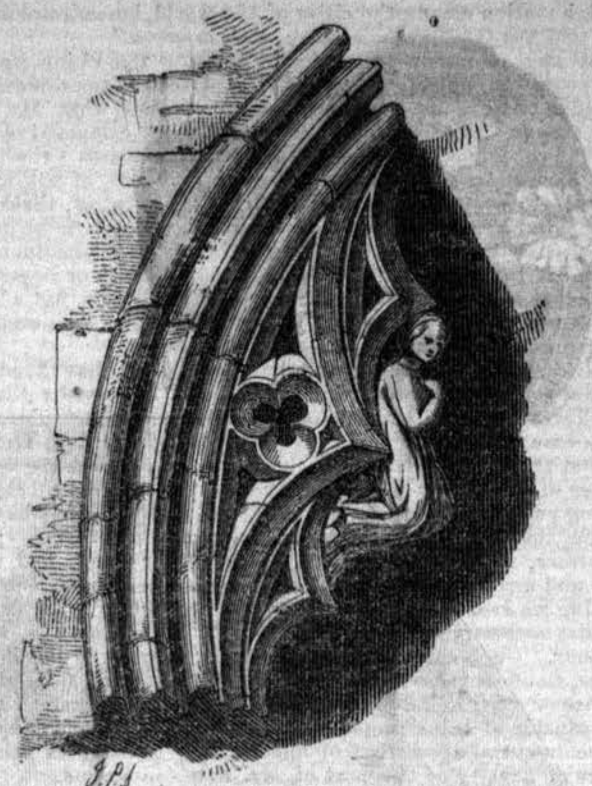
By John P. Seddon, Architect.

(*Continued from page 580.*)

Tour en Bessin.—About a league from the city of Bayeux, on the route towards Isigny, is the small village of Tour en Bessin, and at some distance from the road may be seen the spire of its church rising among the trees. This has somewhat an elegant proportion, and presents the usual features of the Early Gothic spires of this locality before described. Altogether, it seems to invite a closer inspection; and, after a ramble for the distance of a quarter of a mile though green lanes, the church will be found amply to repay the trouble expended in its search. It is, indeed, of a remarkably interesting character, having been erected at several periods, and presenting pure and beautiful examples of the architecture of those times. The nave and transepts are Norman, and rather simple and plain; apparently the aisles have been destroyed, and the nave arches supporting the clerestory have been built up and now form the external walls. The western doorway is highly enriched; the tympanum of the semicircular arch is filled with small stones, each bearing some decoration, such as rosettes, and, in one instance, a boat with figures—not forming, however, any general design or pattern. In these ornaments may be traced the same feeling for rosette decoration in which the later Gothic architects often revelled, as at Bayeux Cathedral; thus proving that which I have before advanced, namely, the intimate connection of these different styles with each other, and their gradual development one from another. This has been most strangely overlooked by many architectural writers, who, being struck by the frequent occurrence of a class of enrichment not used so often or in the same manner, in our own country, have chosen to call it Moorish; which term I have seen applied to those sculptured discs on the wall of the triforium of the nave of Coutances Cathedral, without indeed the very slightest foundation. The tower, which is central, being over the crux, the spire and the choir are Gothic—according to Mr. Whewell, Decorated Gothic; but, while they possess many of the features of that style completely developed and almost unequalled in their beauty, the mountings are as simple and bold as those of the earlier, consisting of roll mouldings, some with a faint ridge separated by deep hollows, exactly similar to those of Coutances; and yet so perfect is the buidling in every quality, that it would be treason to call it Transitional, otherwise than has been said *all Gothic is transitional.* The interior of the choir is not separated into lateral aisles, but the eastern end is divided into three chapels by slender clustered shafts; the central chapel is rectangular, with an exquisite geometrical traceried window in the end; the side chapels are polygonal, but are actually surrounded by fairy-like, miniature aisles, vaulted over and about a foot in width. The vaulting ribs of these aisles and of the chapels themselves are supported by single shafts of extraordinary slenderness, but which could not stand of themselves were they not attached to the walls in several places by bars of stone. There is a rich arcade carried round the wall of the choir, with crocketted canopies covered with delicate sculpture; the greater part of which, however, though not in the slightest degree requiring it, has been mangled by recarving. I would therefore warn any one who may visit the church, not to assist in the furthering of this detestable restoration, since a box is placed there to receive subscriptions in aid of that *evil* design. A few exquisite bits—thanks only to the emptiness of the said receptacle—still remain: instead of cusps, in some instances small figures of angels are curiously but gracefully introduced.

On the southern side externally there is a small neglected doorway, which is now blocked up and disused. It is near to the angle formed with the transept. The long and tangled grass bows wearily over the bases of its slender shafts, weeping upon them with its silver dew drops as if it could sympathise with the state of their desolation; the fern is clinging to the walls, and thrusting its roots between the stones; and perchance some stray sheep, taking refuge beneath the friendly shelter of its canopy, would be its most usual occupant. Yet to this slighted corner of a village church, this uncared-for relic of the past, would I turn, were I asked to point out in one example the whole serenity and beauty of Gothic architecture enshrined. I shall not easily forget the impression which it produced upon me when I first discovered it, which was not till I was about leaving the churchyard, having examined as I thought the whole of the building. Nor could I then quit the spot, although the mists of a chill November evening were rising thickly around, till I had carefully drawn every one of its details.

SOUTH DOORWAY TO CHANCEL, TOUR EN BESSIN.

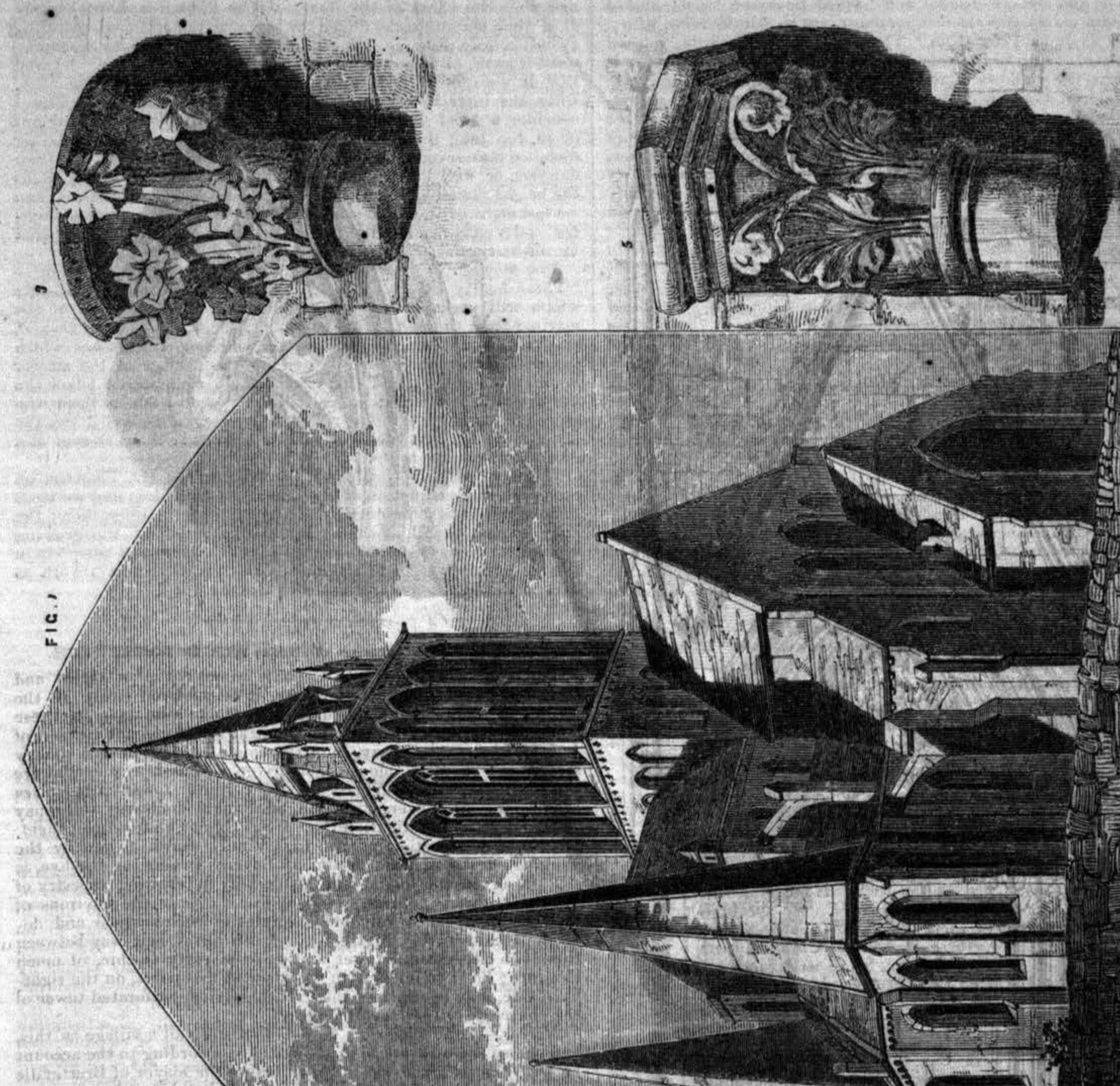


CUSP TO ARCH IN CHANCEL, TOUR EN BESSIN.

The road from Bayeux to Caen is somewhat of a varied and interesting character; at any rate, it is rendered lively by the astonishing number of the diligences which ply upon it, these being of every description, from the neat if not elegant turnout of Lafitte, to the most crazy, country vehicle, with lean and shaggy steeds, and shouting, blouse-clad driver. Almost as plentiful are the churches which they pass upon the route: towers and spires are peeping up in every direction, and would doubtless well repay a more careful investigation than I was able to bestow upon them; for, from a collection of drawings kindly shown to me by the obliging curator of the museum at Bayeux (where, by-the-bye, is still preserved the quaint but historically interesting tapestry of famous notoriety), there would appear to be in the environs of that city many most valuable examples of ecclesiastical and domestic architecture. Bretteville, a town about half way between these two cities, has a tower and spire of early Gothic, of much elegance; but two miles from the road at this point, on the right-hand side, may be descried the imposing, lofty, perforated tower of the church to the village of Norrey.

Norrey.—It is somewhat curious that so small a village as this, and one so little advanced in civilisation—according to the account of Dr. Whewell, who was marched before the mayor of Bretteville as a spy, to account for the daring act of sketching the church—should possess what might be almost termed a cathedral. Its inhabitants, however, I can testify to be somewhat improved since that unenviable occasion,—as witness the accompanying engraving, the drawing for which I was able to make without being placed in "durance vile;" indeed, I met rather with the greatest civility. It appears that the parish belonged to the Abbey of S. Ouen, at Rouen, and that the churches of this abbey were always more sumptuous than others. The style of the building is the purest and most beautiful Early Gothic. It is nearly a Greek cross in plan, and its outline pyramidises in a remarkable manner, and would have done so even still more had the spire been completed as intended. It has been carried up a short distance and then discontinued, and it is now covered by a low, wooden one. A curious legend is related in explanation of this circumstance—namely, that the architect of Bretteville Church, seeing the progress made in that of Norrey, which was being erected by his pupil, in a fit of jealousy threw the latter from the top of the tower. This seems to have been a common failing among the French architects, and, if it be true, detracts somewhat from the piety which some perceive in their works.

The nave is rather plain, and is without aisles. The transepts have eastern aisles only. The choir has an aisle continued all



NORREY CHURCH, NORMANDY.

round it, and also an apsidal end formed by seven lancet arches supported on double circular columns, set so as to radiate, with a slender shaft between them. The clerestory has narrow, pointed windows rising up to the ridge of the vaulting. Over the crux is a lantern, the windows of the tower being seen from within. On either side of choir aisle is a small, polygonal chapel, with an enormous, half-conical, stone roof, forming an abutment for one of the buttresses to the choir vaulting. I have never met with another example of such an arrangement, nor can I conceive its purpose, excepting that it were intended to aid the general pyramidal effect of the exterior. The north transept has a most beautiful, richly decorated porch; the mouldings of the arch are peculiarly bold and good. In the interior there is a profusion of varied and exquisite foliage, in the several capitals, bands, panels, mouldings, &c. On the northern wall of the choir aisle there is a most quaint representation of the murder of the Innocents, which is being perpetrated by men dressed in *chain armour*, while the grief of some of the mothers is far more ludicrous than pathetic. A view of this church, and some of the details from the interior, are given in the accompanying engraving.

HORSBURGH LIGHTHOUSE, NEAR SINGAPORE.

A CORRESPONDENT informs us that this important beacon has just been lighted. To Mr. J. T. Thomson, government surveyor, Singapore, the mariner is indebted both for the design, and, as in all works of similar difficulty, for its superintendence, which involved much personal risk and discomfort, as well as great forethought and indefatigable perseverance. The dome, lanterns, and optical apparatus, which latter is on the holophotal system, were prepared at Edinburgh, under the directions of Messrs. Stevenson, civil engineers; and, with the exception of these, the whole is of native workmanship.

The Horsburgh Lighthouse, which was so named as a just tribute of respect to the merits of the late distinguished hydrographer of the India House, is erected on the Pedra Branca Rock, situated ten miles from the nearest land, and forty from any place where supplies can be had. The rock measures, at high water, about 100 feet by 150 feet. In a letter just received from Mr Thomson, he mentions the following interesting particulars:—"The sea does not, at any time, break against the building (which measures, from the water up to the centre of the light, 95 feet), though a considerable spray goes on the rock. This, of course, rendered it unnecessary to build the lighthouse on the principle of the three great works in Britain (the Eddystone, Bell Rock, and Skerryvore). The work may be considered curious, for the tower was built by Chinese and natives of India; of whom, about fifty souls were generally employed at the rock. None of them could talk English, and one-tenth of whom could only speak, imperfectly, Malay (the language of these parts). What is still more curious, there were, at times, three classes of Chinese, none of whom could speak each other's language, being as different as French is to English. Besides these, were Malays, Javanese, Boyans, Klings, Bengalese, Papuas, from New Guinea; Rawas, from the interior of Sumatra; which, with English, counted eleven languages. Such confusion of tongues was there, at times, as to be a very Babel! The Chinese, who were the most numerous, had to be mostly directed by signs." In spite of these most discouraging difficulties, Mr. Thomson brought his arduous labours to a successful issue in a remarkably rapid manner, and at an astonishingly small cost. The work was commenced on the 11th April 1850: the last stone was laid on the 1st June 1851; and the light was ready to be shown by the 20th September 1851. The expense was only about 4000*l.* for the building, and about 1400*l.* for all expenses connected with the lantern, dome, and optical apparatus. The whole cost, therefore, exclusive of gun-boats for protection, wooding, watering, and the occasional presence of a government steamer, was only about 5400*l.* All the exposed stonework is of granite, from Pulo Ubin. Before fixing upon the exact position and design of the tower, Mr. Thomson had recourse to the ingenious expedient of testing the violence and direction of the waves, by attaching to the rocks with cement, isolated pillars of brickwork.

The light apparatus is one of the forms of the holophotal system which was invented by Mr. Thomas Stevenson, of Edinburgh. It consists of nine truncated, parabolic, silver-plated reflectors, 25 inches in diameter, with hemispherical reflectors behind, and a set of holophotal prisms, with a lens in front, so as completely to inclose, and usefully to employ, the whole of the sphere of diverging rays which proceed from the flame. Mr. Thomson thus describes the effect of the light:—"The light was shown exactly at 6, when the sun sinks under the horizon; the effect was dazzling at half a-mile distance. We proceeded on our return to Singapore until it sank, at fifteen miles distance, below the horizon. I found that it was never invisible till we gained a distance of nine miles, when the interval between the flashes became eclipsed. This I consider a great desideratum supplied, as ships, when tacking out or in, can take their bearings at any moment; and, at a further distance than seven miles, ships are either well out to sea, free from dangers, or well into the straits. At a distance of fifteen miles the bright period appeared to be about four to five seconds. When we lost sight of it, it had still the magnitude of the planets Jupiter and Venus......The light possesses all the advantages required by the mariner."

The *Singapore Free Press* thus describes the first illumination:—"Three hearty cheers welcomed to life the meteor-like brilliancy which will probably serve to guide the midnight path of the mariner for a thousand years to come. A breathless silence ensued, as every one seemed absorbed in watching the flashes which appeared each minute, and lighted up the surface of the sea for more than a mile around the tower.......It disappeared below the horizon at fifteen miles; but it still continued visible to those who ascended the rigging for nearly an hour afterwards, and it was the general opinion that the light will be seen as brilliant as ever at a distance of twenty miles."

We have only, in conclusion, to congratulate Mr. Thomson on the successful completion of his arduous undertaking, and we trust that he will give some detailed description of the operations; the more so, as it will afford an interesting proof of the growing resources of our distant settlements, which are found adequate in science and in wealth to the creation of so important a work as that of the lighthouse on the Pedra Branca Rock.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

ARCHITECTURAL ASSOCIATION.

NOV. 28.—"*On the effect of new Discoveries, Appliances, and Materials in practice, and how such innovations should be met.*" By JAMES EDMESTON, jun., V.P.

Mr. EDMESTON commenced by tracing the effects of new wants and discoveries on the most primitive usages of early times. He then alluded to the elaborations on the merely necessitous or simply useful—to the artificial tastes and wants created and to be satisfied; proceeding then to the demands of art—the cravings of the mind and eye to be filled; and dwelt particularly on the danger to the architect of applying himself exclusively to one or other of these demands, so that mere æsthetical thought may woo him to quicksands wanting the necessary foundation of the useful; or he may be cast away on the rock of mere utilitarianism. He stated the right office of art to be, so to clothe the every-day means by which man's commonest wants are satisfied with its own beauties, so that the better, the happy, and pure feelings of his mind may be called into action. He then alluded to the folly of attempting to avoid the necessity of using a new material or medium; and argued, that it should be a matter of rejoicing to the architect, as offering a fresh field for his skill. He stated the greatest novel feature of this day to be the growing introduction of cast metal into all sorts of buildings, and observed, that if the metal had within itself the elements of successful utilitarianism and progress, however a cold reception might prevent the development of its powers for a time, it must ultimately triumph. Practically there might be great difficulties in the way. We had been used to admire orders of beauty arising from causes which iron did not possess: it has not solidity and breadth, being rigid and of great strength in a small compass; it hardly has at all the beautiful effects of thrust and counter-thrust and security maintained in the midst of contending forces; for it is in its nature firm and unyielding, and this intrinsic independence of one part of another has led to its being treated in parts, never as a whole,—a series of panels and posts,—a range of weighty beams, forming unpleasing combinations, because the effect of mind is wanting: no thought is written on them—it is the strong metal, not the mind of man you see. Mr. Edmeston then, at great length, went through the various properties of iron; and to put as extreme a case as possible, supposed an architect required to build a church, the main feature of construction to be iron. He gave a detailed description of how such a building might be executed, and endeavoured to examine those feelings of repugnance which such an idea ever created in most minds. He alluded particularly to the way in which other materials might be mingled with iron, and colour obtained; and instanced the introduction of porcelain, by Mr. Truefitt, member of the Association. He laid a most earnest stress on treating such a structure carefully, according to the properties of the metal, avoiding all usages which belonged to stone or any similar material. He objected to anything in imitation of the arch as being improper. Having gone through the main features of construction, Mr. Edmeston then alluded to various modes by which ornamentation might be obtained. In conclusion, he argued that even so extreme a case, on examination, did not appear so decidedly inappropriate, unworthy of art, and impossible.

He then briefly considered the manufactured art decorations, &c., which the architect was sometimes called upon to use, the result of a growing demand and one of the features of this day; and inclined to the opinion that they should be avoided as much as possible, since, if fully acted on, he in the end would be the greatest architect who possessed the largest collection of trade tariffs. In alluding to the use of machinery to prepare parts of buildings, mouldings, &c., the author examined the objection raised by some to such a usage, and declared that such productions were as much examples of man's skill as hand-work, and that the powers of science brought to bear in the service of art was more wonderful, and gave even more food for the imaginative mind.

In concluding the paper, Mr. Edmeston dwelt at some length on the necessity of observing and being thoroughly mixed up with the things of the present—with what was going on around us; and stated, that to be trained and instructed by the past, while at the same time being thoroughly imbued with the present, was the way to be truly original; and believed that such inquiries as these must be profitable, when it was considered that never yet had architects tested or ascertained what might be done with iron,—and that whatever might be the extent of its available properties, one thing was certain, that they should be known and brought out,—that it should have its right station in the art given it,—and that we should no longer be in ignorance of what, whether little or much, might be done with it.

INSTITUTION OF CIVIL ENGINEERS.

Dec. 2.—Sir William Cubitt, President, in the Chair.

The discussion was renewed "*On the Application of Machinery to the Manufacture of Rotating Chambered-Breech Fire-Arms, and the Peculiarities of those Arms,*" by Colonel Samuel Colt, U. S. America, in which the Honourable Robert J. Walker (late Secretary to the U.S. Treasury), General McNeill, Mr. Hodge, and other visitors, as well as a large number of the members took part; the processes of manufacture were described, and the importance of machinery in a country like America, where labour was so dear, was clearly shown.

The machines employed were too numerous to be particularly described; but it appeared that slowly rotating rose cutters were the chief tools used, the various pieces being held up to the tool, and presented in different directions to the required cutting action, almost without any intervention of the workman, after being brought under the action of the machine. For instance, the lock-frame, after being centred, passed through twenty-two machines before it was completed, and all the operations had reference to the arbor, or centre pin first inserted. The same took place with other parts; and such a degree of uniformity was arrived at, that the 30,000 arms constantly in progress of manufacture in Colonel Colt's works, were put together from pieces taken promiscuously from the mass. This advantage of uniformity was very beneficial in active service, as 70 or 80 per cent. of serviceable armscould be made up from those injured in action.

In the course of the discussion it was observed, that the present object of all enlightened Americans was to promote intercourse between their country and this, their fatherland, and that this would be more aided by the labours of civil engineers than by any other class of men. That in the United States, though there was a less amount of high acquirement among the engineers, there was a greater amount of sound education and ingenuity among the working mechanics, than generally existed among the same class in this country.

The aid of English civil engineers was claimed in the great attempt to traverse the Isthmus of South America by a navigable ship canal, for which the American engineers were the pioneers, with the railway now in course of execution; and in paying a graceful compliment to the attention to American engineers on the part of Telford, and his successors in the profession, it was stated, that almost every English engineer, of any talent, who had gone to the United States, even in very humble positions, had in a few years, attained eminence and fortune.

The influence of Colonel Colt's arms in the late wars in Mexico, was again flatteringly alluded to, and the ingenuity and perseverance exhibited by him, in the formation and conduct of such an immense armory, were highly eulogised.

ARCHITECTURAL INSTITUTE OF SCOTLAND.

On November 27th the first meeting of the second session of the Architectural Institute was held within the Hopetoun Rooms. The following is the list of Office-bearers and Council for the year 1851-2:—

President: the Duke of Buccleuch.—Vice-Presidents: Earl of Morton, Earl of Haddington, Earl of Aberdeen, Earl of Rosebery, Duke of Roxburghe, and the Marquis of Breadalbane.—Councillors: A. Maconochie, Rev. E. B. Ramsay, D. Rhind, architect, J. Robertson, G. Smith, A. Alison, C. Wilson, J. Smith, C. Baillie, Rev. Dr. Grant, Sir W. Johnston, Sir J. Anderson, J. A. Bell, A. F. Irvine, J. Dunlop, T. Brown, J. Salmon, A. M'Lellan, D. Cousin, J. T. Rochead, Hon. Robert Stewart, Lord Provost of Glasgow; J. Hope, D.K.S.; T. Grainger, C.E; Col. M'Niven.—Honorary Secretary: W. A. Parker.—Honorary Secretary for Professional Correspondence: J. Dick Peddie.—Honorary Treasurer: J. Kirk.—Auditors: J. Wilkie, W. G. Evans.

The Report stated that, at the close of its first session, the Institute had enrolled 267 members, in various parts of the country. The previous year's transactions had been printed, and the secretary was now engaged in transmitting copies of them to several institutions connected with art both in this and in foreign countries. With reference to the excursions and extra meetings which the council were empowered to appoint during vacation, in Aberdeen, Perth, or elsewhere, they had to explain that the fact of no such meeting having been as yet held, was to be attributed to the all-absorbing attractions of the Great Exhibition, which had proved during the past summer and autumn the grand excursion for the whole provincial population. They were happy, however, to state that arrangements were in progress for holding a meeting of the Institute in Aberdeen, in January next. There was a balance remaining to the credit of the Institute, upon the annual accounts, of upwards of 90*l.* The council had resolved that 15*l.* of the sum in the hands of the treasurer should be applied towards the endowment of an architectural chair—a scheme which they recommended should now be opened, and the claims of which they urged on the consideration of all interested in the advancement of architecture in Scotland. They had, accordingly, appointed a committee to receive contributions for the proposed endowment.

The Very Rev. Dean Ramsay, the chairman, then delivered an address. He said that an Association like the present should embrace as wide a range of members as possible. It was not desirable that the Institute should be composed exclusively of professional or working architects, although, of course, they were to be looked to as the staple materials; but, such an association, he should say, was for the use of those who employed architects, as well as for architects themselves. The principles of the art, however, and something of its history, should be known to every one. Non-professional admirers of the science might co-operate with the architect, and much assistance might be derived by the scientific builder from the taste, general knowledge, and picturesque eye of those to whom he had to furnish designs. Take for example the instance of effect in buildings. This was altogether different from the merely technical and scientific skill of the builder. By effect he meant the impression produced on the mind by the place, circumstances, and associations connected with a building. Effects followed from viewing a building in one place which were lost when the same building was placed in another. Setting aside the effects of association, much depended upon the site. He doubted the propriety of ever using pure Grecian art where the observer was not generally stationed at a point below the level of the basement. The peculiar effect of that style seemed quite gone whenever they looked down on roofs and pillars foreshortened into themselves. Position should be well considered before the Grecian portico or temple were used. He was well aware of the difficulties in the way of architects in regard to setting down buildings in towns, and amidst most unarchitectural effects, and he was also aware of the zeal of some for putting down classical models everywhere, and whether the architect opposed it or not. A legitimate and beneficial use of an Institute like the present, was to illustrate local and national edifices, and to raise an interest in their preservation and restoration. It was astonishing how much might be done in this way by architectural association. The round church at Cambridge was restored under the auspices of such a society, and a great deal had been done to the fine old church, or once cathedral of Dorchester, by the efforts of an architectural association; and he had only heard the other day that, under the auspices and exertions of a similar institution, 60,000*l.* had been raised for the repair and restoration of the finest parish church in England—St. Mary Redcliffe, Bristol. To take the case of the useful in architecture, public attention had been called, amongst other subjects, to cottage building as well as to palaces and churches. The benevolence of several great English landlords had thus been called forth for the good of their people; and the Duke of Northumberland, it was said, had pledged himself to rebuild 1000 cottages for his people.

At the conclusion of the address, the Secretary read a paper communicated by Mr. David Laing, Treasurer of the Society of Antiquaries of Scotland. The subject being, "*Who was the Architect of Heriot's Hospital?*"

In looking into the earlier printed travels or descriptions in which mention is made of Heriot's Hospital, the credit of having designed the building is attributed to his chief executor, Dr. Walter Balcanquall, Dean of Durham.

That Dr. Balcanquall was the chief person in carrying into effect the founder's intention is sufficiently ascertained; and it was surmised that the design for the building was furnished to him by the celebrated English architect, Inigo Jones. There is, however, no evidence to warrant this supposition. Nor can any trace be discovered in the published works of Inigo Jones, or among his original drawings and sketches preserved at Oxford, or in the Duke of Devonshire's possession, of his having furnished such plans.

The great resemblance in the plan, the style of building, and the internal decorations, of Wyntoun House to Heriot's Hospital has been often remarked, and, indeed, is much too striking to be overlooked by any visitor. No doubt that it was designed and built by William Wallace, who then held the office of King's Master Mason for Scotland; and he was the person who actually built the original portion of Heriot's Hospital. Of the early history of Wallace we know nothing, and can only conjecture that he may have enjoyed an opportunity of improving his skill as an architect by foreign travel. His name occurs as a burgess of Edinburgh in 1601. In a charter granted by the Free Masons of Scotland to William St. Clair of Roslin, William Wallace signs as "Deacon in the Lodge of Edinburgh." This office he held from 1626 to 1628. But he had previously distinguished himself, and had been employed in the reparation of his Majesty's Castle of Edinburgh and Palace of Holyrood. That Wallace was employed by several of the nobility there is no reason to doubt; and the House of Wyntoun, in the parish of Tranent, may have contributed, through the recommendation of Mr. Robert Balcanquall, then minister of the parish, to his brother Dr. Walter Balcanquall, joined to the personal knowledge of his fellow-citizens in Edinburgh, for his being employed in the erection of the new hospital. In the mere quadrangular form of the building there is nothing so remarkable, except that the beauty of its details are so much in accordance with the general design. A print was published in 1647, which represents the hospital as completed, with a handsome spire over the north entrance, and with large circular domes at the south-east and south-west towers. These domes, which were built by Aytoun, were removed by order of the governors in July 1649, but the spire remained unfinished, probably from want of funds; and at a later period the present cupola was built.

ROYAL SCOTTISH SOCIETY OF ARTS.

Nov. 10.—THOMAS GRAINGER, Esq., President, in the Chair.

THE President opened the session with an appropriate address, in which he showed the great benefit to be derived from a more extensive cultivation of flax in Scotland.

A communication on the "Application of Wind to the Raising of Water, for the purposes of Irrigation in the Colonies," was given by Professor C. PIAZZI SMYTH, F.R.S.E.

The Report of the Prize Committee awarding the prizes for session 1850 51 was read, and the prizes were delivered to the successful candidates, viz.:—

1. To J. Leslie, C.E. Edinburgh, for his "Description, with Working Model and Drawings, of an Inclined Plane for conveying Boats from one level to another on the Monkland Canal, at Blackhill, near Glasgow, constructed from his design in 1850."—The Society's Silver Medal, and Plate, value Fifteen Sovereigns.

2. To T. C. Gregory, C.E. Edinburgh, for his "Description and Drawings of an Improved Self-acting Apparatus for Disconnecting the Carriages of a Railway Train from the Tender, upon the Engine leaving the Rails."—The Society's Silver Medal, and Plate, value Ten Sovereigns.

3. To W. R. Douglas, millwright and engineer, Leith, for his "Description and Model of an Improved Retort for the Manufacture of Prussiate of Potash."—The Society's Silver Medal, value Five Sovereigns.

4. To J. Steven, Edinburgh, for his "Description, with Working Model, of a Railway Signal, constructed on a new principle; and intended to be useful in the prevention of Accidents, by showing the precise time at which a previous train had passed the point where it is erected."—The Society's Silver Medal, value Three Sovereigns.

5. To W. Proctor, Forfar, for his "Description, with a Working Model and Drawings, of an Oscillating Steam Engine," capable of being easily reversed.—The Society's Silver Medal, value Three Sovereigns. *Note.*—The prize is given for his stop-cock and mode of reversing, and is recommended by the committee only for steam-engines of 10-horse power, and under.

6. To W. Swan, F.R.S.E., teacher of mathematics, Edinburgh, for his "Formulæ for constructing Mr. T. Stevenson's Totally Reflecting Hemispherical Mirrors."—The Society's Silver Medal.

The Society elected its office-bearers for 1851 52, viz.:—President: G. Lees, LL.D.—Vice-Presidents: W. Paterson, C.E., T. Stevenson, C.E.—Secretary: J. Todd.—Treasurer: J. S. Moncrieff.—Ordinary Councillors: J. Cay, D. Rhind, D. Wilson, P. Wilson, D. Maclagan, Rev. Prof. Kelland, J. Dalmahoy, T. Grainger, R. Whytock, A. Rose, J. Leslie, A. K. Johnston.—Editor of Transactions: G. Wilson, M.D.—Curator of Museum: A. Jamieson.—Medallist: A. Kirkwood.—Officer and Collector: H. Johnston.

Nov. 24.—GEORGE LEES, LL.D., President, in the Chair.

Account of Observations on the Solar Eclipse of July 28th, 1851, *made at Sebastopol.* By EDWARD SANG, Professor of Civil and Mechanical Engineering, Constantinople.

Mr. Sang stated in his communication that he had not received the "suggestions" to observers, which the secretary had suggested to be sent to him by the Astronomer Royal, until it was too late to enable him, with all the aid he had graciously received from the Russian Minister at the Ottoman Porte, to reach Theodosia in the Crimea, which was within the line of totality. By the kindness of his Excellency Baron Titoff, the Russian brig of war, *Perseus*, was put at Mr. Sang's service, but as she was a sailing vessel, she was unable from light winds, to do more than reach Sebastopol, which, though near, was not within the line of totality. His chief observations were consequently made upon the "beads," and his pre-formed opinion was strengthened by this observation that these appearances were due to irregularities on the moon's surface alone. The irregularities on the moon's edge were so great, not only in detail, arising from mountains and concavities, but in the general way also, from the orb of the moon not being of a circular form, that he conceives serious errors are constantly made in determining the longitude by occultations, because a few degrees change of place on the Earth's surface would bring the observer either opposite to a protuberance or a concavity on the lunar surface, and, as a consequence of this, make the occultation of a star to appear to take place, perhaps 15″ before or after it appears to take place at another point a few degrees distant. The irregularity also leaves us uncertain what is the diameter of the moon, and consequently we have no determined base line from which to compute the altitudes on the moon's surface. The author suggested the importance of having photographic pictures of the moon at different times during her libration.

Description of a Design for an Improved Anemometer or Wind Gauge. By WILLIAM CROSS BUCHANAN, C.E., Glasgow.

The object of this improvement is to remove as far as possible friction from the working parts. It is proposed that the weight of the vane and tube to which it is attached should be removed from the axis on which they turn by means of a float which bears up that weight, and that the axis be reduced to about ½-inch in thickness, the under one working at the foot of the apparatus, and the upper one in a hole in the centre of strong iron supports, crossing each other at right angles, and allowing room for the vane to traverse without touching them, the axis to work loosely both above and below. The vessel containing the float to be placed betwixt the vane and the index apparatus, and filled with water or oil. The wind passing down the tube acts upon an inverted vessel in water, and this vessel carries a rod with a pencil, which marks the force of the wind on a cylinder carried round by clockwork. There is another cylinder which is moved by a connection with a wheel on the upright tube, which gives the direction of the wind; so that the time, force, and direction of the wind are given by the instrument.

ROYAL SOCIETY.—The anniversary meeting was held on December 1st, when the President delivered his annual address, after which the Copley medal was presented to Professor Owen, for his discoveries in comparative anatomy and palæontology; one of the royal medals to the Earl of Rosse, for his observations on the nebulæ; and the second royal medal to Mr. G. Newport, for his paper on the impregnation of the ovum. The following were elected as officers and council, those in *italics* being new members this anniversary:—President: Earl of Rosse.—Treasurer: Lieut.-Col. E. Sabine.—Secretaries: S. H. Christie, and Thomas Bell.—Foreign Secretary: Capt. W. H. Smyth.—Other members of the Council: W. Bowman, *B. C. Brodie, C. Brooke*, Rev. Professor Challis, *W. Clark, M.D.*; *C. G. B. Daubeny, M.D.*; *Sir J. F. W. Herschel*; Professor W. H. Miller; *Lieut.-Col. Portlock*; E. Solly; *W. Spence*, and *N. Wallich, M.D.*; Sir P. de M. G. Egerton; *Dean of Ely*; *J. P. Gassiot*; M. Hall.

SOCIETY OF ANTIQUARIES OF SCOTLAND.—The anniversary meeting of the Society of Antiquaries of Scotland was held on Nov. 28th, in the Hall, George-street, Edinburgh. The following gentlemen were elected Office-bearers for the ensuing year:—President: the Marquis of Breadalbane.—Vice-Presidents: H. H. Drummond, M.P.; Lord Murray; Rev. W. Stevenson, D.D.—Council: Lieut.-Col. Yule; G. Seton; W. B. Johnstone, R.S.A.; W. W. Hay Newton; J. W. Mackenzie; G. Harvey, R.S.A.; Sir J. Ramsay, Bart.; R. Chambers; A. T. Boyle.—Secretaries: D. Wilson, LL.D.; J. A. Smith, M.D.; Rev. A. Brunton, D.D.—Treasurer: D. Laing.—Cashier: T. B. Johnston.—Curators: R. Frazer; J. Drummond.—Librarian: A. Christie. The report stated, that the negotiations long pending with the Treasury had been brought to a satisfactory conclusion; and by the deed which has been drawn up and signed, the Society have made over to the Crown as national property the whole collections of antiquities formed by them during the last seventy years, to form the nucleus of a National Archæological Museum for Scotland. The Treasury have, on their part, vested the curatorship of the collection permanently in the hands of the Society's office-bearers, and become bound, so soon as the new gallery on the Mound is finished, to fit up the entire suite of rooms occupying the north and west sides of the Royal Institution buildings on the upper floor, for the accommodation of the Society's collections and meetings.—The Secretary expressed his hope, as the collections will be placed on the same footing as any other national museum, Scotsmen may be induced to deposit there some of the numerous valuable antiquities at present scattered through private collections, and liable to all the vicissitudes by which such objects are so frequently lost.

METROPOLITAN IMPROVEMENTS.

1. *Plan for a Central Railway Terminus.* By Charles Pearson, Esq.
2. *Project for Improving the Communication on either side of the Valley of the Fleet.* By Robert Hesketh, F.R.I.B.A. London: Weale.

With the approach of the session of parliament, exertions are being made for the improvement of the metropolis. The area of St. Paul's churchyard is in progress of being thrown open, a new bridge is proposed at Putney, and a railway communication over the Strand-bridge to Hungerford-market. The chief plans are those, however, the titles of which we have given. Mr. Pearson, on Thursday and Friday, severally explained his plan to the engineers and architects, in which he proposes to take advantage of the extension of Victoria-street, to obtain a sub-way with rails to communicate with the Great Northern, and thence with the other metropolitan lines on the north side of London; above the sub-way there will be a common carriage-way. It also contemplates the complete remodelling of Smithfield, Holborn-bridge, Skinner-street, and Farringdon-street, including the establishment of a central railway station, and new dead-meat markets.

Mr. Hesketh's plan is to run a grand street, on a high level, from St. Paul's churchyard across Farringdon-street to Holborn-hill, opposite Hatton-garden. This is a new solution of the Holborn difficulty; and Mr. Hesketh presents the design of a fine range of buildings, so as to produce a first-class street.

VISIBILITY OF THE AIR.

An interesting paper of M. Andraud, the engineer, who is so well known to the public, by his experiments with compressed air, as a substitute for steam on railways, was presented at the last sitting of the Academy of Sciences. This paper is entitled by the author *Aeroscopie*, or the visibility of the molecules of the air. M. Andraud proves, that by a very simple contrivance the air is rendered visible. By taking a piece of card, coloured black, and piercing it in the centre with a fine needle, this interesting fact is established. If we look through this hole at the sky, on a fine day, or at a strong lamp having a ground-glass, we see a multitude of little transparent globes moving in the midst of confused nebulosites. These little globes, some of which are more transparent than others, are molecules of air. Some of them are surrounded with a kind of halo. These latter, says M. Andraud, are the elements of oxygen, whilst others are elements of azote. After continuing the observation for some time, we shall see small points detach themselves, and disappear in falling; these, says M. Andraud, are atoms of carbon. This phenomenon of vision, it is essential to remark, passes within the eye itself; the molecules of air which are observed are those which float in the liquid which occupies the anterior part of that organ. According to the author of this paper, the discovery is not interesting merely as a phenomenon, but may be applied to important puposes in medicine. He says, "The physician will one day make use of the aeroscope as an important means of diagnosis. The vertigo, the giddiness, which are the forerunners of apoplexy, will be announced by the perturbation in the molecules. Fever always exists when the molecules under the action of a magnetic current circulate on a vertical ground, sometimes in one sense, and sometimes in another; and when this movement of gyration becomes more precipitate, the patient experiences the singular sensation of turning, as it were, upon a wheel of Ixion. In most cases of opthalmia, a prompt cure might be effected by securing the eye completely against contact with the external air; for inflammation (which is only an oxidation) is kept up by the too abundant absorption of our molecules of air, which is effected by the pores of the pupil; this absorption prevented, the malady must cease. This observation may apply to all cases of inflammation,for the air is an element of which the affected part must be deprived."

NOTES OF THE WEEK.

Hungerford Hall.—An entertainment, entitled Optical Illusions, commenced on the 1st, in a theatre opened for the first time. The performance consisted of feats of legerdemain, by M. Langlois; games and exercises by a juggler, and dissolving views. The latter were well executed, and are deserving of inspection. The Grand Picture Gallery of the Louvre is striking and faithful. It is intended to exhibit the interiors of all the principal picture galleries in Europe.

Putney Bridge.—Parliamentary notices have been given, and a company advertised, for a new bridge from Putney to Fulham which promises to be one of the cheapest and most elegant bridges on the river. The new bridge is to be of cast and wrought iron, 695 feet long, with five openings of 133 feet span, 20 feet above Trinity datum. The piers will be formed of cast-iron cylinders, 8 feet diameter, on Potts's process, and carried to such a depth that the conservators of the river may proceed with the dredging of the river to the extent they propose. Each pier will consist of four cylinders athwart. The bridge will, with its approaches, form a straight line from High-street, Putney, to High-street, Fulham, and get rid of the present dangerous curves. The Chelsea waterworks take part in the undertaking. The engineer is Mr. Clegg, jun.

Bank of England.—Extensive preparations are being made for heating the interior of the Bank with warm water. A large-sized iron pipe is to be used.

Models.—Many of the architectural and other models from the Great Exhibition have been removed to the circular corridor of Wyld's Globe, which now forms a complete museum.

Clement's Inn.—A new gateway to this inn has been made from the Strand entrance, and is of a little more respectable character than the old one.

Wax-chandlers' Hall.—This building is on the point of being pulled down, to widen Gresham-street West, which is much narrowed at that point by the ugly neighbour to Goldsmiths' Hall.

Salisbury Diocesan Church Building Association.—From the report presented at the annual meeting, it appears that four grants have been made during the past year. Steps have been taken for the erection of a new church in the poor and populous parish of Fisherton. 100*l.* has been voted towards the erection of a chapel of ease in the parish of Calne, 20*l.* towards rebuilding the south aisle of Child Okeford church, and 60*l.* towards re-seating the church of Figheldean. The church at Little Cheveril has been rebuilt in admirable taste, and without regard to cost. The nave of Sherborne Abbey has been completely restored to its pristine beauty. The church at Moor Cretchill has been restored and enlarged, and the church at Dorrington entirely rebuilt. The drawings for the enlargement of Marnhull church have been laid before the diocesan architect; and a new church is likely to be erected at Bradpole. New churches are needed in the parish of St. Edmund, Salisbury; at Westbury Leigh, and Chapmanslade; Southwark, Hilperton Marsh; East and West Lavington; Poole, Wimborne Minster, West Parley, Canford, Lytchett, Maltravers, and Warrington.

Gurney's Carbonic Acid Gas Jet.—Mr. Gurney's plan for extinguishing fire in mines by the above process, was lately tried at the Great Lever Mine near Bradford, which was ignited by an explosion of fire-damp on November 8th. The process was stopped in due time, it being the opinion of the government inspector and other practical men that the fire was extinguished, and several persons were sent down, but had to retreat. There is no doubt that the fire had been greatly subdued by the carbonic acid gas; but where the shaft was opened the current of atmospheric air appeared to have renewed the flame. The shaft was closed, and the process of filling the mine with carbonic acid gas renewed, under the superintendence of Mr. Gurney. It was intended to keep the mine charged with choke-damp for a fortnight, and by that time it was believed the fire would be entirely extinguished.

Royal Dublin Society.—At the last meeting of the above society attention was called to a plan which had been prepared for the erection of an Irish Crystal Palace, on a scale much smaller than that of the Great Industrial Palace in Hyde-park. The urgent necessity that existed for the erection of such a building on the society's grounds, for the purposes of their triennial exhibition of manufactures, was well known; as they had been heretofore very much inconvenienced for want of sufficient accommodation. A sum of 5000*l.* was all they required to carry out the design.

Galway and New York Steam Communication.—Mr. Wagstaff, of New York, has announced to the harbour commissioners of Galway that he has built a large and powerful steamer which he means to start from the commercial capital of America to Galway. He calculates that this vessel will make the trip in eight days; and, if he finds that the speculation will pay, he will put on another to accomplish the run in seven days. He promises also to provide superior accommodation for steerage passengers, with separate places for males and females, and to fix the fare as low as 6*l.*

Northern Lighthouses.—The commissioners intend erecting a lighthouse on the Outskerries of Whalsey, in Shetland; the work is to be proceeded with as soon as the other engagements of the board will admit it. The commissioners have recently completed the important lighthouses in Hoy Sound, Orkney, for opening up the anchorage of Stromness. They are now proceeding with the erection of one on North Ronaldshay, in Orkney, and another at Stornoway in the Lewis. They have likewise in prospect one on the island of Devaar, at the entrance to Campelton Loch; another in Loch Indaal, Islay; and a third in the Sound of Skye.

The Tyrol.—A large blasting operation has taken place at Mezzolombardo, in the Tyrol, under the direction of Herr Theodore Mansberger, civil engineer, of Vienna. A large quantity of stone being required at Weischmetz for the construction of bridges, viaducts, and large magazines, it was determined to blast a huge perpendicular rock, 360 feet in height and 85 feet in breadth, near the base of the rock. Seven large openings were made, leaving the rock standing on eight small columns; in each opening a mine was placed. After the operation of mining was completed, the whole of the eight mines were lighted by the galvanic battery, and, in twelve minutes after, the rock fell with a tremendous crash, the earth being shaken in a radius of two leagues, the debris extending over thirteen acres. Upwards of 800 workmen were employed

Local Intelligence.—Messrs. M'Callum and Hodson, papier-maché manufacturers, of Birmingham, have completed a magnificent suite of furniture designed as a present from a Polish firm to the Emperor of Russia. The order resulted from an inspection of the English papier-maché goods in the Great Exhibition. The furniture consists of a sofa, three sofa-tables, two occasional tables, and a toilet-table, two arm-chairs, and six gondola chairs. The style chosen for the various articles is the Louis Quatorze, and the distinctive features of the ornament are carefully preserved. The sofa is richly inlaid with pearl, and is also decorated with groups of flowers, painted with exquisite truth of form and colour, and the chairs are similarly ornamented. The latter have solid curved backs, a space equal to a good-sized panel being thus gained for the introduction of flower groups. Both sofa and chairs are seated with crimson Utrecht velvet. The tables are very elegant in shape and chaste in ornament, in which, though the manufacturers have been compelled by the terms of their contract to introduce a large proportion of pearl, they have, by a judicious employment of that material, and by the skilful tinting to which it has been subjected, produced an exceedingly beautiful effect. Two of the sofa-tables contain picturesquely-treated views, the centre one being merely ornamented with a splendid group of richly-painted flowers. The forms of the tables are agreeably varied, and considerable effect is gained in them from the employment of bold, well-carved moulding; and the pedestals are elegantly shaped, and splendidly and tastefully ornamented.——Every mans cottage at Crewe is lighted with gas, at a cost of 1½*d.* per week.——It is proposed to erect public baths and wash-houses in Shrewsbury. The success which has attended the erection of such institutions in the metropolis and other towns of the kingdom has induced a number of the principal inhabitants of Shrewsbury to originate a similar project, and there is reason to believe the design will be carried out.——The authorities at Runcorn are about to apply to parliament for an improvement bill for that increasing locality.——At a meeting of the trustees under an act passed in the present year, entitled "The Derby, Duffield, Wirksworth, and Sheffield Turnpike Road Act," held at Chesterfield, Mr. John Bradbury, of Unstone, near Dronfield, was unanimously appointed the surveyor of the North district between Sheffield and Derby, *vice* Mr. Fall.——Mr. Cashin has been appointed engineer by the promoters of the Improvement Act, to be obtained for Worksop, and has prepared plans for a water supply from Hobwood, about two miles from the town, near Worksop Manor.

RAILWAY NOTES.

The large and extensive works on the Great Western, at Paddington, for the London station, are being now rapidly proceeded with. The front of the station, which is in Conduit-street, Paddington, has already reached the fifth story, and, judging even from its present unfinished condition, promises to be a large and handsome building, it having above 70 windows on the first floor. It is composed almost entirely of bricks, and it is expected to be opened early in the ensuing year.——The remaining portion of the South-Eastern, on the Tonbridge Wells and Hastings line, from Robert's-bridge to Battle and St. Leonard's, is just completed, and is expected to be opened in the course of next month. This line completes the coast communication respecting which there has been so much wrangling.——The contract for the works on the Newport, Abergavenny, and Hereford Railway, has been taken by Mr. Rennie, who is about to commence operations. This line, it is expected, will be opened for traffic in 1853.——The extension of the Derry and Enniskillen Railway to Newtownstewart will be open to the public before Christmas. The contractor, Mr. M'Cormick, has been over the line, and has undertaken to have it ready for the inspection of the government engineer by the 15th. It is the intention of the company to proceed with the line to Omagh almost immediately after, so that there is every probability of the railway from Derry to that town being completed before the close of next summer. The directors have applied for further powers to complete the full line to Enniskillen, and we have no doubt, now that they are using so much energy for the furtherance of this important undertaking, that we shall have a continuous railway communication between the capital of Fermanagh and Derry before any lengthened period shall elapse.

Foreign.—The Russian line, from St. Petersburgh to Warsaw, has been, by command of the Emperor, already marked out, and the earthworks have been commenced. General Gersfeldt, who was the assistant of General Kleinmichel in the works of the line from St. Petersburgh to Moscow, superintends the construction. As the contemplated line is nearly double the length of the Moscow and St. Petersburgh, it is not expected that it will be completed in less than ten years. The works of the last named line occupied in all eight years.

MONTHLY PRICES.

TIMBER AND DEALS IN LONDON AT THE DOCKS, NOV. 29TH, 1851.

TIMBER *per Load of Fifty Cubic Feet.*

	£	s.	d.		£	s.	d.
Baltic timber Dantzic, Memel, and Riga	2	5	0	to	3	5	0
" Crown Memel	0	0	0	to	3	10	0
" Swedish	2	4	0	to	2	8	0
American Red Pine	2	15	0	to	3	10	0
" Yellow Pine	2	15	0	to	0	0	0
" Birch	2	5	0	to	0	0	0
" Elm	2	10	0	to	0	0	0
" Oak	4	10	0	to	6	0	0
DEALS *per Standard Hundred* (120 12 ft. 1½ by 11 inches).							
Baltic Yellow Deals	10	10	0	to	15	10	0
Petersburgh, Riga, and Archangel Yellow	11	0	0	to	15	0	0
" White	9	0	0	to	11	0	0
Quebec Yellow Pine Deals, First Quality	12	0	0	to	16	0	0
" " " Second	9	10	0	to	10	10	0
" " " Third	8	10	0	to	9	0	0
Gottenburgh Yellow Deals, per 120, 12 ft. 3 in. by 9 inch	16	0	0	to	20	0	0
" White	15	0	0	to	17	0	0
Christiana Yellow	19	0	0	to	22	0	0
" White	17	0	0	to	19	10	0
Red Pine Deals	15	0	0	to	20	0	0
Spruce Deals	14	10	0	to	17	0	0
Petersburgh Yellow Battens (per 120, 12 ft. 2½ by 7 inches)	11	0	0	to	15	0	0
Gottenburgh Ditto	10	0	0	to	14	0	0
Baltic Deck Deals, 40 ft. 3 in. each	0	12	6	to	1	2	0
" Lathwood, per fathom of 6 ft.	8	0	0	to	8	10	0
Dantzic Oak Plank per load	5	0	0	to	7	0	0
Mahogany—St. Domingo, per foot super. inch			6*d.*	to		1*s.*	9*d.*
Cuba			6	to		1	6
Honduras			4½	to		1	0
African			5	to		0	6
CEDAR —— Havana			5½	to		0	6¼
ROSEWOOD—Rio .. .. per ton		12*l.*	0*s.*	to		20*l.*	0*s.*
Bahia		8	10	to		12	0
WAINSCOT—Riga logs for 18 feet cube		2	5	to		4	0

MONTHLY PRICES OF METALS, NOV. 29TH, 1851.

	£	s.	d.		£	s.	d.
IRON—Welsh Bar, Bolt, and Square, in London ..	5	2	6	to	5	5	0
Nail Rods	6	0	0	to	6	2	6
Hoops	6	10	0	to	6	15	0
Sheets, single	7	7	6	to	7	12	6
Bars in Staffordshire	5	5	0	to	0	0	0
Bars in Wales	4	7	6	to	4	10	0
Rails in Staffordshire	5	10	0	to	0	0	0
Pig, No. 1, in Wales	3	0	0	to	0	0	0
Do. Forge	2	5	0	to	2	10	0
Ditto, at Glasgow	1	19	0	to	2	9	0
Chairs, at Glasgow	4	0	0	to	0	0	0
COPPER—Ordinary Sheets .. .. per lb	0	0	10	to	0	0	0
Old	0	0	9	to	0	0	0
Yellow Metal Sheets	0	0	0	to	0	0	8¼
TIN—English Block .. .. per cwt.	4	4	0	to	0	0	0
" Bar	4	5	0	to	0	0	0
" Refined	4	10	0	to	0	0	0
TIN PLATES—C IC, ... per box	1	8	6	to	0	0	0
IC	1	8	0	to	0	0	0
LEAD—Pig, English .. .. per ton	16	10	0	to	0	0	0
Sheet	17	10	0	to	0	0	0
Pipe	18	0	0	to	0	0	0
ZINC—English Sheet	21	0	0	to	0	0	0

	£	s.	d.		£	s.	d.
Red Lead, per ton .	£19	10	0	Linseed Oil, per cwt.	1	10	0
White Lead, per ton	25	0	0	Turpentine, rough ..	0	8	0
Tar, Stockholm, barrel	0	18	0	" spirits .	1	13	9

ON THE FORMATION OF A SCHOOL OF ART FOR ARTIST WORKMEN, AND THE ESTABLISHMENT OF A MUSEUM OF MEDIÆVAL ART.

By C. Bruce Allen, Architect.

[*Paper read at the Royal Institute of British Architects, Dec. 1st, 1851.*]

Without occupying your time with a detail of instances to show the great distinction existing between the intellectual and the mindless work—which is equally visible, and surely of equal importance, whether in the productions of the artist or of the workman—I trust I am not wrong in saying that the higher and more instructed members of society now begin to consider it their interest, as well as their duty, to raise those who are less fortunate to the use of their mental faculties, the only difficulty being the exact manner in which that object may be best accomplished. It is certain, however, that to all those who are in any way connected with art, this is a matter of great interest, and to none more so than to the architect, as in no other profession is skill, or the want of it in the workman so soon felt, or so lastingly deplored, as in his. In painting, in sculpture, in gem engraving, in gold and silver chasing, and indeed in all other arts, the artist himself can go over and retouch what the student or the workman has done, and thus in a measure make up for his shortcoming; but in architecture this is impossible, as the architect cannot follow the unskilful workman, and with his own hand correct what has been done amiss. Whatever interest therefore may be felt generally in improving the workman in the knowledge and practice of his trade, to the architect it is especially a matter of concern. All, indeed, allow this, but they ask how the improvement is to be effected. The government have offered to teach the workman to design, and others have undertaken to instruct him to draw and model; some have thought lectures would do, and have given him books to read; and I have no wish to depreciate the value of either, but it seems to me that in the great majority of cases they are likely to fail, because the mind of the workman is usually altogether unprepared for their reception, and however numerous and however able they may be, his memory is so little practised, and his powers of abstraction and attention so little cultivated, that he cannot follow them up. He hears a very able lecture, and perhaps remembers some striking part, probably some illustration, but of the general scope and bearing of it he sees nothing, and of the principles which it may be the object of the lecturer the most fully to inculcate, he remembers or perceives nothing, as he comes to the subject, whatever it may be, profoundly ignorant, not only of it, but of all other collateral and necessary branches of knowledge. It has, I cannot but think, been too hastily assumed, that as an audience of academy students can, without doubt, be greatly benefited by a course of able lectures, say on sculpture, a number of working men may be so too; but the student, although needing to be taught, comes to them with a practised mind and a cultivated ear, qualifications wholly wanting in the workman. It is, I believe, from thus confounding the student and the working man that nearly all have failed, as nothing can be more unlike than the two cases. Lectures to be useful to the workman must be written for him, and should be illustrative of something he is practically engaged in, so that he may see as well as hear them. Thus we find in each one of these systems certain points open to grave objection; either something is proposed which cannot be taught to the workman, something is offered him for which he has no use when acquired, or something far too difficult is given him to think about, and thus the very short time he has to spare for improvement is in a measure, though not altogether, wasted; for even if he were taught the Greek language he would of course be so much the wiser and better for it; but his time for improvement being so very limited, whatever is done to help him should be done in the most direct way, so as to produce, as far as may be, an immediate effect on his mind, and have, as far as possible, a bearing on the work he lives by; first, because his happiness depends on the amount of interest in it felt by him day by day, and next that others may profit as well as himself by his increased knowledge.

In the school which I am about to propose for your consideration, these requisite conditions, which I conceive no one will dispute, will be in no small measure fulfilled, for we shall take the workman just as he is, viz. from his bench, without, it may be, any knowledge whatever of the fine arts, derived either from lectures or books, or the teaching of his master, and possessing, indeed, nothing whatever but the knowledge of his handicraft which he has acquired at his daily labours. Thus, no man would be excluded on the ground of ignorance or from any other cause. He would first be required to make a copy of any simple object in the common material of his trade; but this his first task, he would do by himself in his own way, so as to enable us to judge of his capacity and skill. Thus in a very short time it would be seen what each man could do, and for what he was best fitted—in short, where his strength lay, and we could direct him accordingly. It would not be necessary that he should complete his first task, its object being simply to ascertain practically what progress he had already made in his art. Another model suited to his present powers thus ascertained, would then be set before him, and he would be required to draw on the stone (supposing him, for example, a mason) a correct outline of the plaster or natural model. I do not mean a neat drawing, but a broad, bold sketch. He would of course, if altogether ignorant of drawing, begin in a clumsy way, and to tutor his hand as a draughtsman he would be set—but not till after he had made some trials on the stone—to make a rough sketch of the object in black chalk on a board, and of the full size, for nothing can be more thoroughly useless to a workman than small drawings. The simple purpose of this process would be to train his hand to draw, and not to make a picture of the object, for to do this we should have to teach him perspective, foreshortening, and a host of other matters, with all of which, however interesting in themselves, the workman as a workman has nothing to do; his time and the money he pays to learn are valuable, and he cannot afford to bestow them on picture-making and neat drawing, but what he is anxious to do is to copy the model, not in a drawing but in stone. After becoming in this way tolerably expert in the leading lines of his model, he would commence drawing it on the stone itself, in which, perhaps, he could not well have too much practice, for the most accomplished draughtsman on paper, fresh from the Royal Acdemy itself, would find some difficulty in drawing the foliage of an early Gothic capital on the turned block. I think this difference between drawing on a flat surface, as on paper, and on the round, or perhaps uneven one of a strange material, affords a strong argument in favour of keeping the workman to his own tools and to his own material. When this was done, and a fair though rough drawing was made on the block of stone, he would proceed to carve it, line for line, keeping steadily to the model before him, using the chalk occasionally as the work went on, to make him think; for when the mallet and chisel are constantly going, the mind of the workman goes on mechanically, and he ceases to think of what he is doing. Thus drawing would form one most essential part of the proposed scheme of educating the art-workman, but instead of his making a pretty little picture, or a number of pretty little lines on a piece of paper, assisted perhaps with prize instruments and prize colours, to be treasured up hereafter like a child's copy-book, and fit, in fact, only for waste paper, he would make a drawing in black chalk on the rough stone, not to be kept, nor yet for that reason to be lost, but to be used aga n and remembered, and to become firmer and clearer and more expressive as he progressed. Thus the workman would be taught to draw.

When the work was so far completed as to be ready for finishing, it would be the business of the teacher to point out carefully to him where the general lines failed, and where they were successful, and to caution him against the common fault of cutting away too much and impoverishing the work; for is is better to have the lines too heavy than too light, as time takes away but never adds to the crumbling stone, and one would like a more art-enlightened age to see what the working men of to-day could do; for their interest in old work will arise from the knowledge that so many centuries have elapsed since it was cut, and their pride will be that it has been untouched by all but time, whom assuredly they will pardon for taking away so many grains of the stone when they see the colour he has given. The workman would next proceed to finish his work, and bring it up to the model, still using the chisel, and still being cautioned (else all his previous labour would be vain) against the almost universal idea that the value of sculptured work is to be measured by its smoothness to the touch; for people are to be found who will pass their fingers over the surface, and then pause enthusiastically over the feeblest work, because it is smooth to the eye and finger, when, perhaps, had the artist been contented to leave some marks of the tool, he would also have left some life. The workman would hence be taught, and in time would come to see, that if he could do nothing with the rough chisel, sand-paper would not assist him. He would thus proceed from his first effort to another, perhaps a trifle more difficult, and would be again required to draw on the rough stone the outline of the model, and by this method of frequently repeating the same process we should teach him all he requires to know, or can ever need professionally, of the art of drawing; and, in addition to the advantage of thus seeing clearly the practical use of every line he drew, he would have that of never feeling the fatigue of making drawing after drawing in long succession, in each of which he saw no immediate benefit. But by the mode here proposed of drawing the model in chalk, line for line, and then following those lines with the chisel, he could never fail to perceive the use of each line, and what it represented, and how much such lines assisted him, and thus he would be compelled to think, whether he would or not. Indeed, in thus pausing to look at what he had done and had yet to do would consist the chief advantage of a school, for in it he would not work with his hand only, getting through as much work as he could, as he does during the day, but he would proceed slowly, carefully, and thoughtfully, and not only copying line for line, but making all efforts to catch the spirit of the work before him; and, if working from a living model—the type imitated in all truly fine old work—endeavouring to breathe life into his copy of it. It would be the duty of the teacher now, as before, to point out where he had been successful, and where he had failed, and to show him the peculiar merits of the work he had copied. He would in this way be led at once to the study of the finest models remaining to us. If all this did not interest the intelligent workman, and incite him to think and to perceive the value of mental culture, nothing would. The workman would in this way proceed from one model to another, from the simplest to the more difficult, till his eye became so far educated as to enable him to see for himself how near he could come to his model. The principles which guided the artist in the production of the original work would, as far as possible, be pointed out to him, for he would now be prepared to listen to them with advantage, and to appreciate their importance, just as a learner when able to read correctly begins to perceive the importance of grammar, and to feel interested in it, not as a dry study, but as something essential to his further progress. By this means, too, the workman would come to see the line which separates the great works of past ages from those of to-day, and the difference existing between the products of machinery and those of the artist—between the products of the hand and those of the hand guided by the mind—between the dead and the living. In this way, step by step, would he proceed, till having mastered to a certain point, and as far as possible, the difficulties of the great models left to us—and they are far fewer than many think—he would be set to copy the leaf as it grows; first a single leaf, as an ivy-leaf; and then two or more, as a composition; and then the group—forming the complete architectural capital, the living leaves being placed round a block bell, at first by the teacher, and then, as the workman began to see his way, by the workman himself, who would thus be tried in composition without being taught to design—though tested at the same time to show whether he had in his mind any idea of it. He would in this way be guided to the road which leads to invention, and brought as near to the artist as the most accomplished and able teacher could bring him. This would, beyond all other plans yet tried, compel him to think, and make him something more than a machine, by inciting him to feel an interest in his daily labour—not a mere ordinary sluggish interest, just sufficient to enable him to do his work, but an interest so great as to induce him to strive to get forward; his work would rise in his mind from a dreary necessary labour to a delightful and pleasurable occupation; from a feeling of doing nothing but his master's work, and for his master's interest, and for weekly wages, he would come to feel that he was working for himself, and to his own credit. All this he can never acquire from lectures or books alone, or by any other system, than through the trade he is daily engaged in. We must teach the workman through his hand and so reach his mind, in this respect differing widely from any plan of instruction fitted for the artist, for in him the mind is the instrument, the hand following it; in the workman this is reversed—the hand is the instrument, the head guiding it; and between these two modes lies the hair to be split. Thus we should, step by step, perfect a plan of instruction suited to the want of the workman himself, and directly and immediately beneficial to his employers and to society.

The education of the artist is, I take it, now conducted on as entirely wrong and wasteful a system as human ingenuity could have well devised, and the time is close at hand when it will be rectified. I feel sure that the learned few who now preside over the education of our rising artists, will come to see that drawing the figure from the feeble remains of worn-out Greek art is not the only way in which the artist may be instructed. It may, and I feel sure that it will, happen too that the discovery will be made of objects in nature worthy of the student's pencil and thoughts. If a boy should delight in flowers, some other means of teaching him to draw them will be found than spending three or five years in drawing the antique, and three more in drawing in a life school, and three more in multiplying copies of touched-up pictures. When household furniture, domestic utensils, and such like, shall be regarded as subjects not beneath the mind of a great artist, the notion may occur that the shortest road towards their improvement does not lie through an antique school, and that any one's ability to make a pleasing sketch of the Gladiator, or a painfully stippled drawing of the head of Homer, is no earnest of his ability to design a table or a footstool. Assuredly the artist has had in our country, as compared with the continent, little enough, but in that little has been everything but just what he most required—that is, what he instinctively asked for. So, too, it has been with the artizan, but with this difference, that he has never had anything at all; he, at least, has nothing to unlearn, for he has learned nothing—no one has ever offered to teach him; what he knows he has acquired of himself, without help and without guidance, and hence it is no wonder he comes short of what is required of him. It would seem time, therefore, to do something for him, not for his sake only, but for our own, and for the sake of the fine arts, and to evidence to the public that art can never come from patent machinery, but must come from the mind, whether of an artist or a workman; rude, it may be, as in the carving of a capital in a Norman doorway, but still, let it be done, not by machinery, but by the hand of some one, however rough. And not in architecture only, but in every other department this need of the art workman is found; intelligent men, able to see the merits of any design intrusted to them, and able and willing, and proud to carry it out, and contented to carry it out; not eagerly ambitious to throw away the flowers as soon as understood, to carve the heads and robes of kings, but the loving them the more as their skill in rendering them increases, and happy in being permitted to copy the leaves of the ivy on a church door. Let us, then, make the endeavour to give him what he asks for—not words of ten syllables, because they are hard and mysterious, but words of one, because they are easy; not the artist's tools, but the workman's. Artists, we shall find, will of themselves rise up, and designers will always be found equal to the wants of the times and to the nature and amount of the encouragement offered to them; and, we may depend on it, that the best way to encourage the artistic talent of a nation, and to develope it, is not by attempting to manufacture new ones by the score, but by affording to the few opportunities for a study worthy of them, and so to rouse in the mind of the public such an appreciation of their labour as shall induce the public to pay for that, and all other intellectual labour, not by measure and weight, but according to its weight and its influence on the higher minds of the community. But for the workmen no means can be more than sufficient to make them more intelligent, and their labour more valuable to those who employ them, and to make them art-workmen, thus to rouse in them, through the trade which each one follows, a feeling for the beautiful. To carry out this object on a national scale would, indeed, be a noble result of the Great Exhibition, and worthy of any sum, however munificent, which could be expended on it. I am convinced it would do more for art, and for artists, and for workmen in five years, than the present system, if it can be called a system, can do in fifty.

I propose, therefore, to teach the workman simply to copy line for line, and to catch the feeling and spirit of the artist's work, or of nature's work, in the material of his trade. I do not propose to teach him to design; that is, I do not propose to re-construct his mind. I do not propose to teach him to model in the face of his certain answer, "You have taught me to model so that I can copy anything in plaster; but to go on by myself, and without copies, I must design, and I have not the mind of an artist or designer. I have no original ideas." I do not propose to teach the workman to draw, and for the same reason; but I propose to go to work in the same spirit as the Egyptian did of old, when he placed before the eyes of his workmen a row of hieroglyphics, cut by some master hand, and then taught his men to carve them line for line, and to catch their spirit; he knew too much to expect, and so never asked of his workmen more than this, but this he got—just what we cannot get: and you may see in the Museum evidence of this skill. In the Erectheum frieze you will see that the Greek did the same. Gibbons did the same; and the diaper in stone, and the dog's teeth, and ivy leaves in all our great cathedrals and village churches, will show that the workman of the middle ages was thus educated—not on paper, but on stone.

A recent author of note, speaking of artists, says—"It is most difficult, and worthy of the greatest men's greatest efforts, to render, as it should be rendered, the simplest of nature's works." "The excuse," he continues, "that it is easy, and therefore, in a measure contemptible, to copy nature, is of the lips only, for every painter knows that when he draws back from the attempt, it is oftener in cowardice than in disdain." "And," he adds in another place, "if there be any greatness among us, it will best be attained by following in this path, that is, by beginning in all humility and hopefulness to use the powers we may have to represent the things around us, as we see and feel them, trusting to the close of life to give the perfect crown to the course of its labours." And what he said of the artist, I say of the workman. It is most difficult, and worthy of the ablest and most skilful workman, to render in stone, as it should be rendered, the simplest leaf that ever grew. But the excuse, it is easy to copy, is of the lips only, for every architect knows that such is not the case, and that the workman does not live who can do it. I would add, too, that if there be any greatness lying dead among our working men, the system now proposed will bring it out, for it cannot long lie hid; but let him begin in all humility and hopefulness to use the powers he has to represent the simplest of the things around him, not in a strange material, but in his own; and let him trust to the faculties mentioned by our author to give the perfect crown to his labours.

With reference to the Museum of Mediæval Sculpture, which it is proposed to form as a necessary part of the school, a few words may suffice, as the importance and interest of such a collection will not, I presume, be questioned, even by those who object to the school. There is not I believe, in England anything accessible to the public which can be called a Mediæval Museum, a fact not a little surprising, when the wonderful remains of the middle ages, and the proud display of which this country can boast, are taken into consideration. The British Museum contains specimens of artistic skill from every country on the face of the earth; but not a single leaf, or flower, or fragment of stone, from our own; not a single shelf in the whole establishment is devoted to British antiquity, though the interest that must attach to such a collection seems past all possibility of doubt. And surely no country has so glorious a collection of effigies of kings, nobles, warriors, and priests; not like the Ninevite, nameless, and without histories, but all of them their names and their deeds, their ancestry and their successors, known as well as the most familiar story. But all these have been passed by as utterly worthless, by the side of some broken Greek inscription, containing, perhaps, a list of the names of the doorkeepers of some forgotten temple. And not only are they of surpassing interest, as monuments of antiquity, but some of them are beyond all praise as national works of art. As works of art merely, and without reference to their antiquity, they are second to none; and specimens, I take it, may be found, not only equal, but perhaps superior to anything on the Continent. The men of the middle ages in our country were not only inferior to none in all Europe, but in not a few instances superior to all, for the beautiful style of architecture which they cultivated never reached in the hands of either the French, the Germans, or the Italians, the point of excellence which it did here. Try it by any standard we will—by principles, when we have them—by rules, when we know how to apply them—or by comparison, where memory serves—the glorious style, as we have it in England, is not only second to none elsewhere, but infinitely and marvellously superior to all. I hold them in all respect, and hope to see all the evidences of their skill; but let us not do injustice to ourselves by giving undue credit to foreign works because they are distant and less familiar.

Let us then try to collect under one roof a connected series of what yet remains to us untouched by the desolating hand of restoration, and thus leave to those who follow us the plaster evidences at least of what our forefathers have left us; and what we have studied, and wondered at, and tried to emulate, let them study, and wonder at, and emulate. I trust I have said enough to induce you to aid in the formation of this Museum, and not to think of waiting till the Museum authorities have travelled round the world in their way to their own country, or till the government find out there are such things as English antiquities. Whatever you may think, therefore, of the proposed school, no one, I presume, will object to the Museum; no one can think it superfluous or uninteresting; even the warmest lovers of the Classical style will be willing to assist in forming this, if not on the æsthetic grounds, at least as an Archæological Museum, as an interesting series of antiquities, the most dear as being those of his own country. But to the student, however, and especially to the architectural student, the value of such a collection as a means of study is surely above all estimate: more would be learnt of the true spirit of the glorious style of the Middle Ages from it, in three months, than in the office in three years, or, indeed, in any number of years. A moulding, or a leaf, a capital in actual stone, or in a cast, is worth more than all the perspectives ever made, or the figured drawings, or the books ever written.

Discussion.—Mr. G. G. Scott said that, without agreeing in all the opinions put forth by Mr. Allen, there could be no doubt that he had brought forward many original views well worthy of consideration. On the main points there could be no difference of opinion; that architect who had not felt the great want of artistic skill in the majority of the workmen employed to execute his designs, was indeed fortunate. The only question was as to the best mode of supplying that want. He regretted that anything had been said which might appear to depreciate the Government School of Design—the only attempt which had been made to meet the want referred to. That establishment might not do all that was required, but it was intended only as a pioneer in the path of art-education. Mr. Allen's plan proposed something more, by teaching the workman his own art, in addition to educating his eye and mind; and he believed Mr. Allen's plan was calculated to promote that end. Probably that gentleman might himself hereafter modify and improve the exact mode which he had laid down; but they must all agree that a school in which workmen might be taught thoroughly to practise each his own branch of ornamental art, was worthy of their support.

Mr. C. H. Smith said that, having been brought up as a mason, he was much more in favour of example than of oral instruction as a means of educating workmen. He thought it would be found that all the best carvers and sculptors had been self-taught. It was of the greatest importance that ingenious workmen should be able to examine a good collection of examples, which indeed would be infinitely more valuable than anything they could be taught; for it was very truly said that, "he who learnt nothing but what he was taught, would never know much." Mr. Allen had referred to Grinling Gibbons; but had Gibbons lived to the present day, he could not himself have executed all the works which pass under his name. He had, no doubt, a number of disciples who executed the works referred to under his directions. So far as he had been able to learn, Gibbons had not been educated as an artist; and certainly in his time there were no schools of art. He (Mr. Smith) attached the greatest importance to an extensive museum of specimens of art-workmanship. Actual specimens were far more valuable than squeezings or plaster casts, which could not possibly convey the spirit of the tool and the sharpness of the chisel. He had been frequently applied to with respect to the execution of Gothic carvings for modern churches, and when he stated the price which ought to be paid for their proper execution, the parties went away quite astonished at the price named. Whilst carving was put into the general contract with builders, it was impossible it could be properly executed. Price was a serious matter for the workman's consideration. If a man found he was clever at carving ornaments, but could obtain better pay for figures, he adopted the latter, and neglected ornamental carving.

Mr. John Seddon said, that it was his wish to advocate the utility of the schools for workmen; but that it appeared to him somewhat extraordinary that both the Society of Arts and Mr. Bruce Allen should so utterly ignore the existence of any attempt of the kind they proposed, while it was a notorious fact, recorded in one of the late reports of the Institute, that such a school was in full and successful operation in Camden-town. He referred to the North London School of Drawing and Modelling, of which his Royal Highness Prince Albert was patron, and many artists and members of the Institute of Architects and Society of Arts were upon the committee. Its masters were all practically acquainted with the carrying out of designs; and the management of the school was likewise in the hands of artists and gentlemen connected with design, which was one of the principal reasons of its success. Between 600 and 700 men have been instructed in the schools since their opening; and in his opinion, and that of many of the members of the committee, the only one point in which Mr. Allen's plan differed from their's—namely, in the proposal to teach the workmen carving *in the school*—was impracticable. Now most of the men who took advantage of the schools were not carvers, for the great variety of the different classes of workmen attending was astonishing, and it would be impossible to provide the necessary space for all the different materials of their trades, if they were to work upon them in the school, while it would be difficult to find parties competent to give the practical instruction suggested. Drawing and modelling were, however, useful to all classes; and a carver might acquire more freedom and delicacy of execution by working in clay than on the stone itself.

Mr. HENEKER thought one of Mr. C. H. Smith's observations was liable to some objection. The fact that some artists had been self-taught ought not to depreciate the value of instruction, as they became great, rather in spite of the want of instruction, than from that immediate cause. When properly conducted, instruction was of the greatest importance. Of course it was absurd to teach a carver to make a finished drawing of the Gladiator, but he should be taught to make good drawings of the objects of his trade, and to acquire proper notions of the designs he had to carry out.

Mr. JENNINGS said that what architects wanted was, that workmen should understand their drawings, and be able to execute the work required from comparatively slight sketches; and it was impossible they could do so without being themselves able to draw. Modelling however was the most important branch of instruction, with a view to acquire aptitude and readiness of execution in wood and stone.

Mr. BARRY could hardly agree with the statement that instruction was unnecessary and superfluous. At the same time every one must perceive the importance of providing as many examples as possible, and of the best kind, as one means of instruction; but the best use could not be made of them if their beauties were not pointed out by those who studied them. He thought the chief difficulty to be surmounted arose from the commercial principle referred to by Mr. Smith; and the ambition which all men felt to better their position. The practical instruction suggested by Mr. Allen would tend to make the workman feel a pride in his own art, and the commercial difficulty might to a great extent be overcome.

Mr. ALFRED SMITH thought that, with regard to carving, architects ought to take it into their own hands, and not allow the builders to have anything to do with it. It should be kept out of the contract or specification, and superintended by the architect himself.

Mr. BURNS said, it was a very easy thing to say that architects should take the superintendence of carving into their own hands, but they had very little power where money was concerned. In reference to the education of workmen, he felt convinced that without teaching them drawing and modelling, so as to appreciate a drawing when put before them, they could never be made carvers. Drawing and modelling were equally essential; no one could be a good carver who was incapable of modelling, and though he should be glad to see a good drawing school for workmen, he thought it would be of little service without teaching modelling also.

A VISITOR considered Mr. Allen's plan most admirable, as it provided that instruction should be extended to the workshop. He would even go further, and establish a kind of university, in which lectures should be given and illustrated by experiments, showing the combination of theory and practice.

Mr. C. H. SMITH agreed with Mr. Burns in the utility of modelling, upon which, indeed, the greatest stress ought to be laid in the formation of any school such as that proposed.

Mr. G. G. SCOTT thought the primary thing was to make the workman understand his own trade, and to teach him modelling collaterally.

Mr. FERREY adverted to the great importance of forming a museum of actual examples, which had been so strongly urged by Mr. Allen.

Mr. PAPWORTH, from his knowledge of Mr. C. H. Smith's own manner of learning, did not think that he had meant to say that precept was not useful, but that so few people in the present day were capable of practical teaching that the best instructors to be looked to were actual examples. Mr. Papworth also stated, that Mr. Franks, of the British Museum, had been placed at the head of a department of that establishment, intended for the reception of a collection of British antiquities.

Mr. HARDWICK, V.P., before quitting the chair, wished to express his sense of the extreme importance of educating workmen in art. Architects constantly experienced the want of a knowledge of form and effect on the part of workmen, and a consequent difficulty in getting their drawings properly carried out. Differences of opinion might exist as to the best mode of conducting the required school, but undoubtedly some education was highly desirable. The Royal Academy was confined to the fine arts, and accomplished its purpose most successfully. The Government Schools of Design were connected with commercial art, and drawing and modelling were there only taught to lead the students to design works for manufacturers. The means of educating men in metal, stone, and wood, so as to understand architects' drawings, were still wanting. He hoped the members of the profession would unite to form such a school as they required, with a museum as a collateral branch of it.

NOTES ON CONSTRUCTION.

By SAMUEL CLEGG, Jun.

*** These Notes, when completed, will be published in a separate form, as a Hand-Book for the use of the Students at the School of Construction.

Slaking Lime.

To bring caustic or quick-lime into a fit state to be mixed with other ingredients to form mortar, it must be reduced to a "hydrate," when it is called slaked lime, and the process of reduction is called "slaking." It is pretty generally admitted that the induration of mortars depends upon their absorption of carbonic acid from the atmosphere; and it seems to be essential to this reunion of carbonic acid with the lime, that the latter should have previously combined with its equivalent, or about one-third of its weight of water.

Stuccoes made with hastily-prepared lime remain soft and powdery for a long period; but those prepared with well slaked and tempered lime soon absorb carbonic acid, and become hard often to a considerable depth from the surface. The presence of water being necessary is further confirmed by the fact, that if dry quick-lime be placed in a jar of carbonic acid no absorption whatever takes place.

There are three methods of slaking lime—viz., 1st, by subjecting it to the slow and continued action of the atmosphere; 2ndly, by throwing over it a proper quantity of water; and 3rdly, by immersion. The first method is only suited for the fat limes, which should be broken up into pieces not larger than a walnut, or a perfect division will not be effected, and even then the centre of a lump will often remain in a caustic state. This process must not be conducted in too damp an atmosphere, and must be stopped directly the slaking is complete, by putting it into sacks or casks and placing it in a perfectly dry place, or by covering the slaked heap up with sand if the lime is to be used in a day or two. For plasterers' work this method is perhaps preferable to any other mode of slaking, as it makes the lime stronger, but it takes a long time in cold weather.

Quicklime slaked by the addition of water is the mode usually used in practice, and is at once the most certain and convenient. Rich limes subjected to this process slake with a hissing noise and the disengagement of much heat. The poorer and more valuable limes exhibit these phenomena in a less degree, and about in the proportion of the foreign matter mixed with the lime, and with some of the hydraulic limes no effect will appear to be produced by the water until some hours have elapsed. In this mode of slaking care must be taken to throw on the necessary quantity of water *at once*; none must be added during the effervescence, or the lime will be numbed, fall to powder imperfectly and continue gritty. Equal care must be taken not to "drown" the lime with too much water. Thus drowned, it loses the greater part of its binding qualities, and is especially the case with rich limes.

Slaking by *immersion* is accomplished by placing the lime broken into small lumps, into a basket, plunging then the basket into water, withdrawing it when the surface begins to boil; the lime is then turned out into casks or heaps, and covered up, that the vapour may complete the slaking. Lime thus slaked may be kept for months, if sheltered from moisture. The rich limes, when slaked and brought to a thick pulp, give from two to three volumes for one; the weather and hydraulic limes do not give, under the same circumstances, more than from one to one and a-quarter or one and a-half at most. All limes become *effete*, or difficult to slake, after having been acted on by the air: this fact is more especially remarkable in the hydraulic limes. Spontaneous extinction is suited only to fat limes. The ordinary method of slaking suits all kinds;* and slaking by immersion is suitable only for the hydraulic limes, and is the only method by which they can be kept long, or much carried about without sensible alteration.

The substances mixed with limes to form mortars are sand, ashes,

* Hydraulic limes are refractory in slaking: it is therefore the practice to break up the lumps, and to cover the heaps over with sand after the water is showered over it, by which means the heat is confined, and the process is usually complete in about 18 hours. These limes may be slaked at once by using boiling water.

and burnt clay.* To enable lime to harden by the absorption of carbonic acid, it is necessary to divide it as minutely as possible, or so as to expose as much surface as possible to the action of the air. The addition of any of the above substances effects their division, and their action is simply mechanical. Sands are of the greatest value, and are, with very few exceptions, the only substances specified to be mixed with lime to form ordinary mortar; sharp angular grains from quartoze, granitic, or schistose† rocks are the best of these. Mortar may be likened to minute rubble masonry, the grains of sand forming the stones, and the lime the cement. The grains must be in close contact, and, consequently, must present only flat surfaces, and not rounded ones (for a rubble wall of boulders would have no solidity); in other words, the sand must be *sharp*. A mixture of coarse and moderately fine sand is advisable, as the finer grains assist in filling up the interstices between the coarser, which otherwise would be filled up with lime. Equally important is it that the sand should be *clean*, that is, unmixed with clay, animal, or vegetable matter; and when rubbed between the fingers it should not soil them, which is a good test. If the sand be otherwise good, this hurtful dirt may be removed by washing—by placing the sand in a shallow tank or tub with a double bottom, the upper end being pierced with holes, and forcing water, by means of a pump, through the sand, until it runs over the top colourless. Road drift, or the powdery matter escaped off the surface of roads is often used by small builders to mix with the lime. When washed, and obtained from flint, it is frequently pretty sharp, and may be used for light works; but unwashed, as it is too often employed, it is quite worthless: indeed, mud would be quite as efficacious as many specimens of matter called mortar, used by the class of men alluded to. Sand procured from the bed of the river Thames, above the bridges, is justly esteemed by metropolitan architects; and when screened or freed from foreign matters, consists of a mixture of coarse and fine grains, eminently qualified to make, with lime, good mortar. But there are many river beds which furnish sand equally good. Sea sand, before being used in the construction of houses, should be got in large quantities beforehand, and spread out in beds of 10 or 12 inches deep, and left to be well washed by the rain, or by fresh water thrown upon them; or by the method described for road drift. The presence of saline matter causes mortar to absorb moisture at any time from a damp atmosphere, and to throw out a humidity to the surface of the walls. In hydraulic works sea sand need not be be washed, as the salt does not appear to be injurious to mortar. Pit and other land sands (such as Bagshot), plentifully spread over the surface, or at a little depth, are generally very excellent; the only care necessary in their selection is, that they must be *sharp* and *clean*.

If cinders, scoriæ, burned clay, or such porous substances, be employed, the lime transfers itself into their pores, and produces a more intimate cohesion. These are, therefore, very useful inert substances to mix with lime: they must, however, be very pure and dry, and rendered pretty fine by grinding. In the case of burnt clay, or brick or tile dust, they must be thoroughly burnt, and free from vitreous particles; burnt clay, and cinders from a smith's forge, give to mortar slightly hydraulic properties.

The Preparation of Mortar.

The purest limes require the greatest proportion of sand; and those which contain foreign matter require less almost in proportion to the extent of impurity. Sir Charles Pasley says, "I have ascertained, by repeated experiments, that one cubic foot of well-burned chalk lime, fresh from the kiln, weighing 35 lb., when well mixed with $3\frac{1}{2}$ cubic feet of good river sand, and about $1\frac{1}{3}$th cubic foot of water, produced about $3\frac{1}{4}$ cubic feet of as good mortar as this kind of lime is capable of forming. A smaller proportion of sand, such as two parts to one of lime is, however, often used, which the workmen generally prefer (although it does not make, by any means, such good mortar), because it requires less time and labour in mixing, which seems trouble to the labourers; and it also suits the convenience of the masons and bricklayers better, being what is termed *tougher*, that is, more easily worked. If, on the other hand, the sand be increased to more than the above proportion of $3\frac{1}{2}$, it renders the mortar *too short*; that is, not plastic enough for use, and causes it to be too friable, for excess of sand prevents mortar from setting into a compact adhesive mass. In short, there is a certain just proportion between these two ingredients which produces the best mortar, which, I should say, ought not to be less than three, or more than three and a-half parts of sand to one of lime; that is, when common chalk lime or other pure limes are used, for different limes require different proportions." Three cubic feet of sand to one of Dorking or of Halling lime will be a good proportion for making mortar. The blue lias lime will not make good mortar if mixed with more than two cubic feet of sand to one of lime. It has been ascertained, by repeated experiments, that one cubic foot of blue lias lime from the kiln, weighing 47 lb., mixed with two cubic feet of sand, and about three-quarters of a cubic foot of water (4·68 gallons) makes mortar fit for use, but which cannot bear more sand without becoming too short; $2\frac{1}{3}$th cubic feet of mortar are produced from this mixture.

When the proportions of sand to lime is stated in the above manner in a specification, it is understood that the parts or proportions are by fair level measure for the lime, and by striken measure for the sand; and that the lime is to be measured in lumps, in the same state in which it comes from the kiln, without breaking it into small pieces or slaking. Attention to this is of some importance, because quick-lime from the kiln occupies, when pounded, a *smaller* space, and when slaked into powder a *larger* space than it originally filled.

* Trass, puzzolano, and other active agents, will be treated of in the chapter upon artificial hydraulic mortars and cements.

† Schist is often used as synonymous with slate; but it may be very useful to distinguish schistose and a slaty structure. The hypogene or primary *schists*, as they are termed—such as gneifs, mica-schist, and others, cannot be split into an indefinite number of parallel laminæ, like rocks which have a true slaty cleavage. The uneven schistose layers of mica-schist and gneifs are probably layers of deposition, which have assumed a crystaline texture.—Lyell's 'Principles of Geology.'

REPAIR OF A VESSEL'S BOTTOM WHILE AFLOAT.

The *Geyser*, steam sloop, has been taken into dock, and her bottom examined, as it was greatly injured by the vessel striking on the rocks at Ile Grand, about 50 miles from Janeiro. Fifty-four feet in length, and several planks in breadth, had been stove in by the accident, but her commander, by adopting a plan suggested by Mr. Moody, foreman of shipwrights at Woolwich Dockyard, the *Geyser* was repaired while afloat, and brought home safe to this country, although the injuries she sustained were within a short distance of the keel.

The following, which has been issued by the Admiralty, explains the mode of repairing the damage the *Geyser* sustained on a shore where she must otherwise have been left to her fate, as the tides only rise a few feet, and the great weight of her engines would have prevented her being drawn up on shore:—

"In obedience to directions to report the manner in which I proceeded to replace a defective sheet of copper on the bow of her Majesty's ship *Hyacinth*, the same being five feet below the light water-line, I beg to state, that on considering what means could be adopted for so doing, short of heaving the vessel out, it occurred to me that the principle of cofferdam might be applied to it. I accordingly caused a watertight case of three sides and a bottom to be made, ascertained the curve on the bow on each side of this defective part, and cut the mouth or open side of the case to fit it; and having lined or dressed the curved edges with felt, saturated with tallow, and attached ballast to the bottom, the case was suspended by a tackle to the rough tree rail, and lowered until the top was within a few inches of the surface, opposite the defective part, over which it was hauled by means of two hawsers, one placed vertically from the rough tree rail under the keel to the opposite side, the other horizontally from the quarter round to the stern to the opposite side, and both set taut with tackles. By these means the case was made to fit close to the bottom, where it was further secured by a shore, reaching from the side of the ship to its outer edge, to prevent its rising. The suction hose of a fire engine was then placed in the case, and the water contained in it pumped out. When empty two shipwrights descended, and removed the defective copper, replacing it with a new sheet. The operation, from the time of suspending the case until completed, did not occupy more than twenty minutes.

"This principle could be applied to the repairs of many defects under water, such as the wing cocks of ships, or the pipes in the bottom of steam vessels.

"W. Moody, Foreman of Shipwrights."

Malvern Improvement Act.—At a monthly meeting of the commissioners, Mr. W. Morison was unanimously elected surveyor and Mr. Henry Davis inspector under the new act.

Tynemouth Local Health Act.—Mr. Thomas Fenwick has been appointed by the corporation, surveyor. His salary is 100*l.* a-year, but his attention will not be strictly limited to the duties of that situation.

ARCHITECTURAL FUNCTIONS AND RESPONSIBILITY.

We have this week to notice the failure of two buildings which have tumbled down, one at Kensington and the other in Cannon-street, City.

The former more particularly claims our attention, because a point has been raised which is vital to professional interests. In this case life haviug been sacrificed, an inquest was held, and it appeared from the evidence given before the coroner, that in consequence of a heavy cornice being adopted and not being properly tailed on to the wall, with a sufficient balancing weight on the tailing to keep it down, it toppled over. Independently of this, another cause of failure was from the use of very inferior mortar, composed of lime and rubbish or mould dug from the foundation. Instead of constructing the core of the cornice and the brickwork above and beneath it in good cement, this stuff was employed, with the unsatisfactory result already adverted to. It further appears that an architect was employed by the owner of the buildings to superintend the construction, and that he was to be remunerated for his professional services at the rate of 15*l.* per house. From the evidence, we learn that the owner, the builder, and the architect were all informed of the dangerous character of the materials, and that Mr. Donaldson, the district surveyor, in particular, warned the parties; but none took any heed of the notice.

So far, Mr. Donaldson's course is clear; but we are now brought to a step of Mr. Donaldson's which requires further consideration, and the more particularly so, because we believe him to be wholly wrong in the doctrines he has propounded. We may say dangerously wrong, because Mr. Donaldson has that standing with the profession and the public, on account of his acknowledged attainments and services, that anything coming from him is likely to meet with acquiescence and be adopted as a rule of conduct. It is more particularly in reference to this influence, that we invite the attention of our readers to his evidence at the inquest.

The question was put by the coroner, "Is not the architect responsible for the proper execution of the works?" To this Mr. Donaldson is reported to have replied, "No! if there is not a proper clerk of the works employed."

Mr. Donaldson may have thought that 15*l.* per house being a very small fee to the architect, the latter is to be commiserated if any unfavourable result occurs; and he might, perhaps, be inclined to hold the owner as the greater culprit for having saved his purse. Whatever the ground of the opinion, we must, nevertheless, altogether dissent from it, because the effect of this doctrine is to throw off responsibility, while we consider it to be the duty of the professional man to court responsibiliy as the essential characteristic of his functions. We must earnestly maintain, that the architect is responsible, whether a clerk of the works is employed or not, and whether the architect is adequately remunerated or not. Who, indeed, in the profession, having charge of an arduous work, would be willing to take the responsibility of any clerk of the works for it; or would share with him the responsibility, the honour, and the emolument?

Look at it in whatever light we may, nothing can be more unfair to the public, nor more prejudicial to professional interests, than to maintain the doctrine of non-responsibility of the architect. If, to suit his own purposes, he makes any bargain for a fee, he must abide by it; but whether he has received a fee or not, he must give his best energies, for the sake of the public and of his own reputation, to insure the work being properly carried out. If he chooses to sew for nothing, and find his customers in needles and thread,—if he chooses to let the employer do without a clerk of the works, he must abide by the real contract, and submit to the whole responsibility. If, indeed, the architect be not responsible for the proper execution of the works, then anybody is an architect who can copy a drawing on paper, and supply it at 5*l.* or 5*s.* per house; and the architect may throw open his vocation to the world. If, too, persons are to be allowed to put their names to drawings for fees, which do not allow them to supervise the construction, or put their reputations in jeopardy, then clearly a monopoly must be given to persons who can employ a large number of clerks and draughtsmen, and turn out drawings by wholesale. Deprive the architect of this incident of responsibility, and he ceases even to be a decent artist.

The cause of the failure in Cannon-street, so far as we could judge from the inspection we made of the ruins, arose from defective application of good materials. The design of the architect seems to have been to avail himself of the alteration of the window duties, and obtain as great an amonnt of light as possible; but the practical operation of his views was not realised. The ground plot was about 40 feet by 13, having two faces to the streets, one flank on a new, and the longest abutting on an old building. On the longer front the lights were arranged in two compartments, the building being of four stories above the footway, with another in the curb roof. Each opening on the ground floor was about 14 feet, with an iron breastsummer. This carried a triplet window, with openings of about four feet, each divided by a stone post or stilt of about 7 inches by 10, and carrying a stone architrave of about 12 inches high by 7 inches wide, upon which rested a portion of the brickwork. The distance between the inner reveals was about 13 feet, over which was an iron girder behind the architrave, and carrying the brickwork of the three upper stories. These were disposed with two windows, and over the centre of the triplet a pier. The architrave seemed to have no connection with the iron girder, nor was there any tie across the building from the front to the party wall. We have very little doubt that stone work was laid on the top of this girder, and resting on the stone architrave of the windows. It is therefore evident, that if there were any pressure on the girder from the great superincumbent weight of the pier immediately over the centre, it would act on the top inner edge of the stone architrave and thrust it out, with the two stone stilts under, and consequently bring down the whole of the front. The result shows the importance of giving close attention to well tying together the whole of the building from front to back.

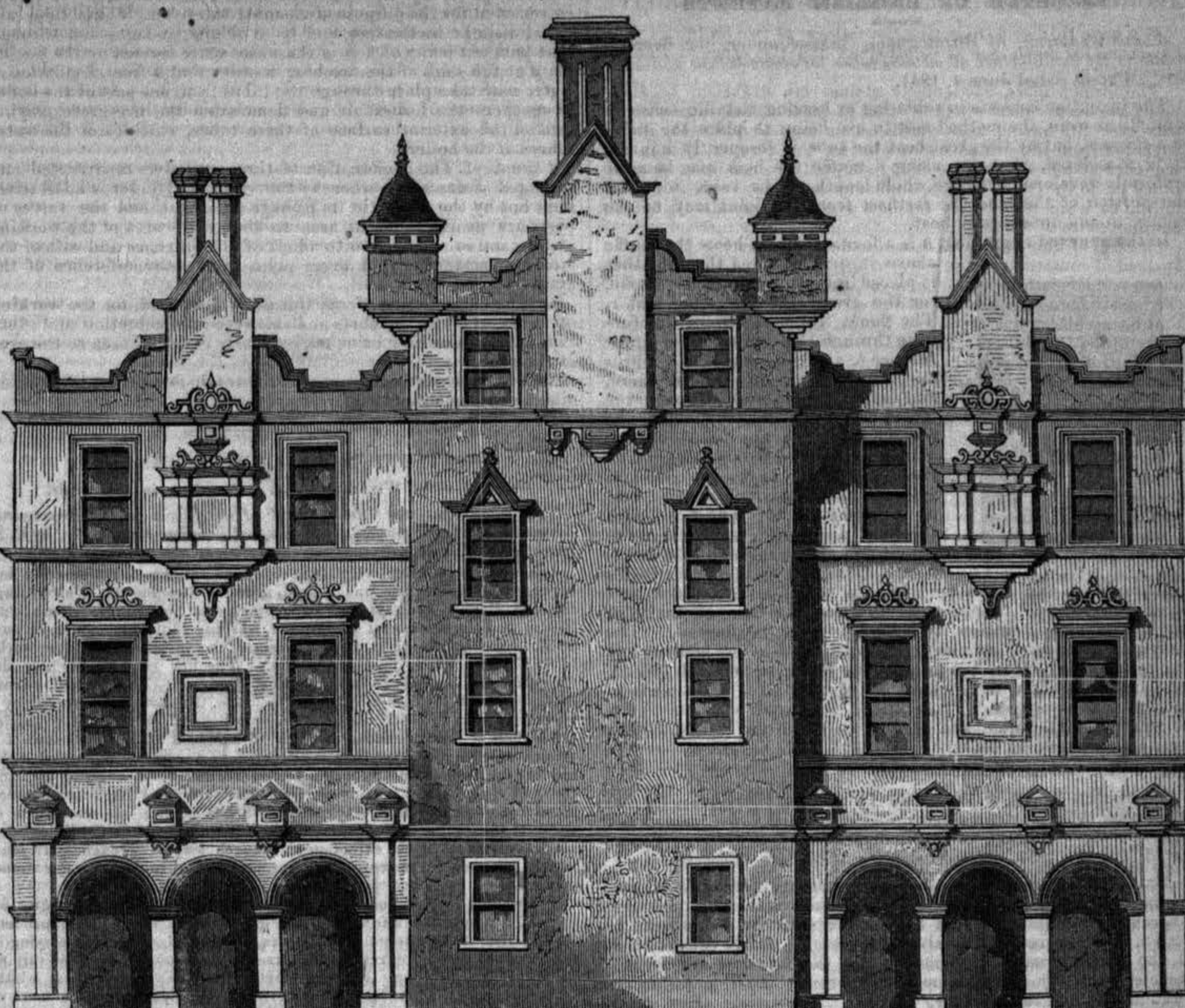
FOREIGN RAILWAYS.

The international commission for the construction of a railway through Central Italy, now assembled at Modena, has just published a preliminary notification, determining the line as follows:—Commencing at Piacenza, on the right side of the Po, it is to proceed north of the Via Emilia or Parmese postal road, intersecting the torrents Rifiuto, Nure, Riglio, Chiavenna, and Arda. Near Firenzola the railroad is to proceed in right lines connected by almost insensible curves, cross the torrent Stirione, touch at Borgo San Donnino, and cross the Taro near the great bridge of the Via Emilia. It is then to be continued in long sweeps till it reaches Parma; thence it is to enter the Modanese territory over the torrent Enoza, and touch at Reggio, where a branch is to be constructed to Mantua, touching at Guastalla, while the main line shall proceed to Modena and Bologna, where it is to meet the branch connecting it with Pistoia and Prato, on the Tuscan territory.

The following is the state of the railway lines between Strasburg and Vienna. Between those places, the lines from Kehl to Carlsruhe, from Studgard to Ulm, and from Augsburg to Munich, are open. Pieces of line remain unfinished between Carlsruhe and Studgard, and between Ulm and Augsburg. These portions will be completed by 1853, at which period the whole distance from Strasburg to Munich will be open to the public. As to the remaining portion—that between Munich and Vienna, a convention has just been concluded between Austria and Bavaria for the completion of the line between Munich and and Salsburg. From that place, the Austrian line will be taken over the Tyrolean Alps to Bruck-sur-la-Mur, where it meets the great line from Vienna to Trieste.

The directors of the Great Luxembourg state that, in consequence of the Belgian Legislature having recently sanctioned the act for the amendment of the concession, the position of the company is greatly improved. The railway commences in the most populous part of Brussels and proceeds in a direct line to Namur, a distance of 34 miles, nearly one-third of which is ready for the permanent way. A junction is to be formed at Namur with the Namur and Liege. The cost of constructing the line from Brussels to Namur, including plant, is estimated at 12,000*l.* per mile, and the time required by the contractors for completing the line is two years. There are to be two branches constructed from the main line, one from Louvain to Wavre, and the other to Charleroy. A guarantee for both these branches has been conceded. A *minimum* rate of interest of 4 per cent. has also been guaranteed upon the extension of the line to Arlon, by means of which the Luxembourg Railway will be placed in connection with the grand chain of railways commencing with the ports of Ostend and Antwerp, and running through Belgium, Wurtemberg, Bavaria, and Austria, to the Adriatic. For the construction of this extension the company have 60,000*l.* in hand, and the government guarantee takes effect on the opening of each successive section. The saving of distance effected by this route will be, between London and Trieste, 500 miles; between London and Vienna, 240 miles; and between London and Strasburg, 130 miles.

COWGATE PORT SCHOOL, EDINBURGH.—Architect, Mr. Black.



COWGATE PORT SCHOOL, EDINBURGH.

Architect, Mr. Black.

The engraving herewith given represents the Cowgate Port Schools, Edinburgh. The design is by Mr. Black, of that city, and will be interesting to our readers, as an example of the adaptation of the old Scotch domestic or Jacobean style to modern purposes, and which stamps it with a certain national character. That style of architecture prevailed from the latter end of the reign of Elizabeth to the beginning of that of Charles I., and was used by the architect who designed and constructed George Heriot's Hospital. It will be seen that the windows are much larger than those used by the inventors of the style, to suit the purposes and convenience of the building, it being for the use of schools, where light and ventilation were imperative.

The first story of the schools, on a level with and entering from the street of the Cowgate, is occupied with an open piazza, which is used as play-ground by the children attending the school on the floor immediately above it; as also a house for the keeper, and necessary conveniences for the scholars. The first floor above the street contains a class-room, 53 by 28 feet; another of smaller dimensions, for juvenile scholars; and a third, 28 by 20 feet, occupied by the female scholars learning sewing and knitting, &c; there are also conveniences for the scholars and teachers. This floor has accommodation for a roll of scholars amounting to four hundred, the average attendance being three hundred and sixty-two. The third floor enters from the high school yards, and from its difference in level (being upwards of thirty feet above the other street, and entering from a totally different locality), accommodates the children of a southern district of the city; otherwise it is similar to the class room entering from the Cowgate Port, and has attached an open court for play-ground, together with an area or square belonging to the public, from which the school is entered. There is a wing entering from the same play-ground, which is occupied by an infant school, accommodating a roll of one hundred and fifty scholars; the height of the ceiling is about 15 feet. The whole building is calculated for at least nine hundred children. The cost, including the purchase of site, was about 7000*l*.

Edinburgh abounds with valuable public institutions, and there is a disposition of late years to take the opportunity of restoring in new buildings the types of the earlier styles which prevailed in Scotland. This, to some extent, is a reflex of the mediæval movement here.

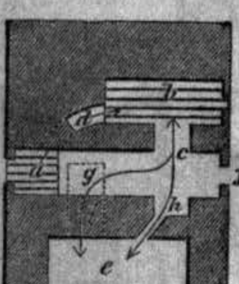
Royal Academy Architectural Medals.—The gold medal for the best design for a marine palace has been awarded to Mr. Robinson; the first silver medal, for the most accurate drawing of Bow Church, to Mr. J. T. Christopher; the second silver medal to Mr. Rowley; and the third silver medal to Mr. Snell.

REGISTER OF ENGLISH PATENTS

James Banister, of Birmingham, brass-founder, for *improvements in the manufacture of metallic tubes for steam-boilers and other uses.*—Patent dated June 7, 1851.

The invention consists in soldering or brazing metallic tubes in a muffle or oven, the method now in use being to place the tubes in a furnace, but by the great heat the tube is frequently injured. It is considered, that by using a muffle the heat may be more uniformly developed over the whole length of the tube, and that the portion of the tube the farthest from the joint may not be subject to any unnecessary heat.

In the annexed engraving, *a* is a furnace, which heats the muffle above it, and prepares the tube that is placed in that portion of the muffle, for the greater heat at the point *c*. The flame, &c., passes from this furnace through the flue *d*, into a larger furnace *b*, and combines with the products of combustion evolved there, and with them passes through the flue *c*, into and across the muffle, one portion going by the flue *h*, into the chimney *e*. The other portion passes through the muffle to the point *g*, where it passes through a flue *i*, into the chimney shaft. The tube, with the joint uppermost, is placed in the muffle, and drawn through by a workman stationed at *f*; the flame passes over the joint, and the solder begins to run at *g*, the greatest heat being evolved at *c*. The workmen, by looking through the tube, can see if the operation is being properly performed. The inventor recommends as a solder a mixture of a low-melting and a high-melting solder, the proportions being respectively, No. 1, 40 parts of spelter to 36 parts of copper; No. 2, 40 parts of spelter to 42 of copper. These are to be mixed, when in a powdered state, with borax, and applied in the usual manner. The tube is overlapped as usual.



Archibald Slate, of Woodside Ironworks, Worcester, for *improvements in steam-engines and steam-boilers, and in the passages and valves for the induction, eduction, and working of fluids.*—Patent dated May 27, 1851.—[*Reported in the Mechanic's Magazine.*]

Mr. Slate's improvements in steam-engines consist in a particular arrangement of the cylinder, slide-valve, and passages, whereby the cylinder is kept hot by the steam in its passage to action, and the area of the valve and ports is nearly equal to that of the entire area of the piston; and the passages are so constructed as to admit the steam simultaneously at all points in the circumference of the cylinder, whereby the complete effect of the steam in driving the piston is obtained, whatever may be the speed at which the engine is working.

In the arrangement described by Mr. Slate, three cylinders, concentric to each other, are employed. The interior cylinder is the working one; the middle cylinder constitutes the slide valve; and the external cylinder incloses the whole, and forms a space all round, into which the steam passes previous to its admission to the working cylinder. The ends of the slide valve have packing rings in contact with the external and working cylinders, and the valve is worked by rods passing through stuffing boxes in the cylinder cover. The action of the valve is that of the ordinary slide, and it may be termed a concentric piston valve.

pipes.

The same arrangement of parts is also applied to the working of fluids and gases; the slide valve, however, in the case of fluids, being formed without any lap; and when applied to the working of gases, the lap of the valve may be varied, and the valve may be divided into two parts, each actuated by a separate eccentric to suit the degree of pressure under which the engine may be working.

In constructing his steam-boilers, Mr. Slate makes a fire-box of double plate, leaving a water space of 3 or 4 inches between the plates, which he connects together at the top and sides of the fire-box with tubular stays closed at their outer ends, but open internally to the action of the flame and heated air in the fire box, so as to expose an extended surface to the heat, and thus increase the generative powers of the boiler. He also applies other tubes, of the full width of the fire-box, but passing through the two thicknesses of plate, and closed at their outer ends with plugs, which can be removed for the purpose of cleaning the tubes. These tubes are set at a slight inclination, and have oblong passages cut through that part of them which is in the water space formed by the double plate at the sides of the fire-box, in order that a free circulation of water may take place through the tubes from one part of the boiler to another—the heated air and flame from the fire-grate playing around the exterior surface of these tubes, which form the water spaces of the boiler.

Claims.—1. The combination of three cylinders constructed and arranged as described, whereby the working cylinder is at all times kept hot by the steam in its passage to action, and the valves or ports are nearly equal in area to the entire area of the working piston, and so arranged as to admit of the entrance and exit of the steam simultaneously at every point in the circumference of the cylinder.

2. The construction of apparatus, as described, for the working of fluids, whereby the ports and valves for the induction and eduction of the fluids may be equal, or nearly equal, in area to the area of the piston.

3. The construction of steam-boilers of double plates, intersected and strengthened by tubular stays.

INSTITUTION OF CIVIL ENGINEERS.

Dec. 9.—Sir William Cubitt, President, in the Chair.

The paper read was "*An Account of the Works on the Birmingham Extension of the Birmingham and Oxford Junction Railway.*" By C. B. Lane, Assoc. Inst. C.E.

The act for this line, which was intended to form the connecting-link between the Birmingham and Oxford, and the Birmingham, Wolverhampton, and Dudley Railways, and so complete the broad-gauge circuit with Bristol, and the south-west of England, was passed in the month of July 1846. Subsequent events, however, caused the suspension of these works in 1849, before their final completion. The line commenced near the Coventry-road, and was to have terminated at Great Charles-street. From Adderley-street to Park-street, both inclusive, the town was crossed by a viaduct; and from Moor-street to Monmouth-street, the line passed under the highest of the eminences on which Birmingham stands, by means of a tunnel, which was to have been constructed as a covered way—that is, by opening the ground, putting in the brickwork, and again covering up; and the part of it as yet completed, from Moor-street to High-street, being about 142 yards in length, was executed in this manner. It was 27 feet in width at the level of the rails, and was built entirely of Staffordshire brick set in mortar, with the exception of the arch lengths through Carr's-lane, which were set in cement. The average rate of progress in the tunnel was 8·1 lineal yards per week.

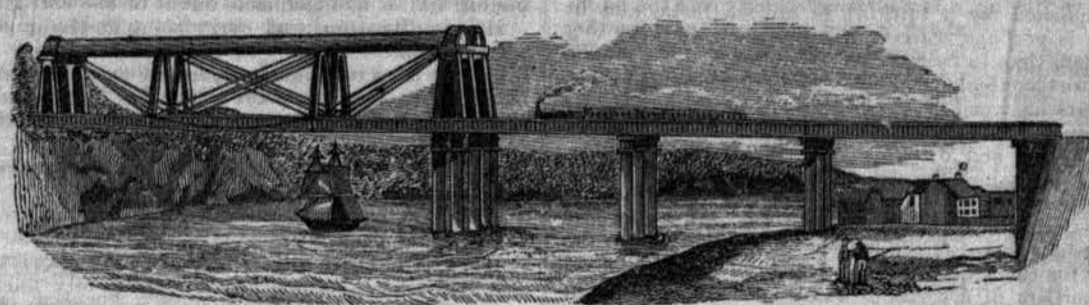
The viaduct consisted of fifty-seven openings, composed of nine segments, each 30 feet span and 6 feet rise; fifteen semicircles also 30 feet span and 15 feet rise; twenty-seven semi-ellipses, each 15 feet rise, and varying in span from 37 feet to 48 feet, and six street bridges, mostly skew, and varying in form, span, and rise. Its total length was 930 yards; general width, from face to face, 31 ft. 7½ in.; and between the parapets at the level of the rails, 29 feet. It was built entirely of brickwork set in mortar, with the exception of the soffit of the bridge over Park-street, which was constructed of cast-iron girders, with a cross-transomed memel flooring. The red brick of the district was used throughout the footings, the internal work of the piers, and the spandril walls; the arches and parapets were constructed of Staffordshire brick, from the "common stock"—the copings, mouldings, and dentals being made of Staffordshire brick clay; and the whole of the work was faced with Staffordshire "best blue." All the brickwork was set in moist mortar, so as to press to a thin joint; and in hot weather the bricks were kept constantly wet. The mortar used in the work was composed of the red sand of the locality, and Dudley or Greaves' blue lias lime, the latter being used in all foundations, arches, and face-work, mixed in the proportions of one part of slaked lime to two parts of sand, and worked by a steam-mill driven by a 4-horse power steam-engine, made by Mr. Nathan Gough, A.I.C.E., of Manchester. This mill was capable of supplying fifty bricklayers per day with a mortar of a perfectly even texture, entirely free from lumps, and therefore less likely to become vesicular, from the transfiltration of water, than that mixed by the common pug-mill. Each set of centres consisted of five ribs, each rib being supported on two vertical, and two sloping props, the former under the heels of the ribs, and the latter under the points, where the struts of the ribs terminated in an iron shoe. The laggings used were 3-inch deals, carefully dressed by the adze to the proper curves, and lined for the courses of the skew arches. Corbels of heading bricks were carried out from the backs of the arches in the range of the spandril walls, of equal width with them, and connected by brick beams from arch to arch, for stiffening and equalising the pressure from end to end of the viaduct; and the useful effect of this mode of construction was proved by the comparatively small amount of the settlements of the arches.

The author then proceeded to give a more particular description of the different works, for the drawings illustrative of which the isometric projection had been chiefly adopted, and the sections taken so that every dimension might be obtained; orthographic sections of the details were added, in some cases, in order to render the various parts more distinct. These drawings were made by the author's pupils of the first year, in the Engineering Class of Queen's College, Cork.

The various modes adopted, and mechanical contrivances used, for raising the materials to a considerable height, were described; and deductions were drawn from a very numerous series of experiments, to ascertain the values for the useful effect produced by the "Labouring Force" (Whewell), or "Travail Mécanique" (Poncelet), of a man under different modes of its application, and also for a horse under alternating motion over a short space. From these it appeared, that the relative costs of raising the materials to a height of 46 feet, by the horse-lift, the swing-lift, and the box-lift, were 3·08, 5·90, and 4·13 pence per ton respectively, showing a saving in favour of the horse-lift against the swing-lift, of nearly 3*d.* per ton, and against the box-lift of rather above 1*d.* per ton.

The communication was accompanied by a most elaborate series of tables on the absorption of water by bricks, by mortar, and by Shrewley sandstone—of the settlements of the arches of the street bridges—of the work performed by the various lifts, under different circumstances, with the concurrent particulars, and that by ordinary hod-men.

THE WYE GREAT RAILWAY BRIDGE AND VIADUCT.



The break that occurs at Chepstow in the railway communication on the South Wales Railway is now likely to be soon filled up by the completion of the great bridge (of which the above is an engraving, from *Herapath's Journal*), now in course of erection by Messrs. Finch and Willey, of Liverpool, over the Wye; but though no time can be fixed with certainty as to the period of its completion, still it is rapidly progressing. The structure is now so far advanced that an excellent idea of the bridge may be formed. Already numerous visitors have been to see it, and it will acquire a fame equal to that of the Britannia or Menai Bridge. The whole will be made of wrought-iron, and will combine the principles of the suspension with those of the tubular bridges. Including the viaduct, the bridge is 623 feet in length; the span or suspended part being 290 feet. There are two separate roadways, each being perfectly independent of the other, and their height is 70 feet over the river Wye at high water-mark, so that vessels can pass under. The roadways of the bridge are formed of iron, put together in plates, and in form they are similar to the tubes forming the Conway and Britannia tubular bridges; but, instead of being roofed in with cellular divisions of iron, there is for each roadway, and suspended above it, and at some distance, a strong cylinder of iron. It is suspended on piers, and from the extremities of this cylinder a looped chain runs under pins placed on each side of the roadway, in order to brace and support it. Likewise strong iron braces pass from the cylinder to each side of the tube, and from the top of each of these side supports to the bottom of the other, chains are placed for additional strength. On the Chepstow side the roadways rest on six upright iron cylinders, which have been filled with concrete, and driven firmly on a foundation of rock. The roadways on this side are continued in the form of a viaduct for about 300 feet more, resting upon these upright cylinders filled with concrete and firmly embedded. On the east side the roadways rest upon solid rock. The masonry is in a forward state. When finished to Milford the railway will be 163 miles in length.

NOTES OF THE WEEK.

Stephenson Monument.—At a meeting of the committee, held on Wednesday, it was resolved that the monument should be erected in the metropolis, and in or near the Euston-square terminus. Nearly three thousand pounds have been already received, including subscriptions from nearly five thousand workmen, whose contributions range from one penny to five shillings.

Paris.—The Municipal Council, in a recent sitting, adopted several measures relating to the prolongation or completion of some of the streets of Paris. The Rue du Cardinal Lemoine is to be prolonged as far as the Rue St. Victor; the Rue de Poissy is to be widened; the new entrance to the Garden of the Luxembourg, opposite the Rue Soufflot, is to be constructed so as to increase the width of the Rue d'Enfer by 8 mètres. The situation of the public works which the municipal authorities have at present in hand is as follows:—The expropriation of the first section of the houses to be demolished for the prolongation of the Rue de Rivoli is entirely terminated. The indemnities accorded by the jury to owners and occupiers amount to 7,027,864 francs. Many of the proprietors have availed themselves of the privilege allowed by the law to retain the plots of ground not required, and they intend at once to begin building on them. Some of these plots have been sold at the high rate of 600 francs the mètre. Measures have already been taken by the Prefect of the Seine for causing the demolition of eighty of the expropriated houses to be commenced on the 16th January next, and terminated the 15th of April. Later periods have been fixed for the demolition of clumps of houses in other streets; and the removal of all that are required will be terminated by the end of 1852. Thus the great enterprise of prolonging the Rue de Rivoli will be accomplished in seventeen months. As to the new Halles, the construction commenced two months ago is being continued. The preliminary operations for the expropriation of the houses comprised between the Rue aux Fers and the Rue Rambuteau, which are required for the Halles, are terminated, and have been submitted to the municipal council. It is supposed that the ground will be cleared by July for the commencement of the works. The widening of the Rues Sainte-Avoie and Montmartre is being actively continued. The houses still standing on the Place du Carrousel are about to be demolished. The levelling of the streets near the Hôtel-de Ville is being continued; and the street which is to put the Place Saint-Sulpice in communication with the Rue Saint-Germain-des Prés, is about to open.

Proposed Breakwater at Liverpool.—Mr. Rennie, C.E., has proposed the following scheme for a breakwater at Liverpool.—"The object of the proposed undertaking is the improvement of the port and harbour of Liverpool by means of a breakwater, to be projected from the Black Rock Point, in a line nearly parallel to the eastern shore. The breakwater will take a north-westerly direction, and rest upon the Brazil and North Burbo Banks, so as to leave open or close the Rock Channel, as may be deemed expedient. The advantages which would be derived from such a work would be, the deepening and maintaining the depth of the Victoria Channel, by the natural action of the tidal currents: the protection of the North Docks and Bootle Shore from the violent effects of prevailing winds, and the improvement of the navigation generally over the Bar; the raising of the Great Burbo and adjacent sand banks, and their probable conversion into many thousand acres of valuable land, along the whole shore of the Leaseowes, from Hilbre Island to Black Rock Point." At the last meeting of the Architectural and Archælogical Society some conversation arose upon this subject, during which it was stated that the Victoria and Rock Channels were rapidly filling up; that buoys which had been, three years ago, 600 yards apart, were now only at a distance of 200 yards from each other, and the question might yet be raised as to a safe outlet from Liverpool. Whether the advantages resulting from the proposed breakwater would be worth the cost was considered by some members rather doubtful.

ON THE DISCHARGE OF WATER OVER WEIRS AND OVERFALLS.

By THOMAS EVANS BLACKWELL, M. Inst. C.E.

[*Paper read at the Institution of Civil Engineers, May* 6, 1851.]

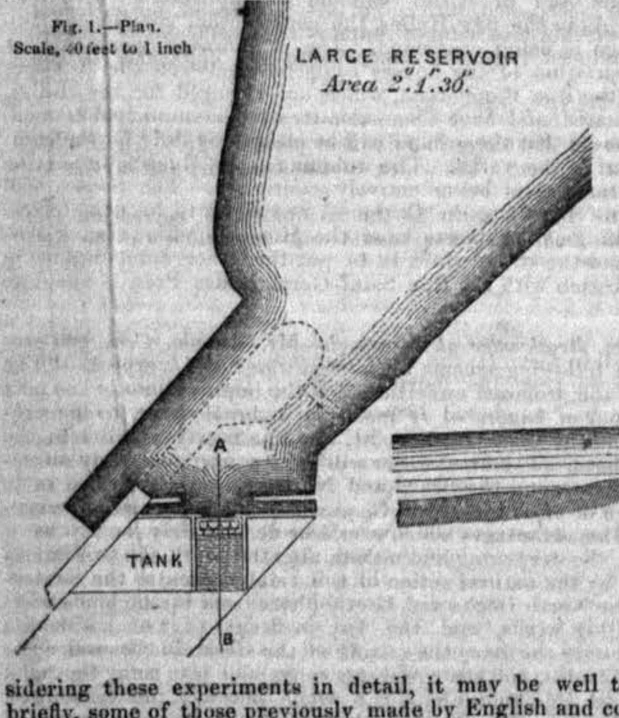
THE establishment of certain natural laws in hydraulics has occupied the attention of philosophers from the days of Galileo to the present time, and although the great principles which now form the groundwork of modern hydraulic science are indisputably settled, yet much remains to be done by practical men, towards applying the necessary corrections for special circumstances; this is only to be accomplished by a faithful record of facts, and in engineering there is perhaps scarcely a branch where there is a greater want of them than in that of hydrodynamics.

This deficiency was particularly felt by the author of this paper, in the case of weirs or overfalls, established, by order of parliament, for regulating and measuring the flow of water into a canal; and, as frequent doubts and disputes had arisen, the following experiments were undertaken for determining, by absolute trials, the discharge that might be expected from such orifices; and, as the opportunities for making such experiments are not of frequent occurrence, the results were carefully recorded, in order to submit them in detail for the consideration of the Institution.

The first set consists of a series of 243 experiments, made on overfalls of 3 feet, 6 feet, and 10 feet in width, with heads from 1 inch to 14 inches, and with the varying circumstances of having, for the overfall bar,—1st, a thin plate; 2ndly, a plank 2 inches thick; and, 3rdly, a crest 3 feet in breadth. These were all made on the Kennet and Avon Canal, in July 1850.

The second set was made in conjunction with Mr. Simpson (V.P. Inst. C.E.), who has kindly permitted the results to be placed on record. The series consists of about 70 experiments, made on an overfall of about 10 feet in width. These were made at Chew Magna, Somerset, also in the summer of 1850. Although in some respects, as being made over a bar 2 inches thick and 10 feet long, many of the experiments are apparently parallel in both cases, they must be separately considered, on account of some peculiar circumstances which will be stated. Before considering these experiments in detail, it may be well to review, briefly, some of those previously made by English and continental observers, and the practical deductions which had been arrived at by the writers on this subject.

Fig. 1.—Plan.
Scale, 40 feet to 1 inch



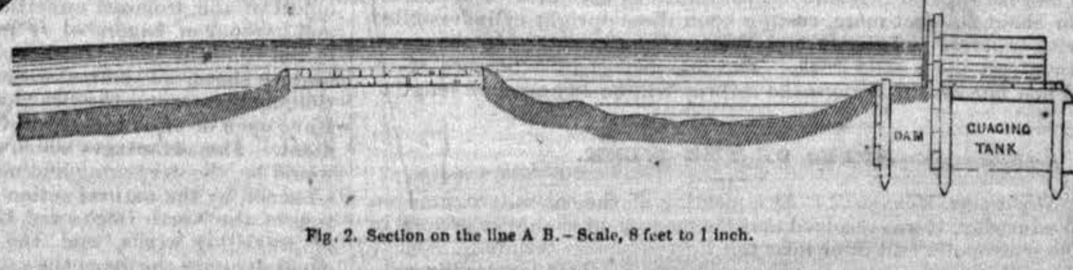


Fig. 2. Section on the line A B.—Scale, 8 feet to 1 inch.

The most scientific series of experiments on the discharge of fluids through orifices have been made by foreign observers, and their labours must be familiar to hydraulic engineers; but the Chevalier Du Buat, Eytelwein, MM. D'Aubuisson and Castel, and MM. Poncelet and Lesbros, have made the principal observations on the passage of water over weirs.

Those of Du Buat, in 1779, were but few in number, and were on overfalls of 18$\frac{3}{4}$ inches wide, and an extreme depth of 6$\frac{3}{4}$ inches.

In 1827 and 1828, MM. Poncelet and Lesbros made a very elaborate series of experiments, on the discharge of water by rectangular orifices. They were conducted in the fortifications at Metz. Of these, only thirty-six related to overfalls, or 'deversoirs.' The head of water was varied from about $\frac{3}{4}$-inch up to 8 inches, and the width was constantly about 7$\frac{3}{4}$ inches. They found that the coefficient for contraction was constantly varying, as the head was increased or diminished.

In 1834, MM. D'Aubuisson and Castel made a series of experiments, at the Toulouse waterworks, with overfalls which discharged water from a rectangular canal 29$\frac{3}{4}$ inches wide, and of variable depth. The widths of the apertures ranged upwards to the full width, and the head varied from about 1 inch to 8 inches.

Messrs. Smeaton and Brindley conducted a set of experiments, made over a waste board of the width of 6 inches, and from 1 inch up to 6 inches deep. These, and the experiments of Dr. Robison, quoted in the 'Encyclopedia Britannica," appear to be the principal observations made and published in this country.

A comparison of the results of the foregoing experiments, and the coefficients applicable to them and to the present experiments, is given in the Appendix.

The Kennet and Avon canal experiments were made on a reservoir, or side pond, measuring 2 acres, 1 rood 30 poles, or 106,200 square feet in area, with a lock at each end, so that there was not any current. The weather was uniformly fine, and during six-sevenths of the time, the wind was very slight, blowing somewhat diagonally up stream, or against the course of the overfall; during one day the wind was more rough, blowing exactly down the stream; such of the experiments made on that day, as are given in the tables, and are used in the calculations, are reduced to the standard of the others; a means of doing so being presented, by exactly parallel experiments, made on the more favourable days. It may not be uninteresting to know, that the coefficient of correction was found to be about 5 per cent.

The form of the overfall and its relative size and position on the reservoir, will be understood by reference to figs. 1 and 2, and the object in presenting this memoir being to give an accurate record of facts, which may be of practical utility, it is necessary to point out two or three special circumstances, which may possibly, to some slight extent, have influenced the discharge, though the observations made during the progress of the experiments, would induce the belief that such influence was very small. The first is, that the water supplied from the reservoir above the one on which the experiments were made, did not feed exactly in the same proportion as it was taken out; it was let in by the upper lock, three or four times a-day, or as often as was requisite. The area of the reservoir, however, was so large (106,200 square feet), that the difference of head between the beginning and the end of any one experiment, could scarcely be perceived. The second feature is, that at some little distance above the overfall, the depth of water was reduced, by a submerged course of masonry, belonging to the dock in which the trials were made, and which rose to within 18$\frac{3}{4}$ inches, or 20 inches of the surface. The third feature is, that the overfall was placed on the outer line of the dam, so as to obtain the requisite fall, and was not exactly in the line of one of the sides of the reservoir. These are circumstances which could not have been conveniently altered, without considerably increasing the expense of the experiments, and as the approach to the overfall was at least 40 feet wide, it was thought that the general arrangements would fairly represent the case of discharge of water by an overfall from a large, still reservoir.

Every care was taken to determine correctly the head of water acting in each experiment, and by such head is meant, throughout this paper, the total depth from the surface of the still water to the crest of the bar of the overfall. The bar forming the top of the overfall was made to rise or fall, and could be very accurately adjusted, by means of a hand-screw at each end; to this bar, which was about 12 feet in length and 2 feet deep, were fixed two gauge-rods, working in grooves, cut in a transverse beam above. The head having been determined on, the crest of the bar was brought exactly level with the still water in the reservoir; the line where the gauge-rods cut the top of the groove was marked with a pencil, and the required head was also measured and marked off on the gauge-rod. A man at each end then lowered the overfall bar down to the given head; the water was allowed to run through the waste trunk, till it had assumed a uniform regime, when at a given signal, the lid covering the gauging tank was raised, and the time of filling the tank to a given height was accurately observed. The time was kept by two and sometimes by three assistants, and it was registered to quarter seconds. The particular mode of obtaining the head was in some degree a matter of necessity, arising from the desire to avoid the waste of water out of the canal, in the larger experiments.

The gauging tank had a floor of brick, laid in cement, with plank sides, and was carefully measured; its total capacity was 444·39 cubic feet; in the experiments with very small heads, it was only filled to a certain height; whatever leakage there was into the guaging tank, during some of the experiments, was measured in a separate vessel, and in the tables of experiments correction is made for this, in taking the quantity discharged during each experiment.

The thin plate, mentioned in some of the experiments as forming the overfall bar, was a piece of iron fender plate barely $\frac{1}{16}$-inch thick; the plank, 2 inches thick, was square on the top, and the broad crest used was an apron formed of deal boards, roughly planed over and fastened on to the outer edge of the plank, so as to form an uninterrupted continuation of it; the object in this case was to approximate towards a well-constructed wide-crested weir, such as is found in rivers, &c.

The experiments tried in conjunction with Mr. Simpson, at Chew Magna, were made on a very small reservoir, which was kept constantly supplied by a pipe 2 feet in diameter, discharging from an upper reservoir, under a pressure of nearly 19 feet; the weather was generally fine, sometimes rather windy, but as the place was well sheltered by high walls, the effect of this was not much felt. In consequence of the distance between the discharge

Fig. 3. Plan.—Scale, 40 feet to 1 inch.

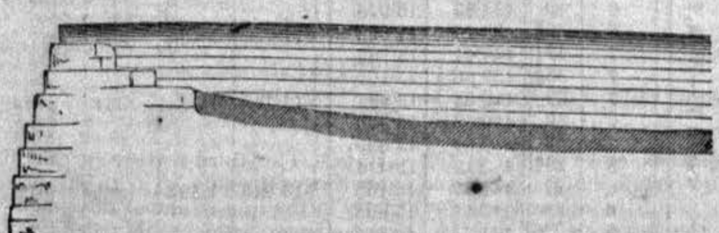


Fig. 4. Section through Overfall.—Scale, 8 feet to 1 inch.

pipe and the overfall being comparatively short (about 100 feet) the water must have retained some part of the velocity due to its discharge under so great a head; this was perceptible to the eye, in heads above 5 inches or 6 inches, but the peculiar form of the reservoir prevented the amount being accurately determined. The results, however, show that this influence must have been considerable, and that the effect of water approaching an overfall with an initial velocity is an element which should never be disregarded.

The form of this overfall reservoir is shown in figs. 3 and 4. It had wings placed at an angle of 45°, well adapted for facilitating the discharge, and the overfall bar was a cast-iron plate 2 inches thick, with a square top. The heads were measured on a bar 4 feet long, so placed diagonally in the still water that its zero was just level with the overfall top, and its upper end was raised 1 foot above. It was divided into twelve parts, which represented inches, and was again subdivided, so that each part was magnified four times, and one-sixteenth of an inch could be easily read. It was protected by a fender from the oscillations of the small waves in the reservoir. The time was kept by three and sometimes by four observers, who differed but little in their registers, of which a mean was taken. The gauging-tank was a very good one, constructed for the purpose, of brick in cement, and built to hold 400 cubic feet; but by accurate admeasurement it was found to contain 389·79 cubic feet, and this quantity is used in the calculations. In this, as in the former set of experiments, efficient means, which it is not necessary to detail, were used for conveying the water from the overfall to the tank, for registering the leakage, &c.

Proceeding, then, to an explanation of the tables, it may be remarked, that the observations have been classified under the several descriptions—viz., over a plank 2 inches thick, with square edges,—over a thin plate,—over a crest, resembling the top of a weir, of which the breadth was 3 feet, the position of the surfaces horizontal—and also at inclinations, downwards, of 1 in 18, and 1 in 12, respectively. These main divisions were observed throughout, and the lengths of the weirs were severally 3 feet, 6 feet, and 10 feet. The first column in the table of experiments shows the head, or difference of level between the top of the overfall bar, or crest, and the level of the still water in the reservoir. The second column shows the duration of the experiment in seconds. The third column shows the absolute quantity of water discharged during the experiment, correction having been made for the leakage if any occurred. The fourth column is the reduction of the two preceding columns into cubic feet per second. The fifth is the reduction of the several results of similar experiments, with the same head and length, as shown in the former column, to an average of cubic feet per second. The sixth is a reduction of the discharge, so ascertained, into cubic feet per second, for each foot of width. The seventh column contains the coefficient of correction (m), deduced from the experiments and applicable to the formula—

$$Q = \sqrt{2g\,H} \times l\,H \times m \quad . \quad . \quad . \quad . \quad . \quad \text{(I.)}$$

in which Q is the discharge in cubic feet per second; $\sqrt{2g} = 8·03$; H, the head in feet; l, the width of the overfall; and m, the coefficient of correction.

The eighth column contains the coefficient of correction (k) deduced also from the experiments and applicable to the formula*—

$$H^{\frac{3}{2}} \times l \times k. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad \text{(II.)}$$

in which Q is the discharge in cubic feet per second; l, the width of the overfall in feet; H, the head in inches, or the height of the still water in the reservoir, above the crest of the overfall.

[Two columns, numbered respectively 9 and 10, were given in Mr. Blackwell's paper, but the particulars recorded not being taken in all the experiments, we have thought proper to omit them; the following may, however be stated as the results arrived at in those which were observed]:—First, that the head of water, above an overfall, may be ascertained approximately, but only so, by the insertion of a 2-foot rule, held against the stream on the overfall bar, and observing the height to which the water rises, as the total head above the crest.—Secondly, that the thickness of the blade of water, relatively to the total head, was much less than that which Du Buat assumed, in the theory on which his formula was based; which was, that this thickness was equal to half the total depth, from the crest to the top of the water. Indeed, it much more nearly agreed with the results which Professor Robison has recorded, and which he gives as about five-sevenths of the total depth. In the present experiments it was found, that, in the case of the plank overfall 2 inches wide, the thickness varied from six-tenths to eight-tenths, following the law of increase, as the total head increased. The exact ratios are inserted in the tables of ex-

* This formula is the same as that in general use among English engineers—viz., $D = H^{\frac{3}{2}} \times 5\,1$, in which D, is the number of cubic feet discharged per minute for every foot in width of the overfall. H, the head in inches 5·1 the *constant* coefficient of reduction. (The *variable* value of the coefficient (k) is, however, shown in these experiments

periments. In each of these cases, the admeasurement was taken at the outer edge of the bar, or at the lower end of the apron.

With a view of ascertaining how nearly the discharges of water follow the natural parabolic law, several curves were projected, in which the abscissæ represented the quantities discharged per second, under the various heads shown by the corresponding ordinates. From these it was seen, that though they evidently followed the fundamental law, yet the various opposing forces called into play, as the heads and widths increased or decreased, produced anomalies and variations from that curve, which entirely destroyed its regularity.

The whole of the coefficients given in the tables have been plotted, in such a manner as to show the mean coefficient for each set of experiments, and the variations for each change of head. This method shows in a striking manner, that no formula with a constant coefficient will give the true discharge of water by a weir. It is also interesting to observe, that whereas, in some instances, the coefficient is higher with a small head, and decreases as the head increases, in others the reverse takes place. Thus it will be seen, that where the overfall bar was a piece of thin plate, with a head of 1 inch, the coefficient was considerably higher than the mean; whilst a similar length of overfall, consisting of a plank 2 inches wide, gives the coefficient as much less than the mean; again, whilst the coefficient for an overfall formed of a plank 2 inches wide and 3 feet long, with a head of 1 inch, gives a coefficient of ·331, the same head and length of crest of 3 feet, gives only ·301 as a coefficient.

Experiments on Overfalls, Kennet and Avon Canal.

Overfall.	Total Depth of Water above Crest, in inches	Time in seconds	Cubic Feet Discharged. Total Quantity.	Per Second.	Average per Second.	Per Second for 1 foot in width.	Coefficients. m	k
TABLE I.—A thin Plate, 3 ft. long.	1	176½	45·97	·260	·260	·087	·451	·087
	2	124½	91·94	·739	·739	·246	·450	·087
	3	72¾	91·94	1·264	1·264	·421	·420	·081
	4	96	182·94	1·906	1·906	·635	·411	·079
	5	99½	259·01	2 603	2 603	·868	·401	·078
	6	131¼	441·77	3·366	3·366	1·122	·395	·076
						Mean	·421	·080
TABLE II.—A thin Plate, 10 ft. long.	1	177½	183·90	1·038	1·038	·104	·539	·104
	2	63	183·90	2·920	2·920	·292	·535	·102
	3	103¼	444·39	4·304				
	3	62	260·50	4·201	4·286	·429	·428	·082
	3	42¼	183·90	4·352				
	4	65½	442·43	6·755	6·755	·675	·437	·089
	5	47½	442·03	9·355	9·355	·935	·433	·083
	5	47¼	442·03	9·355				
	8	26	441·77	16·988	16·909	1·691	·387	·075
	8	26½	441·77	16·830				
	9	24	441·99	18·416	18·416	1·842	·353	·069
						Mean	·445	·086
TABLE III.—Plank, 2 inches wide, 3 feet long	1	757	137·91	·181				
	1	280¾	45·97	·164	·180	·060	·311	·060
	1	235	45·97	·195				
	2	167	91·94	·550	·555	·185	·339	·065
	2	164	91·94	·561				
	3	159	183·90	1·157				
	3	82½	91·94	1·114	1·138	·376	·375	·072
	3	80½	91·94	1·143				
	4	147½	259·00	1·756	1·695	·565	·366	·071
	4	158½	258 92	1·634				
	5	172½	442·67	2·566	2·537	·846	·392	·076
	5	176½	442·63	2 508				
	6	131½	443·07	3 370	3·363	1·121	·395	·076
	6	132	443·07	3·356				
	7	100½	442 38	4·402	4·413	1·471	·411	·074
	7	100	442·39	4·424				
	8	83½	442·30	5 297	5·297	1·766	·404	·078
	8	83½	442·30	5·297				
	9	70¾	442·62	6 256	6·256	2·085	·400	·077
	10	58¾	442·92	7·539	7·492	2·497	·409	·079
	10	59½	442·99	7·445				
						Mean	·380	·073

Experiments on Overfalls, Kennet and Avon Canal.

(Continued.)

Overfall.	Total Depth of Water above Crest, in inches.	Time, in seconds	Cubic Feet Discharged. Total Quantity.	Per Second.	Average per Second.	Per Second for 1 foot in width.	Coefficients. m	k
TABLE IV.—Plank, 2 inches thick, 6 feet long	1 to $\frac{1}{16}$	487½	171·28	·354	·354	·059	·306	·059
	2	137½	184·34	1·317	1·222	·204	·374	·072
	2	159	179·76	1·128				
	3	184½	439·60	2 383				
	3	183½	439 62	2·396				
	3	184	439·61	2 389	2·396	·399	·398	·077
	3	183½	439·62	2 396				
	3	181½	439·68	2·422				
	3	184	439 61	2·389				
	4	127	439·31	3·463	3·563	·594	·383	·074
	4	120	439 60	3 663				
	5	82¾	442 24	5·359				
	5	86¼	442·15	5·126	5·209	·868	·401	·078
	5	86	442·16	5·141				
	6	64¼	442·72	6·890	6·890	1·150	·405	·074
	6	64¼	442·72	6 890				
	7	49¼	443·11	8·997				
	7	51½	443·06	8 631	8 695	1·449	·405	·073
	7	52	443·04	8·520				
	7	51½	443 06	3·631				
	8	43	443·27	10·309	10·309	1·718	·393	·076
	8	43	443 27	10·309				
	9	37½	443·41	11·850				
	9	37¼	443·41	11·850	11·850	1·975	·379	·073
	9	37½	443·41	11·850				
	10	34¼	443·03	12·950	13·156	2·193	·359	·069
	10	33½	443·07	13·363				
	12	26¾	443·32	16·515	16 356	2 726	·350	·066
	12	27¼	443·30	16·207				
	14	20¼	443 58	21·890	22·183	3·697	·366	·071
	14	19¾	443·60	22·477				
						Mean	·377	·072
TABLE V.—Plank, 2 inches thick, 10 feet long	1	230	152·62	·665	·563	·056	·290	·056
	1	454¾	207·30	·461				
	2	81½	172·82	2·125	2·129	·213	·390	·075
	2	81	172·89	2·134				
	3	47	177·51	3·777				
	3	46	177·65	3·862	3 803	·380	·379	·073
	3	48	177·38	3·695				
	3	111¼	431·38	3·877				
	4	67½	436·53	6·491				
	4	67½	436·50	6 468				
	4	72¾	440·76	6·059	6·192	·619	·401	·077
	4	73½	440·72	5·996				
	4	73	440·74	6 038				
	4	73¼	440·73	6·098				
	5	48¾	438·69	8 998				
	5	50¼	438·52	8·726	8·774	·877	·406	·078
	5	51	438·43	8·597				
	6	41¾	438·72	10 512				
	6	40	438 95	10·976	10 881	1·088	·384	·074
	6	40	438·95	10·976				
	6	39¾	439 74	11·063	11·063	1·106	·384	
	7	32¼	440·01	13·780				
	7	33¾	439 80	13·164				
	7	32	440·04	13 887	13·720	1·372	·384	·074
	7	32	440·65	13·885				
	7	32	440·65	13·885				
	8	28¾	440·48	15·474				
	8	27	440·12	16·463	15·943	1·594	·365	·071
	8	28	440·59	15 893				
	9	22½	441·33	19·613				
	9	23¾	441·16	18·575	19·417	1·942	·372	·072
	9	22	441·40	20·063				
	10	20	441·67	22·083				
	10	21	441·54	21·026	21·737	2·174	·356	·069
	10	20	442·05	22·102				
	12	15½	442·29	28·529	28·521	2·853	·356	·069
						Mean	·371	·072

Experiments on Overfalls, Kennet and Avon Canal.
(*Continued.*)

Overfall.	Total Depth of Water above Crest, in inches.	Time in seconds	Cubic Feet Discharged. Total Quantity	Per Second.	Average per Second.	Per Second for 1 foot in width.	Coefficients. m	k
VI. Plank, 2 in. wide, 10 ft. long*	5	$45\frac{3}{4}$	442 11	9·664		0·966	·447	·086
	4	$65\frac{1}{2}$	441·77	6 745		0 674	·437	·088
	2	106	260 50	2 460		0·246	·450	·087
	1	190	183 90	0 968		0 097	·503	·097
						Mean	·459	·090
VII. Crest, 3 ft. wide, 3 ft. long, slope 1 in 12.	1	$254\frac{1}{2}$	45·97	·181	·181	·060	·311	·300
	2	$236\frac{3}{4}$	137·91	·582	·582	·194	·355	·069
	3	$170\frac{1}{4}$	183·90	1·080	1·080	·360	·359	·069
	4	$188\frac{1}{2}$	257·75	1·404	1·404	·468	·303	·0585
	6	$146\frac{1}{2}$	441 46	3·014	3·014	1·005	·354	·068
	7	$117\frac{1}{2}$	442 04	3·762	3·762	1·254	·351	·068
	9	$85\frac{1}{4}$	442·26	5·188	5·188	1·729	·332	·064
						Mean	·338	·065
VIII. Crest, 3 ft. wide, 3 ft. long, sloping 1 in 18.	1	$218\frac{3}{4}$	45·97	·210	·210	·070	·363	·070
	2	$230\frac{3}{4}$	137 91	·597	·597	·199	·364	·070
	3	$170\frac{3}{4}$	183·90	1·077	1 077	·359	·358	·069
	4	194	257·58	1·328	1·328	·443	·287	·055
	5	$197\frac{1}{2}$	440·44	2·230	2·230	·743	·344	·066
	7	$120\frac{1}{2}$	441·98	3·667	3·667	1·222	·342	·066
	8	$103\frac{1}{4}$	441·81	4·279	4·279	1·426	·327	·063
	9	$86\frac{1}{2}$	442·23	5·112	5·127	1·709	·328	·063
	9	86	442·24	5·143				
						Mean	·339	·065
IX. Crest, 10 ft. long, 3 ft. wide, sloping 1 in 18.	1 to $\frac{7}{8}$	282	169 80	·603	·603	·060	·311	·060
	2	$138\frac{1}{4}$	253·59	1·834	1·805	·181	·330	·064
	2	$100\frac{1}{2}$	178·88	1·777				
	4	83	440·24	5·304	5·304	·530	·343	·066
	6	43	442·24	10·285	10 285	1·028	·362	·070
	8	30	442·89	14·761	14 761	1 476	·338	·066
						Mean	·337	·065
X. Crest, 3 ft. wide, level, and 3 ft. long.	1	$265\frac{1}{2}$	45·97	·173	·173	·058	·301	·058
	2	350	183 90	·525	·525	·175	·321	·062
	3	294	260·50	·886	·886	·295	·294	·057
	4	200	258·50	1 292	1·292	·431	·279	·054
	5	$213\frac{1}{2}$	441·19	2·066	2·066	·689	·319	·061
	6	158	441·23	2·892	2·840	·947	·334	·064
	6	$65\frac{1}{2}$	182 59	2·788				
	7	$126\frac{3}{4}$	441·86	3·486	3·486	1·162	·325	·060
	$7\frac{7}{8}$, 8	108	441·69	4·089				
	8	$107\frac{1}{2}$	441·71	4 109	4·109	1·369	·313	·061
	9	$89\frac{3}{4}$	442·15	4·926	4 926	1·642	·317	·061
						Mean	·311	·060
XI. Crest, 3 ft. wide, level, and 6 ft. long.	1 to $1\frac{1}{4}$	405	173·37	·429	·429	·071		
	3	$222\frac{1}{2}$	438·52	1·973	1·971	·329	·328	.063
	3	$223\frac{3}{4}$	438 58	1 961				
	3	$221\frac{3}{4}$	438 63	1·978				
	4	142	438 72	3·019	3 068	·511	·331	·064
	4	144	438·64	3·045				
	6	$77\frac{1}{2}$	442·38	5 781	5·781	·963	·008	
	7	$61\frac{3}{4}$	441·61	7·150	7·150	1·191	·331	·060
	9	$44\frac{1}{2}$	443·24	9·964	10·019	1·670		
	9	44	443·25	10·074				
	0	39	442 84	11·360	11·360	1·895	·310	·060
	0	39	442·84	11·360				
	2	$29\frac{3}{4}$	443·21	14 900	14·965	2·495	·311	·060
	2	$29\frac{1}{4}$	443·21	15·030				
						Mean	·322	·061
Table XII. Crest, 3 ft. wide, level, and 10 ft. long.	1	$339\frac{1}{2}$	166·93	·092	·492	·049	·254	·049
	2	$101\frac{1}{2}$	178·83	1·762	1·736	·174	·319	·061
	2	$104\frac{1}{2}$	178·68	1·710				
	5	$59\frac{1}{4}$	441·43	7·450	7·450	·745	·345	·066
	6	$45\frac{1}{2}$	442·12	9·717	9·717	·972	·342	·066
	8	$32\frac{1}{2}$	442 77	13·622	13·622	1·362	·312	·060
	9	$26\frac{1}{4}$	443·08	16·879	16.879	1 688	·324	·063
	80	24	443·19	18·467	18.467	1·847	·303	·059
						Mean	·314	·061

* With wing boards converging at an angle of 64°.

TABLE XIII. *Experiments on Overfalls, Chew Magna.*
Overfall Bar, 2 in. wide, 10 ft. long.

Total Depth of Water above Crest, in Inches.	Time, in seconds	Cubic Feet Discharged. Total Quantity	Per Second.	Average per Second.	Per second for 1 foot in width.	Coefficients. m	k
1 to $\frac{7}{8}$	$560\frac{1}{2}$	384·71	·690	·690	·069	·394	
1 to $1\frac{1}{16}$ b	469	384·71	·820	·860	·086	·417	
$1\frac{1}{16}$ bare	439	384·71	·870				
$1\frac{1}{16}$ good	$434\frac{1}{2}$	384·71	·880				
$2\frac{3}{16}$	$139\frac{1}{2}$	398·79	2·900	2·900	·290	·455	
$2\frac{1}{4}$	$133\frac{3}{4}$	385·79	2·900				
$2\frac{3}{4}$ good	$98\frac{1}{2}$	383·71	3·906	3·906	·391	·443	
2[illegible]	98	383·71	3·916	4·016	·402	·447	
2[illegible]	$97\frac{1}{2}$	383·71	3·916				
2[illegible]	$97\frac{1}{2}$	383·71	3·950				
2[illegible]	$97\frac{3}{4}$	383·71	4·104				
2[illegible]	$97\frac{1}{2}$	383·71	4·104				
2[illegible]	$97\frac{3}{4}$	383·71	4·104				
$2\frac{7}{8}$	$93\frac{1}{2}$	383·71	4·115	4·115	·412	·437	
2[illegible]	$92\frac{1}{2}$	383·71	4·148	4·148	·415	·435	
$2\frac{15}{16}$	$94\frac{1}{2}$	398·79	4·231	4·231	·423	·436	
3 bare	82	385·71	4·700	4·700	·470	·469	
3 to $3\frac{1}{16}$	80	385·71	4·820	4·820	·482	·483	
4 bare	$52\frac{1}{2}$	385·71	7·340	7·340	·734		
4	50	385·71	7·710	7·680	·768	·497	
4	50	385·71	7·710				
4	$50\frac{1}{2}$	384·71	7·620				
$4\frac{1}{4}$	46	383 71	8·342	8·358	·836	·495	
$4\frac{1}{4}$	46	383·71	8·342				
$4\frac{1}{4}$	$45\frac{7}{8}$	383·71	8·390				
$4\frac{3}{16}$	45	383·71	8·530				
$4\frac{5}{16}$	$44\frac{1}{2}$	387·75	8·770	8·770	·877	·507	
$4\frac{5}{16}$	$43\frac{7}{8}$	386·71	8·890				
$4\frac{5}{16}$	$43\frac{3}{4}$	386·71	8·890				
$4\frac{3}{8}$	44	383·71	8·721	8·721	·872	·494	
$4\frac{7}{16}$	$41\frac{3}{4}$	383·71	9·190	9·017	·902	·500	
$4\frac{7}{16}$	$42\frac{1}{4}$	383·71	9·090				
$4\frac{7}{16}$	$43\frac{1}{2}$	385·71	8·870				
$4\frac{7}{16}$	$43\frac{1}{4}$	385·71	8·920				
$4\frac{1}{2}$ bare	$43\frac{3}{4}$	385·71	8·820	8·887	·889	·483	
$4\frac{1}{4}$ bare	$43\frac{1}{2}$	385·71	8·870				
$4\frac{1}{4}$ bare	43	385·71	8·970				
5 bare	34	383·71	11·290	11·290	1·129	·520	
$5\frac{5}{16}$	$33\frac{1}{2}$	383·71	11·460	11·460	1·146	·521	
$5\frac{13}{32}$	$31\frac{3}{4}$	383·71	12·086	12·086	1·209	·499	
$5\frac{7}{16}$ to $5\frac{15}{32}$	31	383·71	12·380	12·380	1·238	·501	
	31	383·71	12·380				
$5\frac{15}{16}$	$28\frac{1}{2}$	385·71	13·530	13·530	1·353	·485	
6	$27\frac{1}{4}$	385·71	14·150	14·150	1·415	·499	
6	$27\frac{1}{4}$	385·71	14·150				
$6\frac{3}{16}$	$28\frac{1}{2}$	399·79	14·030	14·030	1·403		
$6\frac{3}{16}$	$27\frac{3}{4}$	398·79	14·370	14·030	1·443	·499	
$6\frac{3}{16}$	$27\frac{1}{2}$	398·79	14·500				
$6\frac{3}{16}$ to $6\frac{1}{4}$	$26\frac{3}{4}$	399·79	14·900	14·900	1·490	·498	
$6\frac{15}{16}$	$21\frac{1}{4}$	385·71	18·150	18·150	1·815	·515	
$6\frac{15}{16}$	$21\frac{1}{4}$	385·71	18·150				
$7\frac{21}{32}$	$20\frac{1}{2}$	398·79	19·450	19·610	1·961	·478	
$7\frac{21}{32}$	$20\frac{1}{4}$	398·79	19·690				
$7\frac{21}{32}$	$20\frac{1}{4}$	399·30	19·690				
8	$16\frac{1}{2}$	385·71	23·380	23·380	2·338	·535	
8	$16\frac{1}{2}$	385·71	23·380				
8 to $8\frac{13}{16}$	$15\frac{1}{2}$	384·71	24·820	24·820	2·482	·491	
$8\frac{15}{16}$	$15\frac{1}{2}$	384·71	24·820	24·820	2·482	·500	
9	14	385·71	27·550	27·550	2·755	·521	
9	..	..	..				
9	..	383·71	27·550				
					Mean	·480	

The first twelve tables give the results of the experiments made on the Kennet and Avon Canal, where the reservoir was large, in proportion to the overfall, and the water was still.

Table XIII. contains the result of the experiments made at Chew Magna, in Somersetshire, in which the reservoir was very small, in proportion to the overfall, and it was kept continually supplied by a pipe 2 feet in diameter leading from a reservoir 19 feet above it. The columns, in this case also, have the same signification as those relating to the experiments on the Kennet and Avon Canal.

Additional Observations, forming Columns 1, 9, and 10 in the original Tables, Kennet and Avon Canal.

Thickness of sheet of water taken at the outer edge of overfall plank, or, where there was a wide crest, at the outer end of such crest.

The 1st column is the total depth of water above crest, as given in the Tables.

The 2nd column shows the height the water rose against a 2-ft. rule held flatways against stream

The 3rd column shows the height the water rose against the brass slide of a rule held edgeways.

Height above crest.	Flat rule.	Edge rule.
	TABLE III.	
1	1	3/8
1	1	5/8
4	4 1/4	3
4	4	2 11/16
5	5	3 1/2
5	5	3 1/2
6	6	4 7/8
6	6	4 3/8
8		6 3/8
	TABLE IV.	
2	1 1/4	
3	3	1 15/16
4	5	3 1/2
5		3 5/8
6		4 3/8
7	5 1/8	
8	6 1/2	
9	6 3/4	
	TABLE VII.	
1	1 1/2	1/4
4	6	1 1/2
6	8	1
7	9	2 3/8
	TABLE VIII.	
4	5 1/2	1 3/8
5	7	1 3/4
7	8	2 1/8

Height above crest.	Flat rule.	Edge rule.
	TABLE IX.	
7/8 to 1	1 1/4	5/16
2	3 3/4	9/16
2	3 1/2	9/16
4	5	1 1/8
6	8 1/4	2 1/4
8	9	3 1/2
	TABLE X.	
1	1	7/16
2	2	7/8
4	4 1/4	1 3/8
5	5	2 1/4
6	6	2 1/8
6	6	2 3/8
	TABLE XI.	
1 to 1 1/4	1 1/8	1/2
3	3	1 1/8
3	2 7/8	1 1/4
6	6	2 3/4
9	8 1/4	4 1/2
	TABLE XII.	
1	7/8	7/16
2	2	7/8
2	2	13/16
5	5	1 3/4
6	6	2 3/8
8	7 1/2	3 5/8
9	8 1/2	3 1/2
10	9	4

One of the general laws that appears to be indicated by these experiments, is that in thin plates, the coefficient is highest at the smallest head observed, and that it reaches the mean, at a head of about 3 inches; after which it continues to decrease as the head increases.

For a plank 2 inches thick (which represents the ordinary form of wasteboard), these experiments show, that beginning with a head of 1 inch, the coefficient is less than the mean; that it reaches its mean earlier, as the length of the weir is greater, being in average cases at about the head of 3 inches; and that it then rises higher than its mean, till it reaches the head of about 9 inches; when it is again depressed below the mean.

One remarkable circumstance was found to prevail in a great number of these experiments, viz., that the head of about 4 inches gave a less quantity than could be arrived at by interpolating the results of the experiments with heads of 3 inches and 5 inches. It is not easy to explain the causes tending to produce this depression; but the fact was striking and well established.

A similar result occurred, at about the same head, in the other set of experiments made at Chew Magna.

A few experiments, which were made for ascertaining the effect of converging wing-walls, will demonstrate the great advantages known to be attendant on such a form, as will be seen by comparing the results on the weir of 10 feet in length with and without such wings. The mean coefficients for the two cases were 371 without, and 459 with the wings; the splay of the wings being an angle of 54°.

The circumstance attending the set of experiments at Chew Magna makes the discharges of them analogous to the case of a weir in a river, or in a running stream; but among themselves there are anomalies equally remarkable with those on the canal. The overfall bar was here invariably 2 inches thick, and the length was always 10 feet. The coefficients, up to a head of 3 inches, are below the mean; above that head they fluctuate considerably; but generally they keep above the main line. These anomalies are difficult to account for; the experiments having been very carefully made, and such causes of error as might have arisen are not sufficient to explain them; they are therefore left as facts, to be added to, or elucidated, by the researches of others.

APPENDIX.

TABLE *showing the Variation of the Coefficients for different Species of Overfall.*

Species of Overfall.	Length in feet.	Mean Coefficients m	k
Thin Plate	3	·421	·080
„	10	·445	·086
Plank 2 inches wide	3	·380	·073
„ „	6	·377	·072
„ „	10	·371	·072
„ „ (with wings) ..	10	·459	·090
Bar 2 inches wide (Chew Magna)	10	·480	
Crest 3 feet wide, slope 1 in 12,	3	·338	·065
„ „ 1 in 18,	3	·339	·065
„ „ „	10	·337	·065
„ „ Level	3	·311	·060
„ „ „	6	·322	·061
„ „ „	10	·314	·061

TABLE *showing the Variations of the Coefficients for different Heads of Water.*

Number of Experiments, and Species of Overfall.	Mean Coefficient (m) applicable to Formula (I). Head in Inches.	Coefft.	Mean Coefficient (k) applicable to Formula (II.) Head in Inches.	Coefft.
6. Thin plate 3 feet long	1 to 3	·440	1 to 2	·085
	3 „ 6	·402	3 „ 6	·078
11. Thin plate 10 ft. long	1 „ 3	·501	1 „ 3	·096
	3 „ 6	·435	3 „ 6	·086
	6 „ 9	·370	6 „ 9	·072
23. Plank 2 inches thick, 3 feet long	1 „ 3	·342	1 „ 3	·066
	3 „ 6	·384	3 „ 6	·074
	6 „ 10	·406	6 „ 10	·077
56. Plank 2 inches thick, 6 ft. long	1 „ 3	·359	1 „ 3	·069
	3 „ 6	·396	3 „ 6	·077
	6 „ 9	·392	6 „ 9	·074
	9 „ 14	·358	9 „ 14	·069
40. Plank 2 inches thick, 10 feet long	1 „ 3	·346	1 „ 3	·068
	3 „ 6	·397	3 „ 6	·076
	6 „ 7	·374	6 „ 7	·072
	9 „ 12	·356	9 „ 12	·069
4. Plank 2 inches thick (with wings), 10 feet wide	1 „ 2	·476	1 „ 2	·092
	4 „ 5	·442	4 „ 5	·087
7. Overfall with crest 3 feet wide, sloping 1 in 12, 3 ft. long	1 „ 3	·342	1 „ 3	·066
	3 „ 6	·328	3 „ 6	·063
	6 „ 9	·341	0 „ 6	·066
9. Overfall with crest 3 ft. wide, sloping 1 in 18, 3 feet long	1 „ 3	·362	1 „ 3	·070
	3 „ 6	·315	3 „ 6	·061
	6 „ 9	·332	6 „ 9	·064
6. Overfall with crest 3 ft. wide, sloping 1 in 18, 10 ft. long	1 „ 4	·328	1 „ 4	·063
	4 „ 8	·350	4 „ 8	·068
14. Overfall with crest 3 ft. wide, level, 6 ft. long	1 „ 3	·305	1 „ 3	·059
	3 „ 6	·311	3 „ 6	·060
	6 „ 9	·318	6 „ 9	·061
15. Overfall with crest 3 ft. wide, level, 6 ft. long	3 „ 7	·330	3 „ 7	·062
	7 „ 12	·310	7 „ 12	·060
12. Overfall with crest 3 ft. wide, level, 10 ft. long	1 „ 5	·306	1 „ 5	·059
	5 „ 8	·327	5 „ 8	·063
	8 „ 10	·313	8 „ 10	·061
61. Chew Magna. Overfall bar, 2 in. thick, 10 ft. long	1 „ 3	·437		
	3 „ 6	·499		
	6 „ 9	·505		

Mr. Blackwell, having explained the tables and the diagrams illustrating the paper, stated that his object in bringing the subject before the Institution had been, to make known certain recorded facts; and he conceived, that from these experiments some useful deductions might be drawn, which he trusted would induce other members to make similar investigations.

Mr. Simpson said, the experiments at Chew Magna were undertaken to settle a question, as to the discharge from some reservoirs connected with the Bristol waterworks. These were always kept to a nearly uniform level; but as the water was discharged by a sluice, 19 feet in height, at the rate of about 4 feet per second, there was a slight agitation of the water in the reservoir which would account for some of the anomalies in the experiments alluded to by Mr. Blackwell. On the whole, he did not think these anomalies were greater than was met with in similar cases, when the country was precipitous, and the water was delivered from a high reservoir into a still pool, and then gauged through notch boards. The Wynford brook, on which the reservoir at Chew Magna was situated, fell about 90 feet in a mile, and floods had been recorded which discharged seventy times the ordinary flow of water. The experiments had been carefully made, and gave, he believed, correct results in all cases.

Mr. J. Scott Russell thought Mr. Blackwell's experiments had been conducted in a most useful manner, and on a sufficiently large scale to be applicable to general practice; and he would rank them higher, and considered them more trustworthy, than those made by Du Buat and D'Aubuisson; as those made by Du Buat, though on a large scale, were far from the truth, and those by D'Aubuisson, though better in character, were made on too small a scale to be of practical utility. As far as he had been able to understand Mr. Blackwell's formula, nothing more was meant by it than the nearest approach to a general law, and the difference between it and each practical experiment being ascertained, showed how much the coefficient required to be altered so that the formula and the experiment might coincide. Then the mean of the coefficients of that class of experiments might be taken as a general coefficient for that class, and the difference between it and the coefficient in each experiment would be the measure of discrepancy between the two. The experiments differed so considerably from one another, that the method adopted was the only rational one; because if they took any isolated experiment, and put it down as a fact to be followed in other cases, it would lead to erroneous conclusions. He believed, therefore, the mean of the coefficient was the only thing which would represent the truth, so far as it resulted from experiment. The first table exhibited seemed to him to show, not so much the law of overflow, as the deviations from the supposed law; whilst the diagram appeared to show the law which the delivery followed, as determined by the height of head, under different circumstances of breadth of overfall. And the two together conveyed to his mind a very simple and clear view of the results of all the experiments which had been compared together, so that in order to apply these results to practice, it was only necessary to take the height of head, as given in that table, and the quantity discharged by a unit of breadth, and then to judge which of these most nearly approached the case under consideration. With regard to the discrepancies, which had been noticed by Mr. Blackwell, in the Chew Magna experiments, he believed they might be attributed to the variations of the velocity, caused by the current of the stream entering the reservoir; for he had himself seen, in a reservoir 120 feet wide, that a small stream running into it with a velocity of 4 feet per second, caused the water in the reservoir to be disturbed for a distance of 100 feet; indeed, formed a distinct current for that distance. This proved how necessary it was to notice every minute fact when recording each observation. It would be a great boon to the profession, if the members of the Institution would make a point of transmitting the results of experiments on any question; and it was exactly that kind of contribution which the younger members could make with so much certainty, and with so much advantage to themselves and the profession; for whilst, on the one hand, the collection of well-authenticated facts induced a habit of accurate research, on the other hand, it brought to the older and more experienced members, the means of drawing general conclusions, and of deducing correct rules from actual experiments.

Mr. Hawksley coincided with the expression of the general value of the results of the experiments, as a record of observed facts. He thought, however, that these experiments had been made under such widely different circumstances, that they would not be available for the determination of a satisfactory formula. He had also made a considerable number of experiments, to determine the value of the coefficient to be used with the ordinary formula, for measuring the flow of water over a "notch-board." These experiments were made on a brook, in which six gauge boards were fixed, having notches, edged with iron, and of different widths and depths. The velocity of the current in the pond, above each notch, was reduced as much as possible, and the water discharged, after passing successively over all the boards, was at last accurately weighed, by a machine constructed for the purpose. Each notch of necessity discharged the same quantity of water in the same time; consequently if the formula employed by Mr. Hawksley was correct, it must necessarily give the same result over all the differently formed notches, and finally coincide with the determination of the quantity by the process of weighing. This was so nearly the fact, that the maximum error did not exceed one-sixteenth part of the whole. On some future occasion he would take an opportunity of placing these, and other hydraulic investigations, before the members of the Institution.

Mr. Cawley believed, that if the diagrams exhibited by Mr. Blackwell were carefully studied, the discrepancies, which at first sight seemed to exist, would vanish, and they would be found to be attributable, almost invariably, to friction. Where the water passed over a thin plate, there was comparatively little or no friction at the sides, and therefore the coefficient would accurately represent the discharge for every width of overfall; but when the height of the head of water was greater, or the overfall had wings, the case was different, as then there would be a considerable amount of friction, varying, of course, with different circumstances.

Mr. S. Ballard stated, that in September 1836, he had made a series of experiments, for Mr. T. Rhodes, on the flow of water over weirs, on the river Severn, at Powick, near Worcester. These experiments were made with a weir 2 feet long, formed by a board standing perpendicularly across a trough. The results are given in the following table:—

Depth of Water flowing over the Weir, in inches.	Cubic Feet per Minute over 1 Foot of Weir.	Depth of Water flowing over the Weir, in inches.	Cubic Feet per Minute over 1 Foot of Weir.
1	5·88	4	46·87
1¼	7·14	4¼	49·45
1½	9·55	4½	54·87
1¾	12·37	4¾	59·60
2	14·93	5	63·38
2¼	18·29	5¼	66·17
2½	23·07	5½	73·17
2¾	27·69	5¾	77·58
3	32·14	6	82·56
3¼	34·61	7	102·27
3½	37·81	8	126·76
3¾	41·47		

At the commencement of these experiments, satisfactory results could not be obtained, on account of the difficulty of observing the exact depth of water on the weir, for a gauge, which had been set up at the side, did not clearly show the height, owing to the capillary attraction. The method then adopted was to attach two needles to the lower end of an accurately graduated gauge, one of which was a very little longer than the other, so that on the water being admitted by a sluice, regulated by a screw, its level was adjusted until it just touched the longest needle, and occasionally, by its uneven motions, the shortest needle, and thus the exact height of the water above the weir was observed. The water, after passing over the weir, fell into a square tank, capable of holding 300 cubic feet, in which a gauge, graduated so as to show every 10 feet of water, was fixed. This gauge had a floating guard around it for keeping the water still, so that the exact height could be taken; and for the purpose of showing clearly when the water arrived at each 10 feet mark, a pin was placed at right angles to the gauge, and the instant the water touched it was immediately seen. As it was thought that the perpendicular position of the board forming the weir might have some effect in diminishing the quantity of water passing over it, a sloping board, inclining on the upper side, from the top of the weir downwards, was substituted, when the quantity of water discharged was increased, with 1 inch depth of water, from 5·88 cubic feet per minute to 6·76 cubic feet per minute, or about 15 per cent. Experiments were subsequently made with a weir of only 1 foot long, when the quantity of water discharged was less, in proportion, than it was with the 2 feet weirs. This was attributed to the contracted stream caused by the direction of the course of the water at the sides of the weir. Experiments were also tried with oblique weirs, and circular weirs, and the result was, that the quantity of water discharged was in proportion to the length of the weir.

THE ANALYSIS OF ORNAMENT.

By R. N. Wornum.

[*Lecture delivered at the Birmingham School of Design.*]

In introducing his subject, Mr. Wornum remarked, that Ornamental Art was divisible into nine styles, or epochs—viz., Egyptian, Greek, Roman, Byzantine, Saracenic, Gothic, Renaissance, Cinque-cento, and Louis Quatorze—three ancient, three middle-age, and three modern.

The first of the ancient styles—the Egyptian—was essentially hieroglyphic in its character; this arose from its having been developed by the priests. Every ornament being a hieroglyph, the whole style was symbolic, the predominant symbols being the winged globe, which was supposed to represent the sun, or Providence, or kingly power; the zig-zag, typifying water, and especially alluding to the Nile; the lotus, a figure of the Nile's inundations, whence the fertility of Egypt was derived; the asp, and the cartouche; but besides these an infinity of geometrical ornaments were introduced. Egypt had given a bias to all arts. The Greek anthemion drew its type from the lotus, and the Hindoo temples bore marks of Egyptian taste. Persia, too, had shared in the influence, for when its monarch Cambyses conquered Egypt he took away with him a colony of artists who built the royal palace at Persepolis. The marbles of Nineveh, as they were generally called, were most likely executed by the same colony; and we are warranted in conjecturing that the great temple of Solomon displayed all the features of Egyptian architecture.

The great periods of Greek art were the Doric, or earlier, and the Alexandrian, or later form. The former was distinguished by great simplicity, though entirely diverse from the simplicity of Egypt. Instead of universal symbolism, everything seemed to have been developed for the sake of beauty of effect. The chief characteristics of the style were the fret, the wave-scroll, the anthemion, and the echinus. These were found on ladies' dresses and on manufactured articles, as well as in architecture. Although geographically called Doric, the style might descriptively be designated the Echinus Order, for the echinus (or horse-chesnut) formed the principal feature in the ornament. The ornaments in this order were rarely, if ever, cut, being generally painted. In the Alexandrian period the forms became greatly enriched; and two new orders arose—the Ionic, or voluted, and the Corinthian, or acanthus. The Ionic was formed by the addition of the volute to the echinus capital, and the anthemion was generally added below. A new ornament—the guilloche, or spiral—also appeared. The astragal, a modification of the echinus, was also a characteristic of the Alexandrian period. The adoption of these various members of the capital resulted in the production of fine effects of light and shade; and each improvement tended to impart to Greek art a more florid character, till at length, what might descriptively be called the Acanthus, and geographically the Corinthian, Order, was produced. Roman ornament was nothing but an exuberant elaboration of the Greek, and the most magnificent works in this style were probably built and decorated by Greek artists resident in Rome. Roman art was rich, but crowded; and the details were so profusely employed that the breadth of effect contemplated by the Greeks was entirely lost. Those ornaments too—the scroll and the acanthus—that the Greeks least used were oftenest employed by the Romans; and as they borrowed and intermingled in their architecture something from each of the Greek orders, the best name to bestow upon their capital was that of Composite.

At the commencement of the Middle Age styles an extraordinary revolution took place. At the introduction of Christianity everything that was Pagan was banished, all Classic ornament was excluded, and this state of things lasted for 300 years; but as, in common with all mankind, the early Christians felt the need for some decoration to their edifices, they had recourse to their religion, and symbolism again came into being. The walls of the churches were decorated with the monogram of Christ, the lily, the cross, the serpent, the vesica piscis, the nimbus, the trefoil, the quatrefoil, &c., all of them setting forth some great mystery of faith. Those symbols having been explained in detail by the lecturer, he showed how they entered into every part of the Byzantine school, and how they imparted in their ever-varying modes of treatment great richness of effect to the strict conventionality that marked the Byzantine architecture. Saracenic architecture was due to Byzantine. The Saracen conquerors forced Greek artists into their employment; and as the Mahometan law forbad the imitation of any natural form, as being akin to idolatry, a style of tracery was introduced, composed of geometrical forms and some times made up of passages from the Koran written in a symmetrical manner. This style was further elaborated by the Moors in Spain and Sicily, and in the latter place evolved the Siculo-Norman style, the principal feature of which was the pointed arch, which had among the Saracens supplanted the debased Roman arch. The capture of Sicily by the Normans gave a new name (that of Siculo-Norman) to this shape of arch, and to the continent of Europe and to England a new form for ecclesiastical edifices. The Gothic was a development of the Byzantine, and was chiefly characterised by its flowing tracery, which, though beautiful in large masses, was hard and unpleasant in smaller pieces. Natural local types were commonly imitated in it, and every weed that grew near the convent walls was carefully copied in the convent cloisters. But though the Gothic was strictly geometrical in its tracery, it was sympathetic in its symbolism. In England it was, as he remarked, introduced in the Norman, and passed through three stages—the Early English, the Decorated, and the Perpendicular, each distinguished from the other by differences in their tracery, and it might also be added by the form of the arch. In conclusion, Mr. Wornum observed that during the three thousand years now reviewed, it was evident that all the great masters of art aimed purely at beauty of effect, and not at precise imitation of natural objects, of which there was very little, and in the Gothic alone. Yet a theory had lately been started that we should go to nature exclusively for the details of the ornament. So we ought, and so we did; it would be difficult to devise any form which was not natural. But there was a great difference between using nature and imitating the accidental individualities of some natural form that happened to be before our eyes. There were many natural forms besides those in which our experience was commonly familiar. Mr. Ruskin, in his 'Seven Lamps of Architecture,' had said that the Greek fret had no meaning, because it was not in nature, and that therefore it was hideous. In this he was mistaken, since the fret did exist in nature, and, therefore, according to his own theory, must be admitted to be beautiful, though he ignored the beauty it had in itself. The lecturer alluded to a piece of tracery, which, he observed, was really beautiful in itself; but according to Mr. Ruskin's theory, those who did not recognise it as natural (it was to be found in the cobweb) were not to be allowed to admire it; there were many other ornamental forms, not commonly observed in nature, but which really did exist—in snow crystals, and in the sections of flowers. These conventional styles were therefore natural. But setting aside that question, the true theory of beauty was quite independent of imitation, or the copying of nature; and it was, therefore, important for the designer, not merely to acquire dexterity of hand, but to cultivate the mind for the conception of beautiful forms, for the mind was the fountain whence must flow the stream through the channel of the hand.

Arriving at the three modern styles, Mr. Wornum explained that the term Renaissance means, literally, the "re-birth" or revival of art; but it was generally employed to designate a certain phase of art. The revolution was effected from two influences, one operating from the south—Sicily; the other from the north—Constantinople. The latter resulted from the attack made by the Crusaders upon Constantinople, an event which scattered the Byzantine artists and the noblest examples of their style over Italy. At this time two styles were prevalent—the Byzantine in Venice, and the Saracenic or Siculo-Norman in Sicily. The one gradually progressed south, the other north, until they met in Rome and formed the Renaissance. Its first variety was the Trecento, or the art of the 14th century; the second the Quatro-cento, in the 15th century; and the third the Cinque-cento, or 16th century art. Tre-cento was a genuine mixture of Byzantine and Siculo-Norman; in it they had the interlacings and delicate scroll-work of conventional foliage mixed with right-line tracery, but it soon became degenerate and mixed up with all sorts of elements. In the Quatro-cento, imitations of natural objects in the details, and the introduction of symmetrical arabesques from ancient sculpture, were added to the characteristics of the previous style. The gates of the Baptistery of St. John, at Florence, by Lorenzo Ghiberti, were fine examples of the Quatro-cento; while in the painting of arabesque Bernardino Luini was the great master of this style. The Elizabethan was the English Renaissance; it was a partial elaboration of the tracery or strap-work and the scrolled shield-work of the Renaissance. It was not, however, originated in England, for many examples were found in Antwerp before it was known here, and it also existed in France and Italy, especially in Venice. The goal to which these varieties of the Renaissance tended was attained in the Cinque-cento, chiefly through the agency of Raffaelle, who conducted extensive explorations among the ruins of ancient Rome, in the Pontificates of Julius the Second and Leo the Tenth. The decorations brought to light were mainly what is called grotesque, from having been found in the grottoes, and they were greatly employed by Raffaelle in his decorations at the Vatican. In connection with them, however, he introduced many incongruous elements and mechanical impossibilities: yet though Raffaelle's works at the Vatican were not fine examples of the Cinque-cento, they established it. This style was carried to perfection by Raffaelle's favourite pupil, Giulio Romano; but from its extreme difficulty, and the high standard of acquirement demanded in its professors, it only flourished during a part of the sixteenth century. The Cinque-cento was a revival not of Greek but of Roman art, yet its artists altogether surpassed the efforts of the ancients. Its great feature was a combination of animal, human, and vegetable forms with beautiful scrolls. The relief of the object represented was made light or heavy in proportion to the boldness of the scroll; thus, if the scroll was a large one, the relief would be boldly projected, but if the scroll were small, the relief would be slight. This feature was beautifully illustrated by a reference to the work of Agostino Busti on the tomb of Count Gaston de Foix, who was killed at the battle of Ravenna. Another characteristic of the Cinque-cento was the thorough appreciation its artists had of the value of colour; and the symmetrical balance they preserved in all their works. Both these points were illustrated by examples from Giulio Romano. The great secret of the style was, that nothing was introduced in it that was not warranted by ancient monuments. The Louis Quatorze aimed at giving a mere play of light and shade, and thus commenced the decline of ornamental art. It was not of French but of Roman origin, and was commenced in the Chiesa del Gesu, or Jesus Church, at Rome, by Jacomo Porta and Pietro Crotona. The best examples of it were at Versailles. Its chief characteristics were the scroll and shell. There was always in the Louis Quatorze a symmetrical disposition of the elements; but there was such a profusion of ornament that it might be called Roman run mad or drunk. The shell was the centre-piece of every composition, and even the volutes of the capitals were shells. Deep shadows and high lights being the elements of the style, colour was of no importance, and as the aim of the ornamentist became so general detail was neglected; therefore in the Louis Quinze the forms were of so vague a character that they were indescribable. The great feature of the Louis Quinze was the utter rejection of symmetry. The acanthus degenerated into the flag leaf, and the anthemion or shell passed into shell-work, or what the French called *coquillage*. Towards the close of this style, the ornament became so confused that it could not be analysed, and was called Roçoço. Here ended the ninth life of Ornamental art, so far as the past was concerned.

The lecturer then briefly recapitulated the points of the various styles of art. First, he said, we had the Egyptian, gorgeous, symbolical, and massive; then in the Greek a beautiful general effect with appropriate detail. In the Roman we saw evidences of decline—ostentation in the place of pure beauty of form and arrangement. In the Byzantine we recurred to symbolism and artistic crudity, but the symbolism was finally converted into a magnificent style, and the general effect was superb. The Saracenic presented a style exactly the reverse of the Byzantine. In the latter every line was a type of something, in the former all types were avoided. Perhaps in the detail the Saracenic was surpassed by scarcely any; in general effect it was the finest of all. The Gothic was a lame imitation of the Byzantine in symbolism, with clumsily executed details, fine in large masses, but unpleasant in small ones. It was artistically crude, and divided the attention by obtruding symbols. In the Renaissance we saw an attempt to free art from crudity by presenting nothing but the highest sensuous beauty of form. But this was not so easy, and the artist was obliged to recur to Roman art for the best examples. After 300 years of vagaries we arrived at the true revival of art; its difficulty caused a decline, and we came to a want of individuality of expression in the Louis Quatorze. This led to the natural death of ornament. In the 19th century a new term of existence had commenced. We were now beginning to understand the value of ornamental forms. Let them compare the artistic works at Munich with the Roçoço style into which the Louis Quatorze degenerated. In the Munich works we had, as in the Greek, the beauty of form, and as in the Cinque-cento a proper appreciation of colour. The individuality of form was the great lesson we were to learn in the study of the great historic stories of past ages. It was only by system that we could attain the individuality of expression, and the best way of getting it was to study the varieties of all ages of the world's history.

NOTES OF A TOUR AMONG THE CATHEDRALS AND CHURCHES OF BRITTANY AND NORMANDY.

By John P. Seddon, Architect.

(*Continued from page 628.*)

Caen.—The country around this city is somewhat flat and bare of foliage, and in its immediate vicinity the numerous wheels which are erected over the quarry shafts, for the purpose of raising the blocks of stone for which this district is famous, attract the attention of a stranger. The city is one of considerable extent, and its many towers and spires, grouped together, form a most striking and beautiful view; the domestic architecture also, as one passes through the narrow and winding streets, presents a strange and remarkable aspect. Nor can the mind of an Englishman fail to be impressed deeply by the association which the memory of William, the conqueror and king of England, sheds around this the place of his burial, and which is still enriched by the stately abbeys of his erection. But such charms as these do not form the theme of this present essay, nor would they assist in any manner the inquiry I am desirous of pursuing; they have been often described at greater length than my space will afford, as particularly by Professor Donaldson, in an excellent paper read by him at a meeting of the Royal Institute of British Architects. I shall not, therefore, dwell long upon the buildings of this city, since, although they are truly most picturesque and curious, they are fitted rather as subjects for the artist's pencil or for the study of the antiquarian, than to be of any particular use in the inquiry I am pursuing into the principles especially of Gothic architecture. Its Norman buildings however, to which I have already referred, are of magnificent character and almost unrivalled. They include the Church of St. Etienne, formerly belonging to the "Abbaye aux Hommes," and those of the "Abbaye aux Dames" and St. Nicholas. I may also mention the tower of the Church of St. Michel de Vancelles, which is represented in the drawing below, and which is situated in the environs of the city.

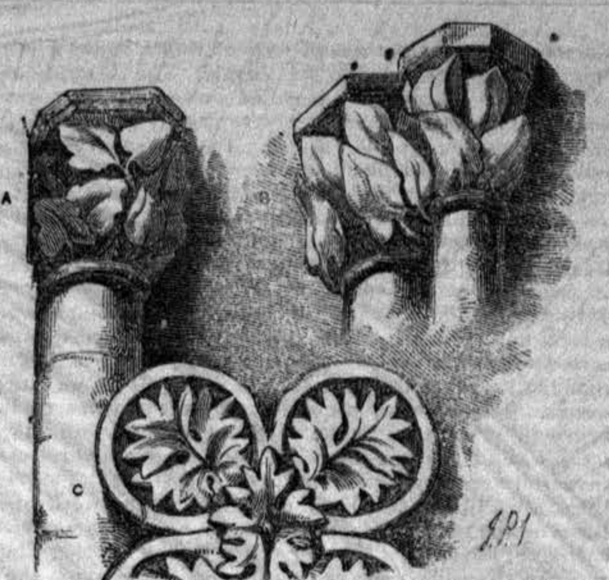
The choir of the Church of St. Etienne is likewise a fine example of the early Gothic architecture, retaining much of the massive Norman proportions; while it presents the same general features as the choirs to cathedrals of Coutances and Bayeux, it is probably earlier than either of them, being far less fully developed; it may, therefore, have formed their type, and is well worthy of attentive study. The tower and spire of St. Pierre (*ante* p. 579) and part of the Church of St. Sauveur may be cited as excellent examples of the early Flamboyant style. The remainder of the churches of St. Pierre, St. Sauveur, and St. Jean, with others, are mostly of the later rich Flamboyant architecture—picturesque, indeed, but Italianized somewhat in detail and *bizarre* in effect; these should be studied, therefore, with great caution, lest they should tend to the degradation of taste. Another circumstance, also, has deprived them of much interest that they might otherwise have had, namely, the shameful treatment that they have received in modern times: of this barbarism and tasteless restoration one cannot speak too strongly. It is thus deplored by M. G. P. Trebutien, in a treatise upon the monuments of the city of Caen:—"Ils on été mutilés, deformés et demolis par le clergé et par ses complices, les architectes." The interiors of the churches have been so universally scraped, recarved, and daubed with washes of the colour of butter, and are so blocked up with heavy altar-pieces, wooden cherubims, shabby calico and coloured lithographs, and are further disfigured by dirt and candle-droppings, that there is no inducement to study or even to stay in them.

There is a most peculiar feature in the domestic architecture of this city, which at once arrests attention, namely, the great height to which the dormers to the houses are carried, most of them having two ranges of windows, one placed above the other. There are also to be found many beautiful examples of wooden houses, resembling those of the city of Chester.

In briefly noticing the ecclesiastical architecture, I may remark that the plan of St. Etienne, in its general features, resembles those before described, having nave, transepts, and choir, well developed and equal in height; but the latter is terminated by a circlet of chapels around its polygonal apse, an arrangement somewhat peculiar and exceedingly beautiful. The effect of the nave, with its twelve compartments of circular arches, and the grand sweep of its vaulting, and the simple breadth of light and shade, is certainly most noble; nor is the same realised in any of the Norman structures in this country, since there are few which retain, if they ever possessed, vaultings of stone. They mostly, as Peterborough Cathedral, have flat wooden ceilings over them. The solemnity of the interior of this church has been grievously

Tower of Church of St. Michel de Vaucelles.

Crocket, Lisieux Cathedral.



A, B, Capitals from Interior, C, Quatrefoil, South Doorway, Lisieux Cathedral.

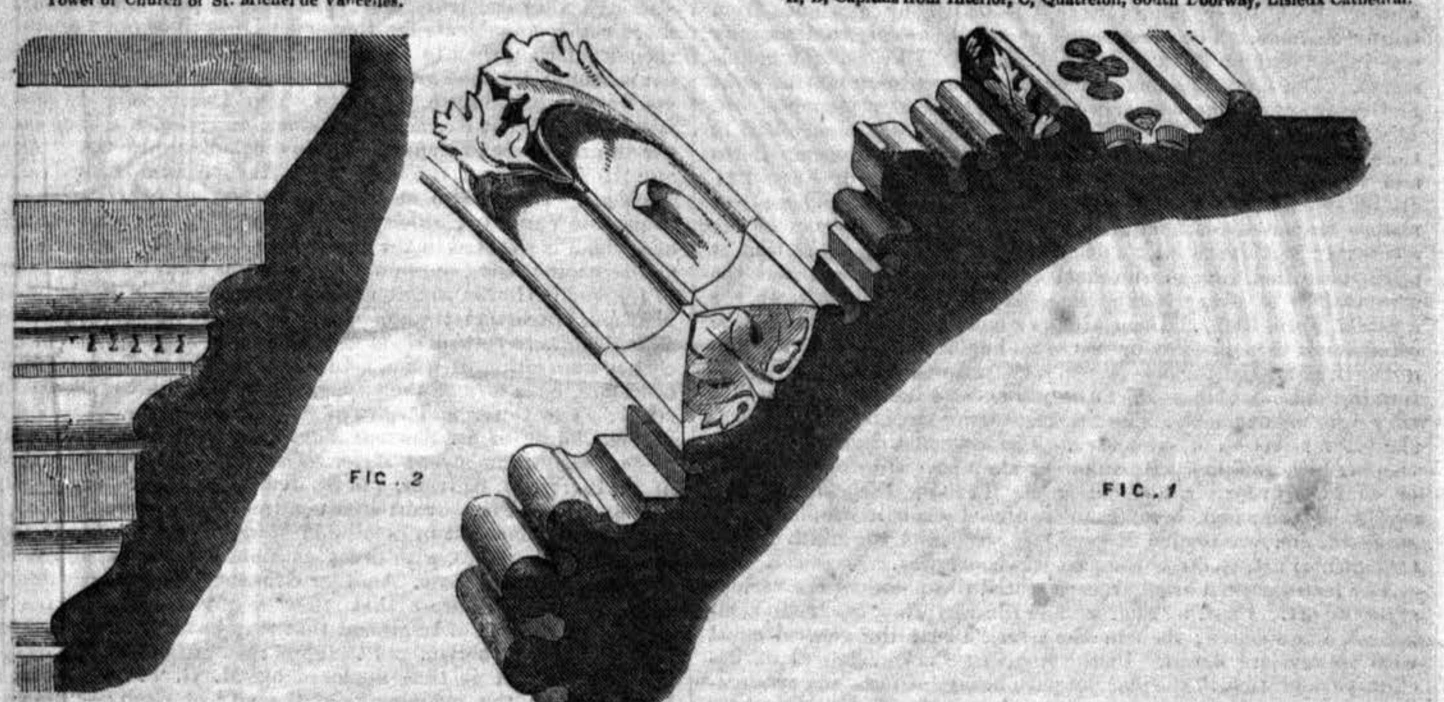


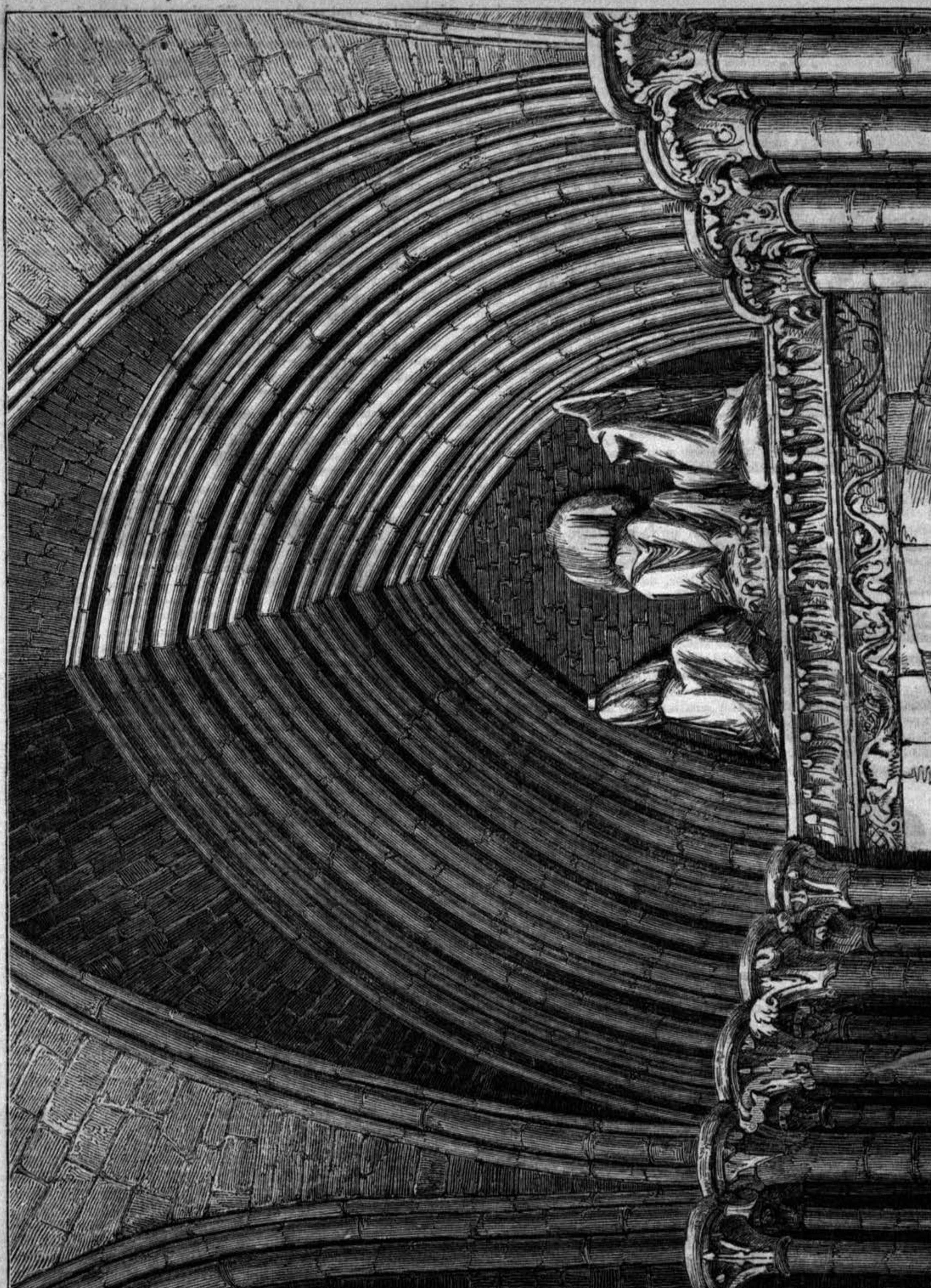
Fig. 1. Arch Moulding to Doorway in Southern Tower, West Front, Lisieux Cathedral. Fig. 2. Base Moulding of Jamb to ditto.

marred by an abominable range of uncouth prison-like holes, which have been made in the walls of the south aisle some short time since. The proportions of the choir, and the feature of the zigzag and dog's-tooth mouldings occurring side by side upon it, show that it belongs to the period of the transition from Norman to Early Gothic; and if it be considered that this imposing structure is certainly prior to, and probably formed the type of, the refined, elegant, and matchless Cathedral of Coutances, and that there then existed no model for, nor approximation to it, it will at once be allowed that it is no ordinary interest which is attached to this portion of the Church of St. Etienne. The gaudy frippery of its modern trappings, the shabby calico and coloured lithographs that deface its chapels, show that every remnant of the spirit of its ancient builders had departed from the present unworthy possessors of this their magnificent heirloom.

Upon the exterior of the Church of St. Sauveur there is much fine flamboyant detail, principally derived from the type of the thistle foliage. The two apsides which abut upon the street afford a good comparison of the earlier and later periods of the Flamboyant style of France, the one which is on the western being delicate, though rich and full of fine feeling, the other extravagant, fantastic, and impure. The exterior of the Church of St. Giles, having a tower rising from the southern aisle, is picturesque; the body of the church is of several different periods.

Lisieux.—This cathedral is of the Early Gothic, showing somewhat of the proportions of the Romanesque. The plan resembles that of Coutances Cathedral; the nave has eight arches in length and the choir four, with a semicircular apsidal end of seven arches. The main piers are massive circular columns, and the arch-mouldings are almost architraves, while the capitals also are mere copies of the Corinthian. There is no attempt at tracery, except that the heads of triforium arches in choir are pierced with quatrefoils. There is much beautiful carving in the interior, of which the figures A, and B, are specimens.

The manner in which this church has suffered from tasteless decoration and restoration is barely credible. The choir, up to triforium, has been daubed over with mottled colour and streaks of yellow, in imitation of marble; the capitals have been painted chocolate colour, and those of the apse gilded; the shafts, vaulting ribs, mouldings, and carving have been smeared with a jaundiced yellow wash, while huge bad oil paintings hide six of the main arches; a carved and gilt wooden circle of rays, with cherubims in white, hangs in the centre of the apse; the vaulting shafts, coloured up to half their height, look as if they had been dipped into a horsepond. But it is upon the exterior that this miserable destruction is proceeding with the greatest rapidity. The western front has been originally a truly magnificent structure. It is massive and grand in character rather than elegant,



DOORWAY UNDER THE NORTHERN PORCH TO COUTANCES CATHEDRAL.

[See page 652.]

although it does not present any traces of the Norman architecture. The work much resembles that upon the side doorways in the western front of Rouen Cathedral, which are perfectly Doric in their proportions. The southern tower is nearly the only portion which remained untouched when I saw it, the rest having fallen victim to the barbarous system of restoration; stone by stone of its perfect carvings being taken out, and a tame, cold, heartless, pretended imitation put into its place, while the old work, all worth its weight in gold, was flung ruthlessly on a heap, then reaching nearly to the height of the church doors, and intended to be used in the foundations of some neighbouring barracks; and henceforth above these precious relics will flaunt the insane boast of "Liberté, Egalité, et Fraternité," raised, as it ever is, on the ruin of the ancient and the good. The doorway under the southern tower, against which at that time they were raising their ladders, is a unique and beautiful work. Some of its details have been given by Mr. Ruskin in his 'Seven Lamps.' Its recess is flanked by a double range of columns, one being set behind the other, and behind the columns there is carried a band of quatrefoils inclosing foliage, of which an example is given in fig. C. The mouldings of the arch are also particularly fine (a section of them is given at p. 650), and the spandrils above are filled with beautiful rosette quatrefoil and trefoil ornaments.

DOORWAY UNDER THE NORTHERN PORCH TO COUTANCES CATHEDRAL.

On the southern side there is likewise a corresponding porch; they both open into the second bay of the nave aisles, and thus are advanced close to the west front, and projecting boldly form one feature with it, carrying its pyramidal outline well down to the ground. The head of the doorway given in the engraving presents a sculpture of marvellous beauty even now, mutilated as the statues have been at the time of the Revolution. The quiet dignity of our Lord, and the reverent and earnest attitudes of the adoring angel on either side, are worthy of notice, as also the graceful *pose* of the figures and the folding of the draperies, which are worthy of Greek art; altogether they present a good example of Gothic sculpture, free from any of the quaintness and rigid stiffness which are too often observable in the sculpture of the time in our own country, though it should be said that we possess many beautiful exceptions to this general rule. The alternating disposition of the various sized shafts, with their capitals uniting in one band of free and flowing foliage, the smaller ones nestling under the exuberant leaves of those which are larger, with the beautiful arrangement of the mouldings above, are particularly admirable. The same idea is repeated upon the fine western front of Bayeux Cathedral.

JOHN P. SEDDON.

ON MINING AND METALLURGICAL PROCESSES AND PRODUCTS IN THE GREAT EXHIBITION.

By Sir HENRY T. DE LA BECHE, C.B., F.R.S.

[*Lecture delivered at the Society of Arts.*]

MINERAL matter, unlike animal and vegetable substances, cannot, in its original or natural state, be modified by man for his use. While he can obtain important varieties of animal substances, by treatment of the animals themselves, or by perpetuating certain varieties of them, and can, by culture, produce valuable modifications in plants, or their parts, no skill of his can alter the natural condition of an ore in the mine. His power commences with that of discovering the mineral matter required by him. Mineral substances have thus to be regarded, industrially, as essentially connected with the means of extraction and the after processes by which they are rendered available for use. While plants and animals differ in various regions of the earth, and the traffic connected with the raw materials they afford is adjusted to this difference, mineral matter of the same character may be discovered in any part of the world, at the Equator or towards the Poles; at the summit of the loftiest mountains, and in works far beneath the level of the sea. The granite of Australia does not necessarily differ from that of the British islands; and ores of the metals may (the proper geological conditions prevailing) be found of the same general character in all regions. Climate and geographical position have no influence on the composition of mineral substances.

Though geographical position has no influence on natural mineral substances, except so far as modifications may be produced by the action of the atmosphere, it may, nevertheless, constitute a most important element among those on which depend the actual uses of those substances. All other conditions being equal, it may decide their extraction or non-extraction. Even important minerals may be so situated as to be unproductive of advantage to those endeavouring to obtain them for use. No doubt, geographical position may be modified by the labour of man, and so that the mineral matter in the same locality, which could not be profitably raised at one time, may be most advantageously worked at another. The condition of man, therefore, occupying different areas on the earth's surface as nations, becomes an element of the utmost importance as regards the useful extraction of mineral substances. The conditions under which such divisions of mankind may exist, their laws and customs, are important to the development of any mineral wealth, as it were, latent in the areas occupied by them. These may either tend to impede or promote that development; and the different divisions of men may, by their regulations, act most variably on each other; and, instead of advancing their common good, introduce systems of mutual checks, to the disadvantage of all.

The more advanced a nation, the greater, under equal general conditions, is its power over the disadvantages which may happen to be presented by geographical position, thus producing facilities for the development of its mineral wealth. The cost of transport —that frequent impediment to the profitable working of mineral substances—may become so lessened by addition to easy communications of various kinds, that finally the working of mineral substances can be changed from unprofitable to profitable. In the cases of many ores, these and the fuel needed for smelting them may be brought together by facility and cheapness of conveyance, so that industries, new to a land, may spring up.

Although man, by his general advance, may thus accomplish much for the development of mineral wealth, there are natural limits to his progress which cannot be overcome. Although he may effect the easy transport of mineral matter over rivers and valleys, and even through portions of the earth itself, either by his canals or his roads; and thus, as regards such transport, change the face of a country from one of difficulty to one of facility, the greater geographical arrangements remain unaltered. He cannot change an inland country, in the central position of a continent, to a maritime state, though he can materially modify its position as to the ready means of transport to the coast. An inland locality may pour in its mineral products, by means of increased facilities of transport, upon a seaport, so that not only may they replace similar substances produced at greater cost near such port, but, by means of the sea, be transported even far to other lands, competing in their markets, should the regulations of the nations holding them permit, with those which had hitherto satisfied them.

The profitable development of mineral wealth will, therefore, depend upon the natural occurrence of mineral substances, due to geological causes—upon the geographical position of the localities where the useful mineral substances are present—and upon the condition of man in a given area. The first condition is unalterable by man, the remaining two may be most materially modified by him.

As mineral matter in its first, or natural state, cannot be modified by man, it becomes important that when specimens of it are shown as illustrative of mineral wealth, especial reference should be made to those processes by which such mineral matter is rendered useful. Without this precaution much misconception may arise. Let us, for example, consider the ores of the metals. The mere exhibition of any ore, however rich, is in itself of little value, beyond the information that the specimen came from some stated locality. The circumstances connected with its mode of occurrence, and with the means at command to render its extraction useful, are essential. Pieces of rich ores are of frequent occurrence in localities where, from a want of their sufficient abundance, it would be useless to attempt any profitable working of them. Hence collections of ores may often be most fallacious; indeed, it is unfortunately somewhat too common to find specimens of ores shown as the ordinary products of mines where they are really rarities, for the purpose of promoting the purchase of shares in such mines. There is a name for such specimens in Cornwall, where they are termed *slocking stones*. These really come from the mines, but they are unfair representations of their produce.

Again, it often happens, that without the slightest intention of producing erroneous impressions, proprietors or agents, when requested to transmit specimens of their ores, will select, instead of such as show the general quality of those raised, some fine example of their best ores, a *good stone of ore*, as it is often technically termed, while at the same time the mine itself may be returning large profits by the working and dressing of comparatively poor ores, operations of which the agents might be justly proud; not the slightest deception is intended, but nevertheless a collection of such specimens becomes extremely fallacious, and conceals and does not exhibit the real industry both required and employed. The teaching influence proposed by collections of ores is defeated alike by both the causes above mentioned. Most important knowledge of its kind is sacrificed, and the public misled by impressions received from gazing on a mass of glittering objects, instead of carefully considering the kind of mineral substances which really produce, by the industry of man, the metals so essential for his welfare and progress.

As fuel is at the base of all the operations the products of which have found a place in the late Exhibition, the power of producing fire being peculiar to man, and one without which his range on the earth's surface would be very limited, and his advance trifling, it may, in the first instance, be desirable to glance at that portion of fuel which is included in Class I.

All our mineral, or, as it has been termed, fossil fuel, is derived from vegetable matter, the growth of various geological times, and of different regions, imbedded amid detrital matter of various kinds from local circumstances, and presenting modified aspects in accordance with the general physical and chemical conditions to which it has been subjected. Its chief divisions, for industrial purposes, may be regarded as lignite (the *brown coal* of the Germans), and coal, the latter of various kinds. Indeed the whole constitutes a series, at which woody matter, but slightly altered, is at one end, and stone-coal, or anthracite, is at the other. It may suffice for our present purpose, to mention that the physical and chemical conditions above mentioned are the causes of these differences, and have been of such an order, that the proportion of the oxygen and hydrogen of the original vegetable substance became gradually diminished as regards the other two component parts, carbon and nitrogen, so that the carbon greatly predominates, and stone-coal, or anthracite, is the result.

The character of these fossil fuels is of the greatest importance in their varied uses, the products of many operations depending upon it, especially certain metallurgical processes. As this character does not necessarily depend upon geological age—though, as a whole, the older rocks usually contain only that state of fossil fuel known as coal of some kind,—it may be expected to vary materially in different parts of the world. The kind of fossil fuel found may determine the development of certain branches of industry, other circumstances being favourable.

That mineral fuel should be much represented in the Exhibition was scarcely to be expected. Its presence, indeed, from lands where it was not generally known to be found might be advantageous, especially if accompanied by proper information as to its mode of occurrence, and probable abundance and power of extraction. For example, it was important to examine specimens of coal from New Zealand, and learn the thickness and dip of the beds of some of them; and inspect others from Labuan, where the Eastern Archipelago Company are now working a 9-feet bed. The importance of such localities for the supply of fossil fuel, as regards steam navigation, is evident. Looking, however, at the demand for, and supply of, fossil fuel of various kinds in well-known lands, as for instance, in our own, it may be very much doubted if any mere exhibition of a few specimens, without regard to general views of the manner in which the coals may be variably employed, could be viewed as instructive. There were, however, some good individual illustrations—as for example, that of the thick or 10-yard Staffordshire coal—showing the different working seams, alike interesting to science and coal-mining.

In this and several other cases, where huge masses of coal were sent from some of the British collieries, we have excellent examples of the disinterested aid afforded to the Exhibition. The greater proportion of these exhibitors could look for no return whatever, except the gratification of having assisted a cause which they considered to be good. It was not probable that ten tons of their coals would be altered in their mode of consumption, except by new adjustments and demands not depending upon the Exhibition, though the cost they incurred was often heavy, in raising and transmitting their specimens.

As regards the coals of the world, it is well known that, though our country may not be that containing the largest amount of fossil fuel (the United States far exceeding us in this respect), it is at the present moment, nevertheless, the land in which the largest amount is raised. The annual weight raised in this country is usually now estimated as equal to 35,000,000 of tons, or, taking the ton of coal as equal to about a cubic yard, more than eleven square miles of a bed of coal, 3 feet thick, supposing the whole of the coal removed. Of this large amount about 2,728,000 tons are exported, leaving the remainder, or 32,272,000 tons for domestic and industrial consumption, the portion devoted to the latter being largely employed for the smelting of our ores, especially those of iron. The annual produce of our collieries may, indeed, exceed 35,000,000, and more nearly approach 40,000,000 tons. Steps are being taken at the Museum of Practical Geology in order to obtain more correct data on this head.

As illustrative of the importance of our position as a maritime state, combined with our possession of cheap heat, well situated, the copper smelting of Swansea, with that of Neath, Tai-bach, and Llanelly in its vicinity, may be advantageously adduced. We there find, in addition to the greater portion of the copper raised in the British islands, cargoes of that ore, and of what is termed the regulus of copper, brought round by the Cape of Good Hope from Australia in one direction, and round Cape Horn from Chili and other South American lands in another. Altogether the copper smelting of South Wales forms an excellent illustration of the advantageous union of geological and geographical conditions combined with a state of man in a given area fitted to seize and utilise those conditions.

Though regarding the specimens of coal, as such, and unconnected with processes to which they were material, the Exhibition might be defective, it contained important illustrations of the mode of occurrence and of extraction of coal. Among the maps, sections, and collections, connected with this subject, the exhibition from the coal district of Northumberland and Durham should be cited. It formed an important series of illustrations, comprising maps, sections, specimens of the various coals, the rocks by which they are accompanied, plans of the mode of working the collieries, section of pits, and the machinery in them, with the safety-lamps used in the district—a highly valuable series, and one formed expressly for the Exhibition. A beautiful model by Mr. Nicholas Wood exhibited the methods of working coal in the northern counties. There were others also in the English department alike instructive, as directing attention to that important subject, the ventilation of collieries, one which has so justly of late attracted public attention. Much good may, no doubt, arise from the appointment of inspectors of collieries in the different districts in this country; but the more effective saving of life from colliery explosions must be looked for in the instruction generally of coal-miners themselves. The amount of mischief arising from the foolhardiness of ignorance in our collieries can only be credited by those who are compelled to employ men with a want of education they deplore, or who have, in discharge of duties, visited coal-mines after fearful and desolating explosions. Safety lamps are important in connection with this subject. In addition to those usually employed in this country, there were two from Belgium, where, as well as in France, much attention is paid to the proper ventilation of collieries by the government authorities.

As relating to the ventilation of collieries, a model of opening and closing the doors in them, by the passage of the horses and wagons, or of the men, without the attendance of boys or others for the purpose, had very important bearings, so many accidents having occurred from the ventilation being disarranged by leaving open such doors. It was a good case of a valuable contrivance, apparently little known beyond the colliery itself—the Foxhole colliery near Swansea—being made more extensively so by means of the Exhibition.

As connected in the Exhibition with collieries, though in reality applicable to shafts generally in mines, we should here mention the very important method adopted by Mr. E. Rogers of sinking shafts at Abercarn colliery, Monmouthshire. By employing electricity in blasting, he is enabled to explode three or more holes, inclined to each other in the depth, simultaneously; and thus lift a large mass at once from the centre of the sinking, other large masses being in like manner afterwards detached from the surrounding portions towards the sides. By thus calling in the aid of electricity, and by employing gutta-percha tubes of great size in connection with the pumps, and so avoiding the destruction of the usual arrangements, which frequently take place during blasts while sinking a pit, better work is accomplished with greater rapidity, and at less cost than by the ordinary methods. This successful application of science and of modern knowledge is deserving of all attention by miners.

That there has been, and unfortunately still is, great waste in our collieries, viewed as a whole, however the working of some districts may exceed that of others (and even those not over remarkable for progress, may yet exhibit valuable exceptions), has been long known, and often pointed out. It was, therefore, an advance in the right direction, when the small coal sometimes consumed at the pit's mouth, at others thrown back into the workings, were used for, as they have been termed, the patent fuels. There are now many of them of different kinds, applicable to different purposes, according to composition. In them the small coal is usually cemented by some bituminous substance, pressure being employed. One kind in the Exhibition was shown by Mr. Azulay, in which great compression alone caused the particles of the coal-dust to cohere. In Warlich's process, specimens of which were also exhibited, after the small coal is made to cohere with some bituminous body by pressure, the resulting bricks are exposed to heat, in order to decompose the bituminous substance, the heat being graduated according to the use to be made of the fuel. This is a highly important point in the patent fuel employed for steam purposes, since by carefully selecting a proper coal, and heating the brick so as to coke the cementing matter without injury to the coal employed, a very useful product for steam-ships may be obtained.

In the French department, and in a small case, accompanied by a description and drawings, the whole seldom heeded amid more showy objects, were to be seen some sorted and crushed coals, with a few pieces of coke, having an important bearing upon the employment of cheap and effective heat. It illustrated the method of M. Bérard for separating foreign matter, such as iron pyrites and slate, from coal. Its principle was that of the "jigging-machine" of the miners, for separating ores, after crushing, from the stony matter with which they may be associated, by agitating the whole in water, so that the various portions become arranged according to their specific gravities. The apparatus, which it would require the needful drawings to explain properly, is remarkably ingenious, and the result certain. In a country like ours, where coal is abundant, such a method might, at first sight, appear little wanted. The Exhibition was not, however, intended for this land alone, but for "all nations;" so that the application of such a method becomes most important in many numerous small seams, or coals with much iron pyrites, rendering them, in common parlance, "sulphurous," and otherwise valueless, being rendered worth working by its use. Its value, is, however, also understood in our country; for, we are informed, works are now erecting for its employment at Newcastle. By using the method of M. Bérard, the Chemin de Fer du Nord, France, was enabled to employ a coal previously found injurious to the locomotives, and a considerable saving was effected. The reduction of ash in the washed coal was very considerable.

Not to dwell longer upon mineral fuel, important as extended views of that subject might be, did time permit, it may now be desirable briefly to consider the ores of the useful metals. The subject of metal mining includes a consideration of the ores, as such; their mode of occurrence in the ground; the methods employed for their extraction; and the means adopted for *dressing* them, as it is termed, or of rendering them marketable. The smelter then receives them, and by such metallurgical processes as may be suitable produces the metal.

Respecting the fallacious impressions which the inspection of mere specimens of ores may convey, some remarks have already been offered. No doubt, ores commonly called of the same kind differ, by containing foreign substances, making a material alteration in the labours of the smelter. This is a subject of great importance, requiring all the skill of the metallurgist. Small additions of peculiar substances produce great modifying influences. Many a smelter finds himself at fault as to the causes of certain deteriorations of produce which the scientific metallurgist traces to the ore; and here science steps in and aids that ordinary practice which might be sufficiently successful so long as ores of the ordinary composition—those to which the smelter had been accustomed—were operated upon.

Specimens of ores are valuable when selected to illustrate important points of this kind, or when they accompany illustrations of their mode of occurrence, modifications in consequence of that mode of occurrence, or are connected with processes and their results. With the exception of the last, the ores of the Exhibition possessed scarcely any of these conditions; indeed, some were sent from mines which, as previously mentioned, should have been justly proud of their methods of dressing ores of ordinary, and even low quality; yet the specimens transmitted were rich, requiring no refined means of treatment. There were, nevertheless, very rich specimens from some parts of the world, known to represent considerable masses of the same kind; as, for example, the Burra-Burra mines of South Australia, have furnished to commerce a large amount of valuable copper ores similar to those exhibited and many a mass of malachite from them, which might, as in Russia, have been extensively employed in works of art, has passed beneath the hammer and crushers, and into the furnace. Small as the metal exhibition of Sweden may have been, the ores sent were good examples of those whence the fine iron of that land is obtained. In like manner, there was no reason to doubt that the rich iron ores of the United States and of Canada did fairly represent masses of the like ores in those countries; and so also with ores from some other lands. Looking, however, at those shown generally, the previous remarks were needed.

One of the most important series of ores in the Exhibition, viewed with reference to its object, and, coupled with the information with which it was accompanied, as illustrating a particular mineral produce in a given country, was that of the iron ores of Great Britain, collected and sent by Mr. Samuel Blackwell. It was formed at both much trouble and cost by its exhibitor, and for no other purpose than to render good service to the Great Exhibition, in the first place, and to the stores of the Museum of Practical Geology, to which it was presented for national use, in the second.

The ores in this collection are of two kinds; the one, known as clay ironstone—an indifferent name—is fundamentally a carbonate of iron, mingled variably with the matter of the ancient mud and silt, among which it was originally deposited, and from which it has, under geological conditions, been separated into continuous beds or ranges of nodules. The amount of metal in the ore depends upon that of the carbonate of iron it. In the ordinary carbonates of iron (which are still not quite pure), known as spathose iron, and of which there were specimens from Austria, the Zollverein, and other places, there is usually from 50 to 60 per cent. of protoxide of iron. In the clay ironstones the metallic iron ranges sometimes up to 40 per cent. The clay ironstones are most important to Great Britain, the greater part being found associated with the coal-beds in our coal measures, and so that they are worked with, or near to each other. From these ores more than 2,000,000 tons of iron are now made in this country. Besides thoss in the Blackwell collection numerous specimens of these ores were to be found attached to illustrations of the products of different iron works.

The other iron ores in the Blackwell collection were varieties of the oxides, chiefly hæmatites, the quantity of metallic iron in which, when the ore is good, is from 60 to 70 per cent. The amount of hæmatite ores worked in this country, though they are abundant, is not comparatively considerable. It is, however, smelted alone, and there were illustrations of this in the Exhibition; and it is, also, mixed with the clay ironstones in many furnaces.

Respecting the mode of occurrence of ores—a most important point—the Exhibition did not furnish many illustrations. As regards specimens of that character, it was not to be expected that they could be readily sent. Such collections are the work of time; requiring, moreover, a constant attention to given objects of inquiry, in connection with the general subject, as is abundantly proved by the difficulty experienced by all mining schools in satisfying these requirements. We have a fine illustrative collection of this kind at the museum in Jermyn-street, but it took us sixteen years, with all our opportunities, and the hearty co-operation of able men in the mining districts, to obtain it. It is by no means easy to find proper illustrations, in sufficiently moderate volume for exhibition, of some of the chief facts observable in a mineral vein, or lode, often only to be seen on the great scale.

With respect to the mode of occurrence of the metalliferous ores, it may, in all its generality, be regarded as twofold, in beds, or layers, or filling cracks, fissures, or other cavities. The clay ironstone, and certain oxides, known as bog-iron ore, belong to the former division. The alluvial, or other detrital beds, in which gold is found, as in California, Australia, Russia, and many other lands, may be considered as also included in it. So, likewise, such deposits as the cupriferous slates of Mansfeld, of which there were specimens in the Zollverein department. The sections on the wall, horizontal and vertical, will show the mode of occurrence of the clay ironstones with the associated coal-beds in Merthyr Tydvil, the chief locality for iron works in South Wales. In such districts some beds of ironstone, and in the sections before you many are shown, bearing various names, often present constant characters for considerable distances, while others are more variable in composition and thickness.

Looking at the auriferous beds in some regions, even those from which much gold may, as a whole, be obtained, we must often regard the mode of occurrence of the metal as, taken with the bed, to represent a poor ore. When, as in some of the Russian gold washings, two hundred tons of the detrital mass has to be washed and examined, to obtain a single pound weight of gold, it can be viewed as little else.

The best illustration to be found in the Exhibition of the mode of occurrence of the clay ironstones and associated coal, was that afforded by the beautiful model accompanying the Ebbw Vale collections; the sequence in which, from the coals, ironstones, and limestone used, through the models of the furnaces to the various products, was highly instructive and creditable to the company exhibiting them. The model was formed of an original part made by Mr. Sopwith (so well known for his skill in that department as well as in others), to which the company had added a continuation. The model is constructed to a common scale for height and distance, the surface represented to correspond with the actual ground, with the rivers, roads, fields, and buildings, while the lower part exhibits—every coal and ironstone bed being shown—the true relative positions of the various beds with the works which have been carried on upon them. Considering how completely these models may be made to record all the workings, and how far superior they are to the usual plans and sections, it appears surprising that they should not be more used than they are, affording, as they do, such clear and accurate information to all interested.

As to illustrations of the mode of occurrence of ores in mineral veins or lodes, the most instructive and important were specimens of part of the silver lode of Kongsberg, Norway; and of part of the lead lode of Grassington, Yorkshire, sent by the Duke of Devonshire. A few large lead specimens in the English department exhibited points of interest; and these, with some specimens in the Australian copper series, certain of the iron and zinc series in the American collection, a few specimens from Canada, a few mining sections from Cornwall, and those accompanying the exhibition of the lead series of Allenheads, Northumberland, may be said to complete the illustrations of this kind. The means of extracting ores from the metalliferous mines were but slightly represented. There were illustrations of safety fuzes for blasting, some methods of raising and lowering the miners and for raising the ores, and a few Cornish mining sections. With reference to this subject, however, a large and beautiful model of water-wheels, connected with pumps, from the Devon Great Consols Copper-mines, requires especial mention. The dressing of ores did not receive overmuch illustration. There was a good model representing the methods of dressing the inferior copper ores of Tywarnhayle mines, Cornwall; and it may be deserving of remark that, although the produce of Cornish and Devonian ores does not exceed an average of about 8 per cent. of the metal after the ores are dressed, the mines of that district have been estimated as furnishing one-third of the copper raised throughout other parts of Europe, and the British Islands. The Truro committee sent good illustrations of preparing tin ore for the smelter, and there were also some other illustrations of dressing tin ore. The lead-dressing of the Allenheads mines, Northumberland, was well shown; and the Kongsberg (Norway) series exhibited the dressing of the silver ores of those mines in a detailed manner.

With respect to the metallurgical processes and the metals produced, the case was different, more especially as regards iron. This metal, the most important to mankind, formed the chief feature in Class I., whether in the British or Foreign departments. There were some excellent illustrations from different British iron-works, including the ores and fuel employed. The various kinds of iron were well exhibited. The Ebbw Vale exhibition contained a model showing the method adopted at those works for utilising the gases evolved from the furnace. The proprietors of the Low Moor and Bowling Iron-works did not forget their old reputation for iron, and exhibited some remarkable specimens. As a general illustration of British iron, that of Mr. Bird may be cited. Some remarkable pieces were to be there found from various works and districts. Among them was probably the largest bar of iron ever rolled, being 7 inches in diameter and 20 feet 1 inch long: this was made by Messrs. Bagnall, of West Bromwich, and weighed nearly $1\frac{3}{4}$ ton. There were some fine examples in this collection of large drawn tubes, and others illustrating the qualities of the various irons. Canada and Nova Scotia exhibited their iron: some bar-iron of good quality from the former was remarkable for being manufactured from bog-iron ore, not usually found good for bar-iron.

The Austrian series of iron was excellently well displayed, and very illustrative. Many parts of the series showed the ores whence the metal had been obtained, with the various parts of the processes, including the slags. In this collection was a most remarkable example of the fine rolling of iron, the latter itself being necessarily of excellent quality. The "iron paper," as it was termed, from Neudeck, in Bohemia, was superior to all of its kind in the Exhibition. It may not be out of place here to cite this Bohemian "iron-paper," in illustration of some of the useful effects of the Great Exhibition. It soon attracted the attention of those skilled in iron, as such thin rolled iron is important for button-making. A spirited party, connected with the iron trade, at once proposed, in a proper quarter, to imitate this Bohemian product. This was attempted, and though the result was not quite equal to the original, before the Great Exhibition closed thin rolled iron of a quality not heretofore produced in this country was to be had in the market.

There were good illustrations also of the Belgian iron, as employed for various purposes. Though Russia did not put forth her strength in fine iron, there were, nevertheless, some excellent examples of it, both from her imperial and private works. Some specimens of sheet-iron were remarkable for their quality. Sweden was deficient in that iron for the quality of which she is so celebrated; and France, though raising a large quantity of iron, was scarcely represented in that metal. There was but little iron in the Zollverein department. The Siegen iron, produced from the carbonate and hydrated oxide, was not, however, neglected, and the illustrations of iron from Nassau were effective, as were, indeed, those of the general mineral produce of that state. Spain sent some of her iron, and the United States forwarded some good illustrations of theirs.

The Exhibition may be said to have given rise to the most co[illegible] plete view of the iron produce of this country which we poss[illegible] Mr. Samuel Blackwell, himself an ironmaster, accompanied [illegible] collection of iron ores, previously mentioned, by a stateme[illegible] great value. He estimates the gross annual production of [illegible] Great Britain to be now upward[illegible] quantity, South Wales furnishes 700,00[illegible] (including Worcestershire), 600,000 tons[illegible] tons. The remainder is divided among the various s[illegible] The iron of England and Wales was produced by 33[illegible] blast in 1850. Though a considerable quantity of Bri[illegible] exported, a very large proportion remains to be variously e[illegible] in our own industry.

The Iron Trade.—This great staple trade of our district has retained hitherto an unchanged aspect of dulness and depression. If any alteration can be noticed, it has been a further tendency to decline rather than to improvement; and the trifling transactions of the last fortnight appear, in several instances, to have been concluded upon somewhat lower terms. It would be difficult, however, to define any actual limit of variation in the prices of iron either at the present moment or during the last six months; but while first makes are commanding something near the nominal figures, it is not going too far to say that others are now to be had at 15*s*. per ton lower. Among the purchasers of pig-iron a strong disinclination is shown to forestall the requirements of the approaching quarter; while holders of materials are everywhere endeavouring to press forward their sales. From the Scotch market accounts are gloomy, reporting 3*d*. per ton decline. The unusually short supply of water in the various canals is also inflicting a serious injury, increasing the expense of transit both upon iron itself and the materials for its manufacture. Notwithstanding these adverse symptoms, it is still generally expected that there will be no declaration of reduction at the approaching quarterly meeting, but that existing prices will be maintained at Christmas; and some go so far as to entertain a hope of acquiring a more satisfactory position early in the spring. Among other reasons for such an opinion, it is stated that the first-rate works are tolerably well supplied with orders, and maintain their quotations with firmness; that no accumulation of stocks, either in wrought or unwrought iron, has taken place during the last twelve months of depression; that the principal evil felt is rather the impossibility of obtaining remuneration than an absolute scarcity of demand; and that while it is impossible that the home consumption should suffer further, the commencement of the spring trade will bring an additional accession to the continually increasing amount of export demand sufficient to warrant higher pretensions. Of the correctness of such views those who are interested must, however, form their own judgment.—*Birmingham Gazette.*

INSTITUTION OF CIVIL ENGINEERS.

Dec. 16.—Sir WILLIAM CUBITT, President, in the Chair.

THE Paper read was "*On the Alluvial Formations, and the Local Changes, of the South Eastern Coast of England. First Section, from the River Thames to Beachy Head.*" By J. B. REDMAN, M. Inst. C.E.

The Paper stated, that the passage of shingle along the English coast, due, as was generally believed, to the action of the waves alone, took on the south coast, a course from west to east, and on the east coast, from north to south. During certain winds the shingle was heaped-up coincident with their direction, and repeated withdrawals and renewals (the latter being the most frequent), caused a leeward movement of the material, forming it, at the same time, into a series of triangles, of which the shore was the base. If any natural or artificial projection intercepted this motion, an accumulation, which would increase and be held in check, according to the state of the wind, took place up to a certain point, or until the angle formed was filled up, when the shingle would pass round. With groynes, by far the most common action was, unless they were of great height or short length for the shingle, after accumulating on the weather side to the level of the top of the groyne, to pass over it, and then travel to leeward.

The degradation of the north shore of Kent, the local formation of shingle around the Isle of Thanet, by the wasting away of that chalky promontory, and the retention of large masses of alluvial matter in Pegwell Bay, were dwelt on The main belt of shingle lying to the south of Deal, and extending from thence to Dover, with its early and present effects on the harbour at the latter place, were then described; also the early condition of Folkestone Harbour, the large accumulation of shingle arrested to the westward of that haven, by the projection of a low-water pier, or groyne, at right angles to the harbour, and its effect upon the shore to the eastward, by retarding the progressive motion of the shingle in that direction. Further on, the curious formation at Dungeness Point, which it was reasonable to suppose did not at one time exist, as the parallel "fulls" of beach between Romney and Lydd, and extending from Winchelsea on the west to Hythe ...east, seemed formerly to have constituted the sea-coast. The rectan- ..." ...ning from the banks on the west side of Lydd towards the ... accumulation of shingle travelling ... by the outfall of the river Rother; the ... and the coast to the westward becoming gra- ...ingle, a silty deposit would take place on the east ...n the gradual loss of Romney harbour, and the length of ... be increased by the parallel ridges of shingle periodically ...d travelling round it. Numerous examples, extending over two ..., showed that the average annual increase was six yards, reaching, ...ver certain periods an average of eight yards per annum—the absolute increase since the time of Elizabeth being nearly one mile; and they proved conclusively, that the average progress seaward, producing a determinate aggregate elongation in a south-easterly direction, was much greater than had been generally assumed, though not regular, for the Ness had even been stationary during certain periods.

The gradual decadence of the ancient ports of Hythe, Romney, and Lydd, to leeward of this Point, were then alluded to; as also the diversion of the outfall of the river Rother to Rye, once an estuary of the sea, and then forming Romney Harbour; the great increase of shingle to the westward; the early and abortive attempts to form a harbour at Hastings; the vast abrasion of the coast along Pevensey Bay, the harbour of which place had been lost by the elongation and extension of Langley Point. Between the origin of this Point and that of Dungeness, there was a remarkable similarity, both having originally had a tidal haven to the leeward, eventually choked up by the elongation of these spits across their outfalls; both had pools, or meres, arising from the land-locked waters, and in both cases the modern "fulls" of shingle could be plainly distinguished from the more ancient, by their forms and direction. The remarkable decrease of this point, about three-eighths of a mile, during the last century, appeared to arise principally from Old Brighton Beach no longer affording the necessary supply of shingle.

The early condition and present state of Cuckmere and Newhaven Harbours, the great degradation of the coast at Rottingdean, the sweeping away, during Elizabeth's reign, of the beach and town of Old Brighton, then standing on the site of the present chain-pier, the materials from which formed the spits to the eastward, were then described.

The author had personally inspected the whole of this coast, the different sections of which he promised to give in succession, and had also examined the earliest accessible maps, and the works of the best topographical writers, who were frequently referred to, in elucidation of the subject, which was one of vast importance in marine engineering, especially in reference to the construction of harbours and coast-works of defence, as he submitted that it was most desirable, that such natural agencies as had been described, and the many instances of the compensating effects of alternating loss and gain, should be correctly understood.

It was announced that the second section of Mr. Redman's paper, treating of the conditions of the Coast from Beachy Head to Portland and the Cheesil Bank, would be read on January 13, 1852.

LIST OF NEW PATENTS

GRANTED IN ENGLAND FROM NOVEMBER 20, TO DECEMBER 11, 1851.

Six Months allowed for Enrolment unless otherwise expressed.

Samuel Colt, of Bond-street, Middlesex, for certain improvements in fire-arms.—November 22.

Thomas Marsden, of Salford, for improvements in machinery for heckling and combing flax and other fibrous materials.—November 22.

Enoch Statham, of Siddal's-road, Derby, for improvements in the manufacture of lace and other fabrics.—November 22.

Frederick Weiss, of the Strand, Middlesex, surgical-instrument maker, for improvements in certain surgical instruments; also in scissors and other like cutting instruments. (A communication.)—November 22.

Frederick Benjamin Geithner, of Camden-street, Birmingham, for improvements in the manufacture of castors and legs of furniture.—November 22.

Jean Baptiste Chaluren, of Rouen, merchant, for improvements in preparing and weaving cotton.—November 22.

William Armand Moreau Gilbée, of 4, South-street, Finsbury-square, London, gentleman, for certain improvements in the process of and apparatus for treating fatty and oleaginous matters, and in the manufacture of candles and other useful articles therefrom. (A communication.)—November 22.

George Mills, of Southampton, Hants, engineer, for improvements in steam-engine boilers and in steam-propelling machinery.—November 22.

Alexander Southwood Stocker, of Wandsworth, Surrey, gentleman, for certain improvements in the stoppering or stopping of bottles, jars, pots, or other such like receptacles.—November 25.

Henry Ellwood, of the firm of J. Ellwood and Son, of Great Charlotte-street, Blackfriars, hat manufacturers, for improvements in the manufacture of hats.—November 27.

Richard Whytock, of Edinburgh, for improvements in applying colours to yarns or threads, and in weaving or producing fabrics when coloured or party-coloured yarns or threads are employed.—November 27.

John Lee Stevens, of Kennington, Surrey, gentleman, for certain improvements in propelling vessels on water.—November 27.

William Exall, of Reading, Berks, engineer, for improvements in certain agricultural implements, and in steam-engines and boilers for driving the same.—December 1.

George Laycock, late of Doncaster, York, but now of Albany, New York, America, dyer, for improvements in unhairing and tanning skins.—December 1.

William Grayson, of Henley-on-Thames, Oxford, watch and clock-maker, for an odometer or road-measurer, to be attached to carriages for showing distances over which the wheels pass.—December 1.

Thomas Burstall, of Lee-crescent, Edgbaston, Warwick, civil engineer, for certain improved machinery for manufacturing bricks and other articles from clay alone, or mixed with other materials.—December 1.

John Macintosh, of Berners-street, Middlesex, civil engineer, for improvements in steam-engines, in rigging and propelling vessels, and facilitating their progress through water.—December 4.

William Wood, of Oxford-street, Middlesex, carpet manufacturer, for improvements in the manufacture and ornamenting of carpets, rugs, and other fabrics.—December 4.

James Thompson, and Frederick Altree, of Compton-street, Brunswick-square, bakers, for improvements in the means of and apparatus for heating ovens.—December 5.

Joseph Harrison, of 10, Oxford-square, Hyde-park gardens, engineer, for certain improvements in steam engines.—December 8.

Peter Armand Lecomte de Fontainemoreau, of South-street, Finsbury-square, for improvements in the apparatus for kneading and baking bread and other articles of food of a similar nature. (A communication.)—December 8.

Richard Archibald Brooman, of the firm of J. C. Robertson and Co., of Fleet-street, patent agent, for certain improved modes of applying electro-chemical action to manufacturing purposes. (A communication.) December 8.

Richard Archibald Brooman, of the firm of J. C. Robertson and Co., of Fleet-street, patent agent, for improvements in the manufacture of sugar, in the preparation of certain substances for such manufacture, and in the machinery or apparatus employed therein. (A communication.)—December 8.

Isaac Alexander, of 112a, High Holborn, Middlesex, biscuit baker, for a mode of preparing and treating certain kinds of cheese, whereby to render the same applicable to a variety of culinary and other domestic purposes.—December 8.

Perry G. Gardiner, of New York, civil engineer and machinist, for improvements in the manufacture of malleable metals into pipes, hollow shafts, railway wheels, or other analogous forms, which are capable of being dressed, turned down, or polished in a lathe.—December 8.

Charles Cowper, of Southampton-buildings, Chancery-lane, for improvements in separating coal from foreign matters, and in apparatus for that purpose. (A communication.)—Dec. 8.

William Pidding, of the Strand, gentleman, for improvements in the treatment, manufacture, and application of materials or substances for building purposes.—December 8.

John Lake, of Apsley, Hertford, civil engineer, for improvements in propelling on canals and rivers.—December 8.

Thomas Restell, of the Strand, Middlesex, watchmaker, for improvements in locks or fastenings.—December 8.

John Frearson, of Birmingham, for improvements in cutting, shaping, and pressing metal and other materials.—December 10.

James Webster, of Leicester, for improvements in dyeing gloves and other articles of hosiery.—December 10.

Etienne Alexander Armand, of Paris, for improvements in the modes of distilling and treating organic substances and bituminous matters, and in the treatment of their products, together with the apparatus used for the said purpose.—December 10.

Alfred Vincent Newton, of Chancery-lane, mechanical draughtsman, for improvements in dyeing textile fabrics. (A communication.)—December 10.

Thomas Masters, of Regent-street, confectioner, for improvements in obtaining and drawing off aërated and other liquids, and in charging vessels with gaseous fluids, applicable to vessels for holding solid matters, and also as a fastening for utensils and apparatus, and in holders for cigars.—December 11.

END OF VOLUME XIV.