VISITS TO THE PROVINCES.

THE WIDNES FOUNDRY.

Fourteen thousand tons of pipes is not a small order. It is large enough to make the owners of a foundry, even a large one, feel that the energy usually devoted to finding work may for a while be called upon to do but little. The Widnes Foundry Company, of Widnes, has now under execution a contract for this quantity of pipes, a part of the large number which will be required by the Vyrnwy water supply scheme. For this purpose the company has provided itself with some special plant, although the speciality of its works has long been heavy castings and pipes of all sizes. A large quantity of the 14,000 tons of pipes for Vyrnwy is, however, of great size, for water, viz., 3ft. 6in. inside, each length weighing about 3 tons 15 cwt. finished, so that it is imperative that every step shall be taken that is necessary to secure economy in all parts of the manufacture of so many large castings, which have to be made at a price demanding the most careful management with a view to securing the lowest expenditure on every detail in the processes of production.

These 42in. pipes, which are for the new Vyrnwy Waterworks of the Liverpool Corporation, are made in accordance with the plans and specifications of Mr. Thos. Hawksley, M.I.C.E., and Mr. G. F. Deacon, M.I.C.E., of Liverpool. The contract is now rapidly approaching completion, under the supervision of Mr. H. Nicholson, the superintending inspector to the Corporation, assisted by Mr. R. Snowden, as resident inspector.

The Widnes Foundry is situated, as its name implies, in the smoky and somewhat odorous alkali metropolis, Widnes, on the Lancashire side of the Mersey, about twelve miles from Liverpool. The foundry is well known wherever alkali and chemicals of almost any kind are manufactured, as it has long enjoyed a high reputation for the high quality of its productions. It seems like sending coal to Newcastle, but it is a fact that its heavy pans for evaporating and for decomposing salt, and for deep caustic pots, are to be found in every quarter of the globe—even the tariffs of "Vaterland" and the United States not being sufficiently prohibitory to prevent their importation. Some of these caustic pots will hold 18 tons, and they themselves weigh about 9½ tons. They are from 2in. to 2·5in. in thickness, and by a lengthy experience in the best admixtures of irons which will withstand the effects of the acids on one side and of fire on the other, the Widnes Company has made these pans very durable—though even so they last but about eight months. We are, however, more particularly concerned with pipes. We propose, therefore, to follow a pipe throughout its manufacture, beginning with the raw material.

The works are conveniently situated on the main line of the London and North-Western Railway to St. Helen's, from which sidings run into them, bringing iron, fuel, &c., alongside the cupolas, which are charged with metal and coke direct from the trucks, thus effecting a considerable saving of labour.

Closely adjoining the cupolas is the pipe "pit," in which the pipes are moulded and cast. Over this pit work two steam travelling cranes on an overhead gantry, running not only the whole length of the foundry, but beyond it, across the yard to the siding before mentioned. These cranes are powerfully driven, and move along the shop at the rate of about 200ft. per minute when required. The moulds, which are drysand, are made vertically, with the sockets downward, the pattern being withdrawn by hydraulic power, and are dried by means of gas flames, the gas for which is produced on the premises by Howson and Wilson's gas-producer, the cores being also dried by the same means.

Considerable care is used in the preparation and drying of the cores, as it is considered very important that the pipe should present a smooth surface internally, so as not to interfere with the quiet and easy flow of the water, or offer facilities for the attachment of parasitic growths, which speedily diminish the capacity of the mains. When moulds and cores are sufficiently dried, the cores are brought forward by one of the travelling cranes over the centre of the moulds, and by a special arrangement of the crane are lowered into place with great rapidity. So quickly is this done that the workmen describe the operation as "dropping the cores in," and in a few minutes the mould is ready for casting.

On page 402 we give a general view of the foundry in which the Widnes Company is making these pipes, and of part of the ground occupied by the testing and coating plant. Some description of what is to be seen during a walk through these parts of the Widnes Works may not be without interest.

Amongst special tools for making pipes, the moulding box or flask, the mould, and the core frame are leading elements. The moulding boxes at Widnes are long cylinders made in halves, and held together by bolts, as shown by annexed engraving, Fig. 1, or by bolts or cotters put into the notches in the vertical flanges, made as also shown in the annexed engraving, Fig. 2. The latter form is most used, as less time is occupied in putting them together and taking apart. The flasks are about 13ft. 6in. in length for pipes which are 12ft. 6in. in length over all when finished, a head of about 1ft. in length being cast on the end to secure soundness. The lower end of the flask is bored to fit the base upon which both it and the core stand, and the core frame is turned to fit in a similar way into the base, which is a casting forming a carriage for the spigot end of the mould. The 3ft. 6in. pipes are 1·5in. in thickness, and the flasks are only made large enough to have about 1½in. of sand all round them, a quantity which would seem to leave a very thin wall of sand. It is, however, found that such a wall stands as well or better than one of greater thickness, and the thin one has the great economical advantage that the time required to dry the mould is reduced to the lowest limit. This is an important consideration, for not only does the number of flasks employed depend upon it, but the size of the casting pit must be larger or smaller according to the number of flasks in use. Thus, by getting the thickness of the sand down to the lowest, several important economical results are obtained, and these are sufficient to make it expedient to have flasks of different sizes for almost every different size of pipe. The pattern upon which the flask is rammed up is about 6ft. in length for 3ft. 6in. pipes. The lower end of this fits into a base, upon which the flask also fits. Upon a stage round the flask four men work with thin T-headed pegging rammers, while two lads fill in the sand. As soon as the sand is rammed up to near the top of the pattern, or to a height of 6ft., the pattern, which is suspended by a chain from the hydraulic crane, shown at page 402, is gradually raised, the hydraulic crane giving it a very steady pull at the rate of about 9in. per minute, the whole mould being rammed up in from sixteen to eighteen minutes. In the walls of the flasks are holes about 6in. apart, to facilitate the escape of gas from the sand and through the sand. The casting pit, shown at page 402, is 40ft. in length, 25ft. in breadth, and 12ft. in depth.

The core carriers are strong castings split at once side, and provided with internal projections on that side, into which fit the wedge surfaces, which are formed on one long bar. When the core is made this carrier is, of course, extended by the wedges. The core is then dried in ovens, as shown in the drawing, these ovens being heated by means of the gas jets from the Wilson gas producer already referred to. The ovens thus require no attention, and the gas is cheaper and cleaner than coke fires. When dried the core is placed on the base above referred to, the flask lowered over it, and the casting made. The ladles carry about four tons of iron, and a pipe is poured in one minute.

Fig. I

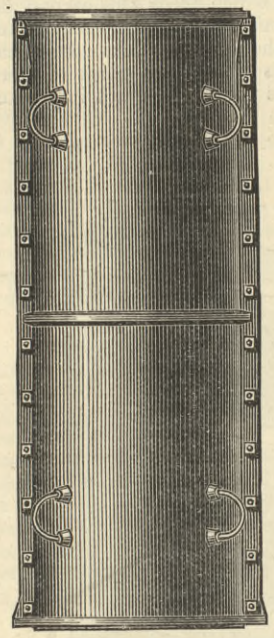
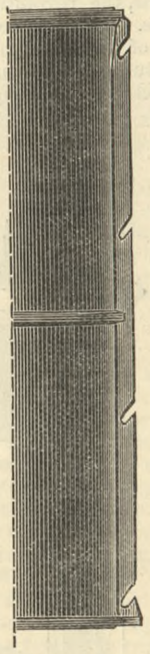


Fig. 2



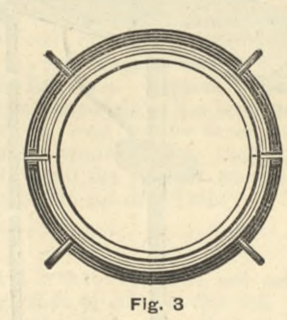


Fig. 3

In accordance with the specification, special precautions are taken in the mixture and melting of the metal. In order to preserve the proper mixture of iron, transverse test-bars of the same metal are cast with each pipe, and numerous tensile test-bars are also cast of the same iron, all of which are subjected to dead-weight tests, a certain proportion of them being also loaded with the prescribed weight for twenty-four hours, the load being then increased until fracture ensues. Several of these test pieces were broken on the occasion of our visit. Those tested by transverse stress are 2in. by 1in., resting upon supports 36in. apart; one broke with 29 cwt. and the other with 30·25 cwt. on the centre, the specified strength being 28 cwt. The tensile strength is ascertained by means of test pieces turned to 1·125 diam., which is 0·994 square inch sectional area, or practically one square inch. Three of these broke with, respectively, 10 tons 16 cwt., 11 tons 16 cwt., and 12 tons 2 cwt. 2 qr. The quality of the iron may be thus gathered, as it will be seen that the iron is tough as well as of a high tensile strength.

When the pipe has been cast a sufficient time the core-wedges are withdrawn, but the pipe is left several hours in the mould to cool, and when sufficiently cooled to be removed without detriment, it is lifted out of the pit and laid on one end of a covered iron gantry to be dressed. As the dressing proceeds it is rolled forward, eventually reaching the lathe, which, while cutting off the head and finishing off the spigot end, simultaneously turns the socket belt for the reception of a wrought iron strengthening hoop. On leaving the lathe it is passed on to the long "proving house," which is shown in the engraving. This is laid with steel rails, along which the pipes are rolled for inspection; here they are each minutely examined, measured, and weighed; the diameter, thickness, weight, amount of socket joint, and other particulars of each pipe—which has cast on it a consecutive number—are carefully taken and separately recorded, and daily reports made to the engineers by their resident inspector. In addition to measurement by gauges to go over the spigots and inside the sockets, the pipes are frequently tested by socketting one into the other, as in laying, and the amount of joint ascertained by the insertion of a gauge. Being found sound, so far as can be seen, they are rolled forward on the gantry to be proved by hydrostatic pressure by Mr. Hawksley's new system, in which oil is substituted for the water usually employed. The proving machine consists of two fixed heads, strongly connected together by tie-bars, between which the pipe passes freely; one head contains passages for the supply of oil from a large tank, elevated considerably above the press, the other a large ram which is forced against the pipe after the fashion of the hydraulic press, oil being used, however, instead of water. A joint is made at each end, by means of gaskets, and the pipe rapidly filled with the oil, which is then raised to a pressure equal to 600ft. or 700ft. of water, and this pressure maintained for several minutes, the pipe being meanwhile repeatedly struck with sufficient force to produce a strong vibration of the metal. Having satisfied this crucial test, they are rolled onward in the direction of the coating tank, commanded by a tall steam jib crane, as shown in the engraving, and are hooped with a 1¼ square wrought iron hoop shrunk on. This hoop is not only to secure strength in the socket, but to prevent breakage in transit. Being hooped they are now ready for coating, for which purpose they are lifted by the steam crane into an oven, and when sufficiently heated are immersed vertically in a bath of Dr. Angus Smith's solution. When sufficiently cooled, they are lifted by the same crane into the railway trucks, and the distinguishing numbers and weights painted inside, the coating examined, and the hoops finally tested by the inspector with the hammer to detect any possible unsoundness in the welding or looseness in the fit, and are then despatched. The special pipes and castings, of which, as may be supposed in an undertaking of such magnitude, there are a considerable number and variety, are made in "loam," in a separate foundry, the same precautions being observed in their manufacture as are used in that of the plain pipes. Great importance being attached to the preservation of the pipes from rust, the foregoing operations are carried on under cover, and it is principally for this reason that oil has been substituted for water in proving.

ARC LAMPS AT THE VIENNA EXHIBITION.

No. IV.

The Pilsen, Crompton, and Tschikoleff lamps.—In the last lamps we described, namely, those of Schwerd and Siemens, the ratchet escapement motion feeding the carbons was necessary, because the iron cores hanging in the electro-magnets could not shift their position through any except a short range without the ratio of the sucking-in force to the current strength varying largely. If the core were allowed to move so far that this ratio altered to any considerable extent, there would result a corresponding alteration in the current through the carbon. The escapement feed is therefore introduced, in order to allow the regulating core to oscillate through a small range only about its position of nearly neutral equilibrium. In the Pilsen lamp—so called from the name of the village where it is manfactured by Piette and Krizik—the necessity of the escapement or "slip" feed is done away with by the ingenious device of making the cores conical and very long. According to the inventor, this results in the sucking-in force being the same for all positions of the core in the solenoid, so long as the current keeps constant; that is, that the ratio between the sucking-in force and the current-strength remains the same for all positions of the core, whether it be high up or low down in the current coil. We are not aware that the theory of this law of attraction of conical cores has been worked out, nor whether it has been proved to be an exact law; but the principle leading in the direction of the above result is easily recognised. It is this. As the cone is drawn further into the solenoid a greater quantity of metal moves into that portion of the magnetic field of maximum intensity. The increase of sucking-in force due to this cause compensates—either approximately, or, according to Mr. Piette, exactly—the simultaneous decrease due to the passage of more of the metal to the underside of the centre of the coil. Originally there was only one core in the Pilsen lamp passing through two coaxial current coils, the one being the arc and the other the shunt circuit. In the recently improved arrangement, however, the two coils are side by side, and through these pass two exactly similar conical cores. These cores are connected by a cord passing over a small pulley situated above both. Both coils have the same external dimensions, namely, 60 mm. diameter and 140 mm. length. Each core has a parallel portion 365 mm. long and 20 mm. in diameter, and a conical portion 280 mm. long, with a straight taper from 20 to 4 mm. in diameter. A brass tube surrounds, and is fastened to, each of these cores, serving to protect them from atmospheric rusting; and to the continuation of these tubes are fastened the carbon holders. The lower carbon is attached to, and moves along with, the core passing through the coil through which the arc current circulates; while the upper carbon is fastened to the core in the shunt current coil. This latter is loaded so as to weigh slightly more than the former, so that when no current passes, and the solenoids exercise no magnetic attractions on the cores, the two carbon points are close together, the upper one pulling up the lower one by means of the cord. As soon as the current flows the arc current coil pulls down its core, thereby lowering the lower and elevating the upper carbon. This separating movement of the points continues until the shunt current is so strong that the attraction of its solenoid upon its core balances that of the arc current solenoid upon the other core. This balance is arrived at when the arc and shunt currents have a certain definite ratio depending only upon the ratio of the numbers of turns in the respective coils, and not depending upon the position of the cores in these coils. Thus as the carbon points burn away, the ratio between the two currents remains constant; and, as the resistance of the shunt remains always the same, it follows that the arc resistance, and with it the arc length, remain constant also. A second small shunt current excites another electro-magnet of small size. When the current exceeds a certain safe limit, the attraction of the armature of this last magnet makes contact for a short circuit through a platinum resistance coil, thereby cutting out the one lamp without interfering with the supply of current to the others in the same circuit. Whether this lamp is perfect in theory or not, as a matter of fact it has burnt with very creditable steadiness at the Vienna Exhibition. It is preferred to couple not more than about eight in series; but they can be used with as many as fifteen in series. The lamps that are used in the Exhibition average about 1200-candle power with 7 to 8 ampères and 50 volts. There are forty lamps of nominally 1500-candle power in the upper gallery of the Rotunda, three of 1000 candles in the Austrian Pavilion, and seven of the same power in the ground gallery of the Rotunda; while they have one lamp of 20,000 nominal candle-power in the lantern at the top of the building.

Another successful lamp shown at Vienna is that of Mr. R. E. Crompton. This is illustrated in Fig. 7. It resembles the Pilsen lamp in having the two carbon holders connected by a cord running over a pulley; but this is really only a superficial point of similarity. The upper carbon *c*, which is also the positive one, is suspended by the cord which, passing over the pulley *a*, is led round the pulleys *b* and *e* and thence down the side of the frame to the guide pulleys *f* and *g*, under the pulley *h* and over another not shown in the drawing to the screw *k*, where it is fastened. Of these pulleys all are fixed in the frame excepting *b* and *h*. The latter carries the lower carbon holder, and when raised lifts the lower carbon with it. So long as *b* maintains its position unchanged, it is evident that if the cord be pulled over so as to lower the upper carbon, this raises *h* and the lower carbon through half the height through which the upper one sinks. The gearing is arranged thus because the positive carbon is consumed at about double the rate of the other, and thus the level of the light focus is kept nearly constant. The above motion of the cord is only possible when all the pulleys are free to revolve, and is prevented by the spring friction brake *l* so long as this is allowed to act on the pulley *b*. When *b* is free, the upper carbon holder being made a little heavier than half the lower, its weight draws the cord round in the above direction, so as to approach the incandescent points. *b* has its bearings in the frame B, which is at liberty to move up and down, swinging on the radius rod R hinged at *i*. This frame also carries the brake spring *l*, and when it rises so far that *l* comes in contact with the stop *t*, this contact relieves the brake pressure and allows *b* to revolve. To the frame B is hung the iron core passing through the two solenoids *s* and S. The latter is traversed by the main arc current, and draws down the core, so as to prevent *l* touching *t* and clamp the pulley *b*. The other coil *s* carries the shunt current circulating in the opposite direction to that in S, and therefore counteracting its effect to an extent depending on their relative strengths, and therefore upon the resistance of the arc. The brake pressure exerted by *l* is regulated by a small spiral spring. When the lamp is working *l* never sinks so low below *t* as shown in the illustration, but, on the contrary, keeps quite close to it, alternately touching it and separating from it a minute distance only. This mechanism is an extremely delicate one if properly adjusted. The lamp, however, suffers from the disadvantage of having large solid parts underneath the light, which throw inconveniently large shadows downwards. This evil is greatly mitigated if, as in the arrangement shown, the light is thrown downwards by a conical reflector cap. To show the direction toward simplicity taken by Mr. Crompton, we illustrate by Fig. 8 his original lamp, as shown at the Crystal Palace. In this there are no fewer than six coils. The general mode of action of the lamp is, however, nearly the same as that of the lamp shown in Fig. 7, the cage being lifted to strike the arc, and the descent of the upper carbon being controlled by a brake and clock train.

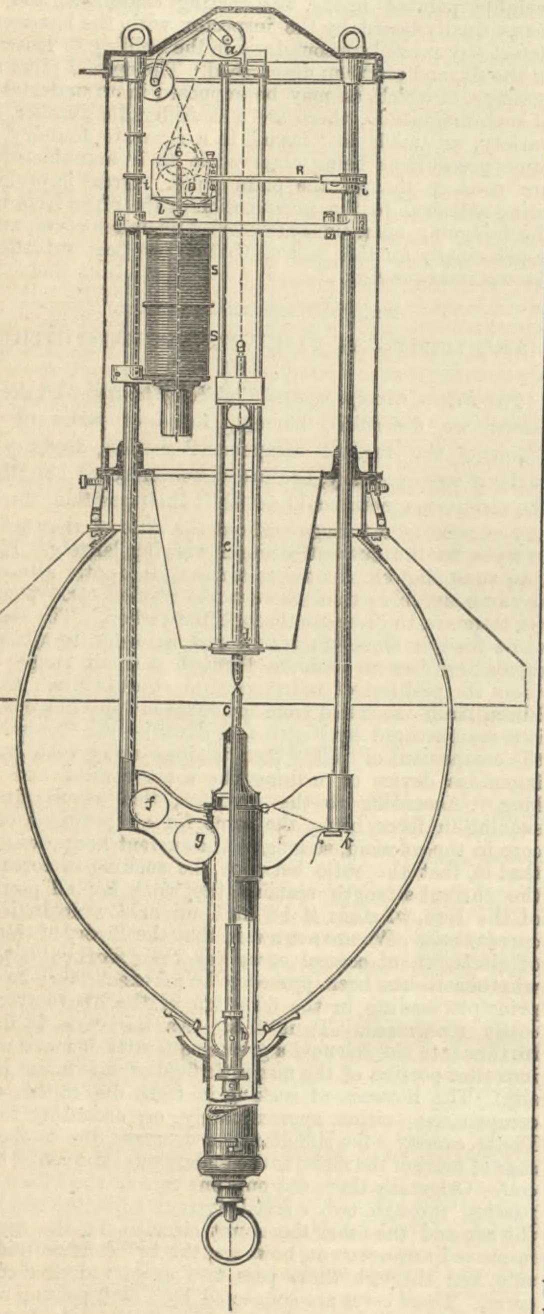


Fig. 7.

It may be interesting to describe very shortly a lamp exhibited by W. N. Tschikoleff, of St. Petersburg. It has some points of merit, but the mechanism is complicated and expensive, and the general idea of the design, although original and ingenious, is rather clumsy. The lower carbon rests in a fixed brass tube, and is fed upwards against a stop of refractory material by a spiral spring like that of a coach lamp. The upper carbon is grasped between two wheels, the revolution of which feeds this carbon downwards. Thus there is nothing but rotary motion in any part of the mechanism, the carbon sticks alone having longitudinal motion. This is the chief point of merit in the design. Although it is not one of much importance—because rotating pieces require, *cæteris paribus*, just as much force to start and stop their motions as do pieces moving rectilinearly—still it might be worth while to work this idea out more neatly than is done in the present lamp. The arc current comes to the carbon through one of these wheels, which, being centred on a swing lever, is made to press with sufficient force to make good contact against the carbon stick by the action of an electro-magnet traversed by the main arc current. This wheel is free to revolve in its bearings. The other is in one piece with a fine thread worm wheel actuated by a worm on the vertical spindle of a diminutive electro-motor. A shunt to the main current drives this motor so as to lower the upper carbon when the shunt gains sufficient strength to do this work. The speed of rotation of this motor is regulated by a small four-ball governor, the legs of which when they fly beyond certain limiting positions catch upon stops, thus stopping the rotation of the motor and the feeding of the carbon. It is hardly necessary to say that this arrangement does not regulate well; but, in spite of the crudeness of the design, some ideas expressed in it deserve attention. A second shunt exciting another electro-magnet makes contact for a short circuit when the current reaches the limit considered safe. This contact is made by carbon points, one of which is mounted on the end of a lever to which the armature of the magnet is attached. There are six of these lamps exhibited in the Rotunda. The current used is 12 ampères.

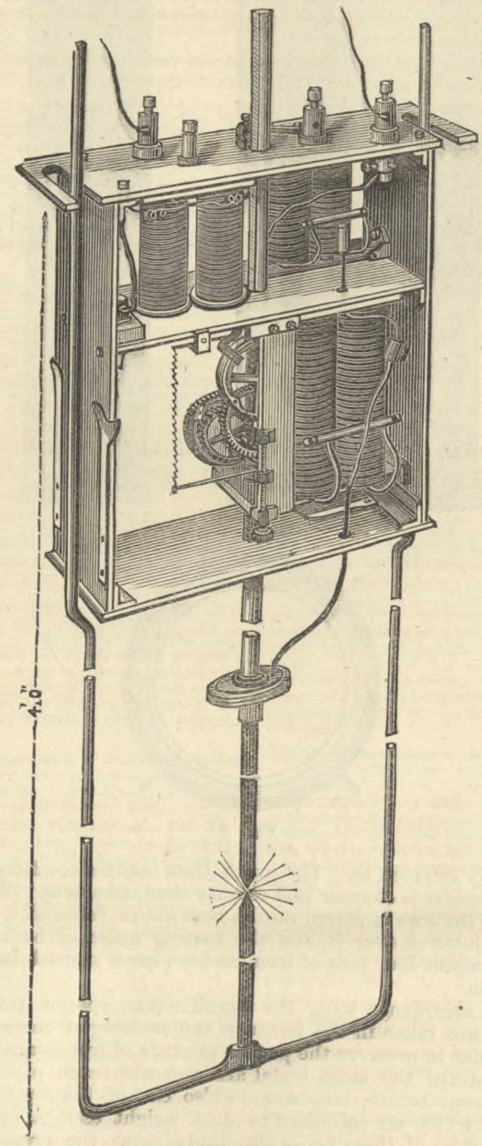


Fig. 8.

According to recent census returns, there are now 88,544 British born subjects in India. This is exclusive of those British people born in India.

GRAPHICS, OR THE ART OF MAKING CALCULATIONS BY DRAWING LINES.

By Professor R. H. Smith.

No. III.

Division of the Subject—Graph-Arithmetic.

Graphics may be divided in correspondence with the ordinarily-recognised different methods and subjects of calculation. These are:—(*a*) Arithmetic, (*b*) Algebra, (*c*) Trigonometry, (*d*) Dynamics, (*e*) Tabulation and Analysis of Experimental and Mathematical Results. A few words of explanation regarding each of these sections of the subjects may be useful before proceeding to the detailed treatment.

Graph-arithmetic.—Arithmetic shows how to find increased or decreased quantities when they are altered by given amounts or in given ratios. As the solution of every practical problem involves, and, in fact, to a great extent consists in a more or less complex series of such operations, the rules of arithmetic are applied continually throughout all graphic constructions. It is thus of great importance to be thoroughly familiar with them, and with the special suitability of each rule for the circumstances to which it is most adapted.

Graph-algebra consists in the solution of equations by drawing straight lines and curves. Not much will be said on this subject, as it is not of special interest to engineers. The usefulness of the method in solving equations, which would be very difficult or impossible to solve by other means, will be illustrated by a few examples.

Grapho-trigonometry is the "solution" of triangles and other rectilinear figures, that is, the calculation of unmeasured sides, angles, and areas from the sides and angles that have been measured. Applications to surveying measurements will be given, especial attention being given to problems that are difficult to solve by other means.

Grapho-dynamics.—Dynamics may be considered under three heads:—Kinematics, or the pure geometry of motion; kinetics, or the laws of motion as dependent on the masses of the bodies moving; and statics, that special branch of kinetics dealing with cases in which the motions are zero, and the forces in equilibrium. Some simple constructions which apply equally to all three sections of dynamics will first be illustrated. There is great practical convenience in treating statics separately from kinetics; and since the bulk of the interesting engineering problems to which the graphic method has been applied belongs to statics—*e.g.*, applications to bridge and roofwork—this portion of the subject will be taken before the more difficult problems of the kinetics of motion. The plan of separating kinematics from kinetics has been followed in many modern text-books of high authority; but, whatever advantages this may offer from a strictly logical and deductive point of view, it is very questionable whether there is any gain in following the system in the teaching of practical mechanics. There is no such thing as pure motion unconnected with mass; and, as it is by far the safest course to draw all our knowledge from our actual experience, it seems best to treat the two parts of the subject simultaneously. This is the course that will be followed in these articles, especially because all our examples must be drawn from the region of practical engineering work.

The results of a series of experiments—for example, on the relation between the speed of a vessel and the horse-power indicated by its engine, or on the relation between the pressure and temperature of steam—are best made clear by plotting them graphically, *i.e.*, drawing a curve, the rectangular ordinates to which are the values of the quantities whose relation is to be investigated. This assists in the elimination of experimental errors; it shows the relation found in a very clear manner to the eye, and through it to the mind; and if a formula is desired to represent the variation, the curve can be analysed as to its geometrical properties.

The best and most accurate formula by which to design some dimension is often complicated and tedious in its application to each special case. This prevents its use in practical life where men are busy and have to economise time. Its use is also prevented by the difficulty of understanding the general meaning or the effect of so complex a rule. These difficulties are entirely done away with if the results of the formula are represented by a curve, and the application of a difficult and cumbrous formula becomes absolutely as easy as that of the most simple. These curves ought to be drawn on square sectional paper, the divisions of which ought usually to be decimal. This plotting out of experimental and mathematical results may be called graphic tabulation.

Simple addition and subtraction can seldom be performed by graphic means with any advantage, so far as ease and rapidity are concerned. Suppose two or more quantities known, and that they are to be added together. The sum can be found by ordinary numerical addition much more easily and quickly than can be completed the process of plotting off the magnitudes to a certain scale along a straight line, each successive length plotted having its left-hand end at the right-hand end of the preceding one, and then reading off to scale the length of the line made up of these separate parts. This is evidently the only possible graphic process of arithmetical addition. If any of the magnitudes are to be subtracted, they are to be measured off in the opposite direction to that of the others—that is, backwards along the line on which these others have already been plotted off. This graphic method of addition is, nevertheless, often convenient as a step in a more lengthy and complex graphic calculation. Suppose that by graphic means we have obtained lines the lengths of which represent to a certain scale certain magnitudes. These magnitudes taken separately may be of no interest, but their sum may be the final object of the calculation, or may be needed in order to continue the calculation to its completion. It would cause more trouble, use more time, and be less accurate to read off each of these parts to scale and add the scaled lengths numerically than to add them graphically by careful use of the dividers, or otherwise, and to read off to scale only the resulting sum of the lengths. The scale cannot be read to such minuteness and accuracy as the dividers can be set to, and the sum of the errors in reading the different quantities to scale is therefore always probably greater than that of the errors due to inexact setting of the dividers. Moreover, the error in reading to scale is nearly always in the same direction—either always a little too much or else always slightly too small, the direction of the error depending on the peculiarity of the eyesight of the draughtsman. The error in setting the dividers has not the same invariable character; it is as often positive as negative, and the chances are that numerous errors of this sort will not accumulate, but will more probably neutralise each other to so great an extent that the sum of a large number of errors will be by no means correspondingly large.

Sometimes a quantity can only be found by adding up a very long series of very small parts. The magnitude of each small part in the series may be determined beforehand, but not unfrequently it cannot be found until the sum of all the previous parts in the series has been calculated. This kind of addition is called integration. Sometimes, when the law determining the successive values of the small parts is a simple mathematical one, the process of integration is very much simplified by mathematical calculation, as explained in the Integral and Differential Calculus. To attain a moderate approximation to accuracy, the parts require to be taken very small, and correspondingly numerous. Thus to integrate by ordinary numerical addition is an immensely tedious operation. The same process, however, may be carried out much more rapidly, and with much less fatigue, by graphic means. In the later of these articles, when we deal with somewhat complicated constructions, we shall have many illustrations of this graphic integration. As illustrations of the beneficial employment of graphic integration occur only in these somewhat difficult problems, we may pass by the subject for the present, promising to return to it when its utility will have become more evident and its interest, therefore, greater.

Graphic multiplication.—The problem is to find the product of two or more known quantities.

Let a and b be the quantities; $x = a\,b$ is to be found. This may be thrown into one of the two forms—

$$\frac{x}{a}=\frac{b}{1}$$

and—

$$\frac{x}{b}=\frac{a}{1}.$$

The graphic construction is to draw two similar triangles, in one of which two sides are made 1 and b (or 1 and a), and in the other of which the two similar sides are a and x (or b and x). This will give us a line x, the length of which to the proper scale represents the product $a\,b$. The pair of triangles may be formed in the two ways represented in Fig. 5. In the first of the Figs. 5 b is associated with 1 in the one triangle and x with a in the other, 1 and a being marked off along the same straight line—or parallels—and x and b lying along the other side of the triangle—or parallel sides. The two lines on which $b\,x\,a\,1$ are marked may stand inclined to each other at any angle.

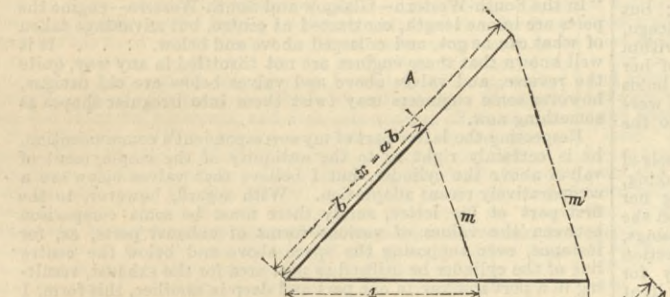


FIG. 5

In the figures the heavy lines indicate the data. The light full lines indicate the lines that require to be actually drawn on the paper. The dotted lines (m and m^1) do not need to be drawn, except at the extremity of m^1, where the intersection has to be marked by drawing a short portion of m^1 across the other line. After marking off b a and 1 the edge of a set-square is laid across the end points of b and 1 in the first figure—or of a and 1 in the second figure—then the set-square is slid on another straight-edge until its edge passes through the end point of a in the first figure, or of b in the second figure; finally, in this position the intersection of m^1 and b produced, giving the extremity of x, is marked with pencil.

These two diagrams of Fig. 5 of course give the same length for x; but the first is a better construction than the second. In the first the intersection of m^1 determining the length of x is a more sharply defined point than in the second figure, because the angle between m^1 and x is greater in the first than in the second. This arises from the fact that b is more nearly equal to 1 than is a. There results the rule for the above construction that 1 should be marked off on the same line with that one of the two quantities a and b which differs most from 1. The difference between the two cases is expressed by saying that the triangles in the first are "better conditioned" than in the second. If in the second the ratio between a and 1 were considerably greater than it is in the drawing, the triangles would be "ill-conditioned." As the angle at which two lines cut each other becomes smaller, their intersection becomes less well defined, and the reading of a length to it becomes liable to a greater possible error. This arises in two ways, illustrated in Figs. 6 and 7. In Fig. 6 the thickness of the intersecting lines is magnified, each line being shown by a double line. The intersection of the two has really the length marked e on the diagram.

Fig 6.

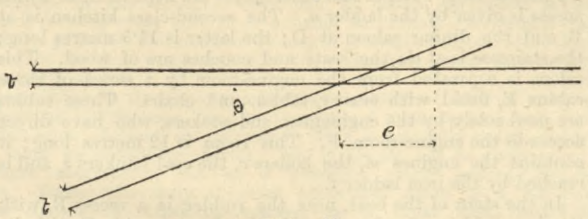
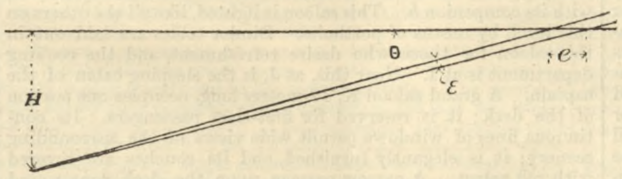


Fig 7



The angle of intersection being θ, and the thickness of the line t, it is easily shown that the length of the intersection is—

$$e=t\,\frac{1+\cos.\theta}{\sin.\theta}$$

which becomes very rapidly larger as θ becomes smaller. The reading of a length to this intersection must be indefinite within this range e.

In Fig. 7 is shown the error in the position of the intersection resulting from drawing one of the lines in a slightly incorrect direction. If the incorrectly drawn line is drawn from a point distant H from the other line, it is easy to prove that the error e resulting from an angular error ϵ in the direction is equal to—

$$e=\frac{\epsilon\,\mathrm{H}}{\sin.^2\theta}$$

which for the same error ϵ increases still more rapidly as θ decreases than does the error shown in Fig. 6.

In Fig. 5, of course, a and b may represent any quantities either of the same kind or of different kinds. For instance, they may both be lengths, and then the desired product is an area. If they are both of the same kind they can be marked off to the same scale. If they are of different kinds they must of necessity be represented on different scales. In either case their product cannot be measured to the same scale as either of the factors. What, then, are the relations between the different scales employed in the construction? This is explained at once by observing that a length to represent unity (1) has been marked off. This unit length has been, of course, measured to a certain scale. In the first diagram of Fig. 5, it is set off on the same line as a. Suppose it has been measured to the same scale as has been used for a, then x must be read to the same scale as b, in order that its length read to that scale may numerically equal the product of a and b, the geometrical ratio equation being—

$$\frac{x}{b}=\frac{a}{1}$$

But if x is to represent, not only the numerical magnitude of $a\,b$, but the real product $a\,b$ itself to a scale of its own, that scale cannot be the same as that of b. The unit of that scale represents unit quantity of the particular kind resulting from the multiplication of a and b. For instance, if a and b are lengths, say in feet, the unit of the x scale is unit area, say 1 square foot; or if a is a length in feet, and b a weight in pounds-weight, the scale of x is one of quantities of work, or of force moments, in foot-pounds. This may be more clearly understood, perhaps, by considering the equation in the form—

$$x\times 1=a\times b.$$

This equation may be expressed in words thus: "x to the scale of a multiplied by 1 to the scale b equals a multiplied by b," or "x to the scale of b multiplied by 1 to the scale of a equals b multiplied by a." It is plain that the scale of x depends on that to which 1 has been marked off, and that any scale may be adopted for 1, provided a corresponding inverse change is made in the scale to which x is read off. For example, in the third diagram of Fig. 5, 1 is marked off to double the previously used scale. The length in inches obtained for x is just half that obtained in the first two diagrams, but when read to half the scale used for x in these first two diagrams, the same result is obtained as before. To illustrate further, suppose a is a number of pounds weight, say 160 lb., measured to the scale of $\frac{1}{100}$in. = 1 lb., and b is a number of feet, say 11ft., measured to the scale of $\frac{1}{10}$in. = 1ft. Suppose, now, that unity is marked off to the same scale as that of b; that is, $\frac{1}{10}$in. is marked off as 1. Then x must be read to numerically the same scale as a, that is, to the scale $\frac{1}{100}$in. = 1 foot-pound. It would be found to be 17·6in. long, and to this scale would mean 1760 foot-pounds. Suppose, however, that 1 is marked off to double the b-scale, that is, ·2in., is taken as unity; then the length obtained for x would be 8·8in., and this length must be read numerically to half the a-scale, namely, $\frac{1}{200}$in. = 1 foot-pound; and to this scale it will mean as before 1760 foot-pounds. Once more, suppose 1in. taken as unity (1), that is, ten times as much as represents 1ft. on the b-scale. Then the length obtained for x will be 1·76in., and the unit of the x scale must be $\frac{1}{10}$ of the length that represents 1 lb. on the a scale, that is, $\frac{1}{1000}$in. To this scale x measures as before 1760 foot-pounds. If 2in. is taken as unity, the length got for x will be ·88in., which, read to the scale $\frac{1}{2000}$in. = 1 foot-pound, means again 1760 lb.

In the first two constructions of Fig. 5, 1 = 1in.; in the third 1 = 2in.* If $\frac{1}{10}$in. had been taken as unity, the lines m and m^1 would have been inclined to b and x at a very small angle, and the intersection of m^1 defining the end of x would have been an ill-conditioned one. It is true that a long length can be read with a smaller percentage of error than a short one. If lengths can be read to ·01in., an error of ·005in. is ten times more serious in a length of 2in. than it is in one of 20in. But the error that may arise from a small inaccuracy in the direction of the line m^1—due either to inexact setting of the set-square to the line m, or else occurring in the sliding of the set-square from the position m to the position m^1—increases much faster than does the length of x—nearly in the ratio of the square of this length. Also it must be remembered that if it is possible to read the long x with greater proportionate exactitude, to obtain the long x a short 1 must be used. As the proportionate error in reading x decreases, the proportionate error in marking off 1 increases. It is evident, therefore, that such a length should be adopted for 1 as will make the intersection of m^1 with x as well-conditioned as possible. This result is obtained by adopting for 1 a convenient length as nearly equal either a or b as possible. But it must not be chosen so as to give an awkward scale by which to read x. Thus, if the scales used are parts of inches, 1 may be chosen 10in., or 5in., or 2in., or 1in., or $\frac{1}{2}$in. If millimetre scales are used, 200, 100, 50, 20, or 10 mm. may be used as 1.

This rule of arranging the units so as to get well-conditioned triangles cannot always be attended to through long complicated graphic constructions involving series of successive multiplications of a variety of quantities of greatly different magnitudes, because in order to follow it it would be necessary to change the unit and the scales from time to time. This would lead to hopeless confusion, and in such circumstances it is frequently necessary to work with ill-conditioned triangles. The above considerations are, however, of the greatest possible importance throughout the whole of graphic calculation, and they have, therefore, been presented here very fully. Whenever it leads to no confusion or other inconvenience, the unit should be chosen according to the above explained principle. Whenever it is impracticable to do so, it is well to remember that increased care and exactitude in drawing is necessary whenever intersections at acute angles have to be used. In all cases it is necessary to have a clear conception of the true meanings of the different scales used throughout the diagram, to understand the relations between the scales; and to avoid the confusion of imagining that scales which are essentially different in kind can be in any sense the "same scale"—that is, for example, that 1in. = 1 lb. and 1in. = 1ft., and 1in. = 1 foot-pound, and 1in. = 1 square foot area, are in any sense the same scales, or that they are equal in any way, except that they are to be read numerically in the same manner. While the difference of the scale of x from those of a and of b should be remembered, its relation to these should be clearly comprehended, and the manner in which it is to be deduced from these and from the value taken as 1 should never be lost sight of.

The construction of Fig. 5 can be modified in a great variety of ways according to convenience in special circumstances. The special circumstances result chiefly from the different relative positions on the drawing paper that are found to be occupied by the factors a and b in the course of an extensive graphic calculation. The factors generally result from previous portions of the calculations as lines in certain parts of the drawing. It is not desired to draw them over again in order to perform the multiplication. They are to be used in whatever positions they may happen to have been placed in already. They may be near or distant, parallel, perpendicular, or oblique to each other. They may both radiate from one point; the extremity of one may lie in some intermediate point of the other; or they may cross each other.

THE WORKS OF MESSRS. ESCHER, WYSS, AND CO. AT ZURICH.

No. I.

THE celebrated Swiss engineering works of Messrs. Escher, Wyss, and Co., of Zurich, were founded in 1807 by M. Hans Kaspar Escher, who had been educated as an architect, and studied for his profession for some time in Rome. Several buildings designed by him may be seen in Zurich, the chief commercial town in Switzerland. The natural taste of Kaspar Escher was, however, in the direction of mechanical engineering. When cotton-spinning machines first came into use in England, their exportation was forbidden by law. Kaspar Escher, who believed they had a great future before them, came to England to examine them; but the jealousy against their inspection by foreigners was so great, that he had to gather what information about them he could, by inspecting what he could see of them from the streets outside factory windows. He returned to Zurich, and set to work to solve the problem; at first he made small models of machines and parts of machines which were worked by hand, until at last he overcame the difficulties in the way of constructing one for practical use, to be driven by water power. He then bought a flour mill at Zurich, erected a spinning mill on a larger scale on its site, and drove his machinery with two new large water-wheels made by himself. Thus was founded the firm of Escher, Wyss, and Co. At the outset it was a joint stock company, formed to erect and work a cotton mill; there were but few shareholders, most of whom were not responsible for more than the amount of their shares. The liability, however, of two of the members, M. Kaspar Escher and his brother-in-law, M. De Muralt, was unlimited. Finally, the establishment became a private firm in the hands of Kaspar Escher and his son Albert, assisted by the afore-mentioned M. De Muralt. The liability of M. Wyss, one of the early shareholders, was limited, and he did not remain a member of the firm longer than any other of the limited liability shareholders. Kaspar Escher was born in 1775, and died in 1859. His only son, Albert, served his time in

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* These are the scales to which these figures were actually drawn for this article, but the engraver has reduced them to a size convenient for the width of column.

some engineering works at Manchester, and contributed much by his ability and inventive genius to the extension of the business and reputation of the firm of Escher, Wyss, and Co. He married the daughter of Mr. John Kennedy, of Manchester, in which city he died, and was buried in 1845. After the death of Albert Escher, M. De May, a lawyer, of Berne, who was the son-in-law of Kaspar Escher, became a partner in the firm. Subsequently, M. De May's son-in-law, Mr. Mousson, likewise Mr. de Gonzenbach, of Berne, who married the only daughter of M. Albert Escher, became partners, and took an active part in the management of the establishment. At the present time, M. De Gonzenbach and M. Gustav Neville, of Geneva, are the sole proprietors of the firm of Escher, Wyss, and Co.; the liability of the former partner is limited to the amount of his share, the liability of the latter is unlimited.

The first cotton-spinning mill of Kaspar Escher at Zurich was erected in 1807, and was in use for many years, together with the adjoining shops which he built for the construction of his own machinery. In course of time, between 1820 and 1830, he also constructed water-wheels, gearing, and such-like, when a demand for cotton-spinning machinery arose among his neighbours; consequently, he began the manufacture of machines for them. In 1837 the general manufacture of marine and stationary engines commenced at the works, as well as steamboats for the Swiss and, indeed, the Italian lakes, which latter steamboats were transported piecemeal over the St. Gothard Pass, and put together in the lakes on the other side. The demand for these lake boats increased from various parts of the world, until in 1850 more than 1200 men were employed at the works; the present reduction in that number is partly due to the abandonment of the construction of cotton-spinning and weaving machinery, and partly to the introduction of labour-saving appliances. In 1841 Messrs. Escher, Wyss, and Co., began to make the various descriptions of machinery used in paper mills, and in 1844 the firm turned out its first turbine. In 1847 it founded the first of two branch establishments, each under the charge of a local manager. One of these branch establishments is at Leesdorf, near Baden, in Austria; it now employs from 200 to 300 men. The other branch, employing about the same number of men, was established in Ravensburg, Wurtemburg, in 1856. At these two branches machinery for paper mills, flour mills, and other purposes is constructed, as well as turbines, water-wheels, and all kinds of gearing. Messrs. Escher, Wyss, and Co. were the first on the Continent to make steam engines on the Woolf principle. An engine of this description, made by them, was the first and only one on view in the London International Exhibition of 1862. In 1870 they turned out ferry boats for the Lake of Constance, by which goods trains up to the length of eighteen loaded wagons are to this day ferried across between the railways on both sides. The locomotives are not carried across with them, but could be if necessary. For a short time Messrs. Escher, Wyss, and Co. made locomotives, and twenty were supplied by them for the line running between Calcutta and Delhi. In 1876, the year of the crisis, they began to specialise more; then it was they abandoned the making of cotton-spinning and weaving machines, as already stated.

At present about 900 men are employed in the Zurich works. The establishment is on the east bank of the river Limmat, by which the surplus water of the Lake of Zurich is carried off. The town of Zurich lies between the lake and the works. It is a remarkable thing to see shipbuilding going on in the middle of an inland country; at present several steamboats for the Brazils and elsewhere are in course of construction on the premises. They are put together under sheds, but not rivetted; afterwards they are taken to pieces and transported to their destination. The river alongside the works, although broad and swift, is too shallow for the floatation of steamboats.

The works consist of a foundry, machine shops, carpenters' shops, and shipbuilding sheds. The foundry is too far from the rest of the works to be convenient, so a new one will soon be built. The present foundry employs about 200 workmen. The pig iron at present in use in it is English and Scotch. The cost of transit to Zurich is from £1 6s. to £1 8s. per ton, including the Swiss customs duty of 6f.—about 5s.—per ton. It comes usually to Rotterdam; then is transhipped into the Rhine boats, by which it is carried to Mannheim, whence it is brought to Zurich by rail.

The machine shop, chiefly devoted to the construction of turbines, gearing, and paper-making machines, has about 400 men working in it. The turbines made in it are from $\frac{1}{2}$ to 500-horse power, and, according to their construction, will work with a fall of water varying from 1 m. to 200 m. The Zurich establishment, as a whole, consists of two branches—one for turbines, gearing, and paper-making machines, the other for the construction of land and marine engines and boilers.

At the present time one paper-making machine for Belgium, one for Russia, two for Italy, and some for France and Germany are in course of construction at the works; also some screw and paddle engines for Rhine boats, and a fine screw yacht for the Lake of Geneva, with an engine made by the firm, which was on view at the late Swiss National Exhibition at Zurich; a saloon steamer ordered by the Austrian Government for the Lake of Constance, and which will ply in connection with the Arlberg Railway, from Innsbruck to Switzerland; nine flat-bottomed boats, 30 m. to 70 m. in length, for the Brazilian rivers; sundry horizontal engines; and various minor pieces of mechanism.

The works themselves present but the usual features of such establishments. In addition to the larger machine shops are a carpenters' shop, for the making of patterns; a large blacksmiths' shop, with numerous forges and three small steam hammers; a boiler-house, with an Englishman as its foreman; and the usual smaller departments. A steam engine of 100-horse power, with sometimes a smaller one in addition, is used to furnish auxiliary power to that derived from the water of the Limmat.

The manufacture of steamboats and marine engines began in 1837, and up to the present time 403 marine engines have been constructed, in most cases with the boats also. The construction of turbines began in 1844, and the number made in Zurich and the two branch establishments to this date is 1302. The paper-making machines made since 1841 number 134. The stationary and other engines made in Zurich from the first number 1100.

The first tangential turbine ever constructed was turned out at the Zurich works in 1846. Most of the turbines now made by the firm are on the Jonval and Girard systems.

The first steamboats built for the Swiss Lakes were the Linth-Escher for the lake of Zurich, and the Ville de Lucerne for that of Lucerne. The steamboats on the Lake of Lucerne are well known to most European tourists, and they are of the description represented in our engravings on page 398, but a few feet shorter, the dimensions there given by us being those of the Helvetia, which has been plying on the Lake of Zurich since 1874, and the Mont Blanc, which has been running on the Lake of Geneva for the same time. These boats are of 120 nominal and 600 indicated horse-power; on the trial trips they attained a speed of 16 miles per hour. Their length between perpendiculars is 64 metres; they draw 1·30 metre of water, and are licensed to carry 1500 passengers. The scale of Fig. 1 is 1 in 600; that of Figs. 2, 4, and 5 is 1 in 275; that of Fig. 3 is 1 in 225. These boats cost at that time, all fitted up and ready for work, 400,000f.; they are warmed throughout by waste steam from the boilers. The hull is entirely of iron. The compound engine *m* is supplied with steam by two boilers *c*, having three furnaces each; they are worked at about six atmospheres. The paddle-wheels are 4·1 metres in diameter, and the floats 2·6 metres long. Ropes and other stores are kept in A, to which access is given by the ladder *a*. The second-class kitchen is at B, and the dining saloon at D; the latter is 11·5 metres long; the staircase is at *d*; the seats and couches are of wood. This saloon is separated from the engine-room by a series of three cabins E, fitted with seats *e*, tables, and chairs. These cabins are used solely by the enginemen and stokers, who have direct access to the engine-room F. This room is 12 metres long; it contains the engines *m*, the boilers *c*, the coal bunkers *s*, and is reached by the iron ladder *f*.

In the stern of the boat, near the rudder, is a recess R, with the iron ladder *r*, to give access to the sleeping cabin G with its bunks *g*. In connection with this is the first-class saloon H, with its companion *h*. This saloon is lighted, like all the others on this level, by means of portholes. Dinner tables are laid out in this saloon for those who desire refreshment, and the cooking department is at I. Near this, at J, is the sleeping cabin of the captain. A grand saloon K, 12 metres long, occupies one portion of the deck; it is reserved for first-class passengers. Its continuous lines of windows permit wide views of the surrounding scenery; it is elegantly furnished, and its couches are covered with red velvet. A narrow passage upon the deck runs round the outside of this saloon. Near the entrance of this saloon on the left is the door of the water-closet L, and near it the little office N devoted to the purposes of the steamboat service. By the side of this is the companion of the saloon H. Near the paddle-boxes on each side are two little smoking cabins O O^1; also the office T of the ticket collector, and the water-closets Q and *q*. S is the second-class deck saloon, with an open space adjoining on the main deck. All the main deck is covered by the upper deck P, exclusively reserved for first-class passengers. An awning is thrown over this in hot weather to shield the passengers from the direct rays of the sun, which have great power on the Swiss and Italian lakes during the summer months. The staircases P^1 give access to this upper deck. High up in the centre of the boat is the bridge occupied by the captain and by the man at the wheel; it is reached by the ladders *u* *u*^{1}.

LETTERS TO THE EDITOR.

[*We do not hold ourselves responsible for the opinions of our correspondents.*]

THE WATER-TIGHT SUB-DIVISION OF STEAMSHIPS.

SIR,—The illustrations of the United States steamship Chicago in your this week's issue show an arrangement of dividing and making water-tight the coal bunkers along the sides. This seems to be an admirable arrangement for protection by coal from shot, and as giving a power or reserve of buoyancy for supporting the vessel in the event of injury to other portions of the hull by torpedoes or other destructive agents. I have for some time advocated this system of construction, which may be carried out in vessels without considerably interfering with their internal arrangements, or without any appreciable increase in cost in the construction; but instead of making the coal bunkers water-tight as in the Chicago, I propose to make or construct these chambers or pockets within the vessel herself, and incorporated with and forming part of her structure, and to have water-tight trunks leading to all the holds and spaces of the chambers. If this principle of construction were more generally adopted, there would be one element given to the vessel for protection from foundering or sinking.

The principle might be introduced with advantage into vessels of the merchant service and mail steamers as protection from sinking, and if the Austral, so recently sunk through water entering her holes, had some arrangement of this kind in her construction she probably would not have so readily foundered. These casings, chambers, or sub-divisions along the sides give not only protection from sinking, but also a reserve of *shoulder* and stability for prevention from capsize. They may be constructed of light plating and divided by partial bulkheads or diaphragms, and the spaces utilised, as in the Chicago, for stowage of coal, mails, specie, passenger baggage, light and valuable cargo, and for other purposes of the ship as desired. The principle has been recorded in the Patent-office since 1878, and is one worthy at least of adoption by the large mail and steamship companies and for all kinds of war vessels, more especially to large armour clads.

Charlton, S.E., October 29th. J. ANDREWS.

GROYNES FOR PROTECTING FORESHORES.

SIR,—Your article in THE ENGINEER of the 26th ult., on groynes for protecting foreshores, cannot fail to be of interest to those of the profession who are more immediately brought in contact with that class of work, and there can be no doubt that in many instances open groynes of fir poles would be found to answer where closely sheeted ones have failed to produce any permanent good.

As you rightly observe, the currents generated by wave action in a day's gale will at many places work a greater change in a foreshore than a year's ordinary weather; and although the close groynes doubtlessly retain the shingle silted against them in ordinary weather, yet during a gale it not unfrequently happens that the back wash of the sea after the water strikes the groynes is sufficient to denude the foreshore of the shingle which has probably been months in accumulating. But more especially does this seem to be the case where a sea wall exists. About three years ago the sea wall of the Esplanade at Ventnor was extended some distance along the foreshore, where a large quantity of shingle had lain almost undisturbed for years past, but no sooner had the wall been erected than the shingle began to diminish, and in a short time entirely disappeared from that part of the shore in front of it, a close sheeted groyne proving altogether ineffectual in permanently retaining the smallest quantity, the little accumulating during fine weather being again swept away by the back wash of the water after striking the wall during the first gale. To remedy this, I advised the construction of some open groynes of fir poles, each in the shape of an inverted V, the apex placed seawards. The greater part of one of these has been erected, and although the work has since been suspended for the winter months, there is already more shingle in front of the wall than has been since its erection, the waves not having sufficient power after striking the wall to draw off the shingle with them as they recede, having previously had their greater force broken in passing through the groyne.

I have not seen the model exhibited by Mr. Dowson at the British Association *conversazione*, probably it is an improvement upon that with which we have been acquainted for years past; but certainly the idea of open groynes has not originated, as your remarks would imply, with that gentleman. ROBERT S. SCOTT.

Town Surveyor's Office, Ventnor, I.W., November 14th.

SIR,—I have not seen your last article on the Brighton beach question, but I understand that you state all the defences recently erected from my design at Hove have been washed away. I am sure you would not intentionally mislead those interested in this work, and therefore I may be permitted to say that the works carried away by the gale on the 1st of September last were quite of a temporary character, and were never expected to withstand a very heavy gale. None of the permanent works suffered in the slightest degree—not a bolt started nor a plank lost. In addition, it may be interesting to you to know that at those parts of the foreshore where the novel system of groyning initiated by me is complete there was no loss of beach. The scour at the back of those groynes, built in the old-fashioned way, by being at right angles, or nearly right angles, to the shore line, has followed the invariable rule. Where, however, the groynes are at an angle of 60 deg. and 45 deg. to the shore lines, there is not now, and never has been since their erection, much scour. At the lee side of the 45 deg. groynes there has never been any scour, while sufficient shingle has been retained on the weather face to protect the shore, although the gale of 1st September was a very severe one, on the top of a spring tide.

So far from the groynes trending to the east having proved a failure, I believe the future of all groyning on the south coast will be in this direction.

November 21st. E. B. ELLICE-CLARK, Memb. Inst. C.E.

SCIENTIFIC PROGRESS.

SIR,—Possibly I ought to apologise for forwarding to you an epistle more calculated to amuse than instruct, but if viewed correctly, it should be both instructive and interesting. In searching through the national archives collected in the Library of the British Museum, I encountered a small pamphlet purporting to offer the causation of the severe frost in 1814—the last time, to the best of my judgment, that a fair was held upon the Thames.

The author, in his preface, states:—"To the reflective mind nothing can be more agreeable than a philosophic account of the marvellous works of nature." After this inviting prelude, the author proceeds with that peculiar self-sufficiency, characteristic of many scientific authors, to inform his readers "that of all substances the atmosphere either absorbs or throws out heat with the most remarkable facility, and in one or the other of these states it always is in regard to the surface of the earth, as for such bodies that are placed on or near the earth they have no proper temperature of their own. When the air has been for some time absorbing heat from terrestrial bodies, a frost must be the undoubted consequence, and if this absorption continued for a length of time, the whole earth would be converted to a frozen mass. There are, however, certain powers in nature by which this is frustrated, and the most violent frost we can imagine must defeat its own purpose, and end in a thaw."

Surely, Sir, this must have been most comforting intelligence. Authors of to-day, to judge from their writings, possess as direct a knowledge as our author; but when did a Tyndal, a Glashier, or any that professedly devote themselves to these things, after their poor readers had endured the misery of wading through their column upon column of figures or facts, ever derive such consoling and comforting assurance as this author of the good old times furnished? R. SHEWARD.

Grange-road, Eastbourne, November 20th.

INSIDE CYLINDER LOCOMOTIVES.

SIR,—Since perusing your valuable article in your number of last week under the above heading—which is, perhaps, at this stage of the discussion, more suitable than that of "The Gladstone"—I have received two or three letters upon the subject from engineers and others connected in various ways with locomotive work, of a more or less contradictory nature. Foremost among these is one who will doubtless not object to publicity being given to his information, and who, after justly reproving me in a manner for not having sent a cross-sectional sketch of the cylinders of the Glasgow and South-Western engine, besides the half-plan, as being liable to mislead one in judging of port area, goes on to say: "In the South-Western—Glasgow and South-Western—engine the ports are in one length, contracted at centre, but advantage taken of what can be got, and enlarged above and below. . . . It is well known that these engines are not throttled in any way, quite the reverse, and valves above and valves below are old designs, however some engineers may twist them into irregular shapes as something new."

Respecting the latter part of my correspondent's communication, he is certainly right as to the antiquity of the employment of valves above the cylinder, but I believe that valves below are a comparatively recent adaptation. With regard, however, to the first part of his letter, surely there must be some comparison between the values of various forms of exhaust ports, as, for instance, even supposing the space above and below the centre line of the cylinder be utilised as port area for the exhaust, resulting in a port shallow in one part and deep in another, this form, I should think, can scarcely be so serviceable as one into which steam can be released directly to an uniform depth, instead of part of it having to squeeze, as it were, past a narrow neck, to find its way to the blast pipe; neither is this arrangement any remedy for the want of space which exists between valve-face and valve-bridge, through which the expanded steam must pass to the exhaust, and it is this want of space which conduces to throttling, and which can only be compensated for by a length and width of port scarcely obtainable in ordinary engines.

Allow me to correct a slight error in your above-mentioned able article. Instead of Mr. Stirling's, should appear Mr. H. Smellie's name, who designed the Glasgow and South-Western engine, to which this correspondence refers. The fault is mine, and I must apologise for leaving this unmentioned in my letter of the 27th ult. F. A. FIELD.

London, W.C., November 20th.

DOWSON'S GAS AS A MOTIVE POWER.

SIR,—While thanking you for the able criticism of my work, which appeared in your issue of the 2nd inst., permit me to make the following remarks on some points you have referred to:—

The seventeen days' trial recorded was made with one 12-horse power and five 16-horse power nominal Otto engines. The engines were watched during the trial, and the power of those not fully loaded was reckoned partly by indicator diagrams, and partly by counting the intakes of gas. It is believed that 90 indicated horse-power is rather under than over the average power exerted.

A 3$\frac{1}{2}$-horse power nominal worked with this gas was tested by Mr. D. K. Clark—*vide* "Smoke Abatement Report," 1882—and the fuel consumption of this small engine was only 1·4 lb. per indicated horse-power per hour.

Later Messrs. Crossley and myself tested an ordinary 16-horse power with a constant load, working with my gas, and the fuel consumption was 1·4 lb. per indicated horse-power per hour. Since then a new 16-horse power, specially made for this gas, was tested separately, and the fuel consumption was 15 per cent. less, or about 1·2 lb. per indicated horse-power per hour.

Details of these trials and sketches of the apparatus used, together with the actual composition of the gas, &c., are given in the last volume—lxxiii.—of the "Minutes of Proceedings" of the Institution of Civil Engineers.

Although more of my gas is required to develope the same power as coal gas, it is not correct to suppose that with an Otto engine a much larger cylinder is required, and that the volume of heated products passing through the exhaust is much augmented. For coal gas the cylinder of this engine is proportioned to receive a large excess of air above the 5·3 volumes theoretically required for its combustion. On the other hand, my gas requires theoretically only 1·1 volume of air, and without altering the ordinary engine it is possible to obtain 85 per cent. of the maximum power obtainable with coal gas. With the same sized cylinder, but with some other parts modified, the same maximum power can be obtained as with existing coal gas engines.

Replying to your question, "Can an engine be made to develope, say, 100-horse power in this way?" I may mention that Messrs. Crossley have already made a double-cylinder engine to indicate

80-horse power with my gas, and they are prepared to make still larger ones.

Your calculations of the relative efficiency of my gas as compared with coal gas and solid fuel would have been somewhat modified had you known its precise composition, and that the enlargement of the cylinder is not necessary; but this is now of minor importance, and I need not trouble you with corrections.

J. Emerson Dowson.

3, Great Queen-street, Westminster, November 19th.

MODERN PHYSICS.

Sir,—In a review recently published in The Engineer of Mr. Stallo's "Concepts of Modern Physics," and again in a leading article on the teaching of science, charges of a somewhat grave character have been brought against the leading physicists of the present day. The gist of these charges is as follows:—That the principles which are taught as the basis of modern physics and chemistry are utterly at variance and irreconcilable with one another; and that the teachers of science are quite aware of the fact, but that they nevertheless go on teaching these mutually destructive theories to their pupils as being the most certain and incontrovertible of facts. But what seems to be urged is, not that the rival theories should be submitted to searching examination, and one or both dismissed as a fiction, to be superseded by something better, but that both should still continue to be taught, side by side, with the understanding that they are not actual proved truths, but merely hypotheses convenient for the purpose of working out results.

I am impelled to ask for space for a brief comment on these articles, partly because my name was mentioned in them as having some time back published some comments on Mr. Stallo's volume, but still more that I may enter a protest against the suggestion just described. If two theories, however long established and widely based, are found to be really in hopeless contradiction, then, in the name of truth and common sense, let one or both go to the wall, and let us do without a hypothesis until we can find a better. To continue teaching them when proved false, because they are supposed to be convenient, seems to me not much more wise or honest than to enact that bad sovereigns shall be a legal tender, provided the coiner admits them to be counterfeit.

In saying this I do not forget that false hypotheses have at times aided powerfully in the advance of science; but surely this has been before they were proved false, and not afterwards. A false hypothesis is better than nothing, but only so long as it is not known to be false; and in any case it is immeasurably inferior to the true one. It may be true, for instance, that astronomy was at one time indebted for its progress to the Ptolemaic theory; but nobody supposes that the progress would not have been immensely quicker if astronomers had from the first adopted the true theory of elliptic orbits, instead of trying for centuries to make the facts square with the false theory of circular orbits. Any physicist who deliberately retains or countenances any hypothesis for one moment after it has been shown to be false, is a traitor to his master, Newton, and an alien to the whole spirit of science and of discovery.

Having made my protest, I may be allowed for a moment to inquire whether there is really any just ground for the sweeping charges we are considering. I venture to assert that there is not. That confusion exists I admit freely, but it is a confusion as to words, not as to things. It is not that science makes conflicting statements, but that the different terms in which different statements are made have not been understood. I hope to make this clear, so far as the limits of a letter will allow.

For this purpose I cannot do better than take the summary given by Mr. Stallo, in his second chapter, of what he regards as the fundamental principles of modern physics. I will not stop to inquire whether there may not be persons who hold some, perhaps all, of these propositions to be true. I will only point out how far they represent the fixed conclusions of modern science, as set forth, not in the speculative papers, but in the methodical treatises of its foremost leaders; and for this purpose I will take them in order, presenting them with somewhat more of method than Mr. Stallo uses, but following his words, and then commenting on them.

Proposition 1.—"The primary elements of all natural phenomena—the ultimates of scientific analysis—are mass and motion." The word "mass" has been interpolated by Mr. Stallo himself—as he admits, p. 25—for matter, and quite incorrectly. In Thomson and Tait, ch. ii., art. 173, matter is defined as "that which can be perceived by the senses, or as that which can be acted upon by, or can exert, force." Force, again, is stated to be "a direct object of sense—probably of all senses, certainly of the muscular sense." And mass is defined as the quantity of matter in a body. But it is the thing itself, and not the quantity of it, which must be the "ultimate of scientific analysis."[*] Again, neither mass and motion, nor matter and motion, are held by physicists in general to be the "ultimate of scientific analysis." I simply appeal to the witnesses cited by Mr. Stallo himself on page 18—Kirchhoff, Helmholz, Maxwell, Wundt, and Häckel, all of whom explicitly recognise, besides motion, the cause of motion, namely, force, and look on it as one of the fundamental factors of the mechanical scheme of the universe. I might, I believe, add the name of every writer of an established English work on mechanics, scarcely even excepting Professor Tait.

2. "Mass and motion are disparate. Mass is indifferent to motion, which may be imparted to it, and of which it may be divested, by a transference of motion from one mass to another. Mass remains the same, whether at rest or in motion." Mr. Stallo gives no definition of the word "disparate," nor am I aware where such a definition is to be found. If it simply means "radically different," the statement is correct, and we may leave it so for the present. To the rest of the statement I have nothing to object.

3. "Both mass and motion are constant." What Mr. Stallo means by this I am really at a loss to say. If it means that the mass and motion of any particular body—*e.g.*, the earth—are either of them constant, it is ludicrously incorrect. If it means that the mass of the universe is constant, that is very much more than Mr. Stallo or anyone else has a right to say, unless he has been in the habit of measuring the universe at short intervals for a very considerable time. All we can possibly say is that no creation or destruction of matter has occurred within our observation. That mass is constant may or may not be true. That motion is constant certainly is not true. If it means what it says, it would mean that the sum of the velocities of every particle in the universe is always the same, which is demonstrably false. If, instead of the velocities, we take any function of the velocity simply, it is equally untrue. To see this, it is only necessary to consult any book on mechanics whatever, dealing with the motion of a system of particles.

Cor. 1.—"Mass and motion being radically disparate, it is evident that mass cannot be motion or the cause of motion—it is inert." That mass is not motion is true; that it is not the cause of motion (in the sense that one mass cannot act on another) is untrue. On the contrary, all action, all change, all physical phenomena, are due to the mutual action of masses. Thus, Thomson and Tait define matter as "that which can be acted upon by, or can exert, force."[†] Mr. Stallo has been led into confusion by failing to define the word "inert." This may be used in at least two senses—(1) a thing may be called "inert" when it does not act *on itself*—this is true of matter, by the first law of motion; (2) a thing may be called "inert" when it does not act on other things; this is not true of matter, by the third law of motion.[*]

Cor. 2.—"Mass cannot be heterogeneous, for heterogeneity is difference, and all difference is caused by motion." The last clause would only be correct—even according to the atomo-mechanical theory—if for difference we substitute "change." That *original* differences in the things moved can be caused by motion is absurd, for they must have been anterior to motion. Mr. Stallo has been guilty of the common fallacy of substituting one statement for another somewhat like it. Therefore mass can be heterogeneous.

Assumption as to atomic constitution of matter.—"Mass is not continuous, but discrete, being an aggregate of unchangeable, and, in that sense at least, simple units." This is correctly stated, if for mass we substitute matter; but it should not be given as a mere assumption, but as a principle amply proved by facts. Those who deny it must hold that space is a plenum completely filled by matter, as a sugar cask with sugar; and I ask how motion can begin in such a plenum? Suppose a particle originally at rest to begin to move, *i.e.*, to change its position; then one of three things must happen—(1) it may push another particle aside; (2) it may occupy identically the same space as the other particle, becoming absorbed into it; (3) it may pass into empty space. On the first supposition the difficulty is only transferred to the second particle. The second I should hardly have thought worth discussing, did not Mr. Stallo show some leaning towards it. I may therefore just remark that it is apparently contrary to all the phenomena of resistance, while I am not aware of any single piece of evidence to be adduced in its favour. We are therefore reduced to the third supposition, in which case space is not a plenum.

Cor. 1.—"The elementary units of mass, being simple, are in all respects equal." If the words "being simple" are supposed to refer the proof of the corollary to the molecular assumption, it is a flagrant perversion of words, for there the word "simple" was expressly limited to mean "unchangeable," while here it is taken to mean "equal." I can hardly imagine two notions more utterly "disparate," to use Mr. Stallo's favourite expression. Apparently, however, the corollary before us is meant to be deduced from the "homogeneity of mass" asserted in Cor. 2 above; but we have seen above that this statement is founded on a fallacy, and the present corollary dies with it.

Cor. 2.—"The elementary units of mass are absolutely hard and inelastic." As I have pointed out on a previous occasion, there are two very different senses applied to the word "inelastic." According to the popular sense it means a body which does not alter its shape or size when exposed to any force—in which sense steel would be said to be much less elastic than india-rubber. According to the scientific sense it means a body which, having been exposed to the force arising from another body, has no power of exercising a counter force in the opposite direction, so as to separate the two again; in which sense steel would be said to be far more elastic than india-rubber. Now, Mr. Stallo uses the word in the first sense, as is shown both by his inserting the word "hard," and by his adding that this is "a necessary consequence of their simplicity, which precludes all motion of parts, and therefore all *change of figure*." In this sense I do not know that any one will dispute the statement; but it is one of no importance whatever in mechanics. But as we know, Mr. Stallo uses it to establish a contradiction, in the statement that atoms are perfectly elastic in the other and scientific sense—a statement which is necessary to the kinetic theory of gases, and is no doubt upheld by every writer on mechanics. In so doing he falls into grievous error from not attending to the definition of terms. The contradiction is a dream of his own, and he might just as reasonably charge mechanicians with asserting that india-rubber was both less and more elastic than steel.

Cor. 2.—"The elementary units of mass are absolutely inert, and therefore purely passive; hence there can be no mutual action between them other than mutual displacement caused by impulses from without." As shown above, the statement that a thing is "inert" need not, and does not, mean that it is "purely passive;" hence the first of the above clauses is incorrect. As to the second, I am at a loss to conjecture what Mr. Stallo means by "impulses from without;" where they come from, and what is their nature. But whatever they be, they are neither mass nor motion, and cannot, therefore, be brought into harmony with Prop. 1 above. If the clause read, "mutual displacement caused by impulses from *within*," it would express very fairly what is really held by physicists.

Cor. 4.—"All potential energy, so-called, is in reality kinetic." This is no doubt a correct deduction from the atomo-mechanical theory, and it has been doubtfully suggested in some confessedly bold speculations—*e.g.*, the Unseen Universe—that it may somehow, in some unknown and altogether unimaginable way, be true. That it has ever, by any writer of repute, been laid down as an axiom I am not aware. But Mr. Stallo adds to it, by way of explanation, the astounding statement that "the term energy, in the language of modern physics, denotes the cause of motion." How he comes to have let this stand in a second edition, when at p. 77 he himself quotes the correct definition, namely, "the capacity to do work," I am at a loss to imagine. It is a cardinal instance of the radical vice of the book, namely, that it does not lay down definitions at starting, and abide by them afterwards.

Here end what Mr. Stallo advances as the ultimate principles of modern physics, in order that, in the next six chapters, he may have the pleasure of demonstrating their self-contradictions and absurdities. One of these principles, however, that of the atomic nature of matter, is, afterwards expanded and re-stated in chap. vii. p. 85: and to this I must draw attention, because it affords another instance of error caused by want of definition, and that an error which is of frequent occurrence. The principle is here expanded into three heads, as follows:—

1. "Atoms are absolutely simple, unchangeable, indestructible; they are physically, if not mathematically, indivisible."

2. "Matter consists of discrete parts, the constituent atoms being separated by void interstitial spaces. In contrast to the continuity of space stands the discontinuity of matter. The expansion of a body is simply an increase, its contraction a lessening, of the spacial intervals between the atoms."

3. The atoms composing the different chemical elements are of determinate specific weights, corresponding to their equivalents of combination."

Now, the word "atom" is used in at least three different senses, which it is every day becoming more necessary to distinguish from each other, and call by different names. They are as follows:—(*a*) *The ultimate atom*, the simple, indivisible, elementary unit, into which all matter must ultimately be reduced, and out of which all matter is built up. (*b*) *The physical atom, or Molecule*, a group of ultimate atoms, which, at some time and in some way of which we know nothing, were united together by bonds such that no known process of nature is able to break them, or to effect any permanent change whatever in the properties or constitution of the group. (*c*) *The chemical atom*, the primary constituent of any chemical substance (whether an element or a compound), defined by the fact that it cannot be divided without altering the chemical properties of the substance. This chemical atom may or may not contain a number of physical atoms.

For the existence and meaning of these three senses of the word, I may refer to Clerk-Maxwell's well-known "Discourse on Molecules," or to his article "Atom," in the "Encyclopædia Britannica," though I believe that in neither of these can exact definitions be found, such as I have done my best to supply. Looking at these it becomes evident that the word in No. 1 section above is used in the first sense; in No. 2 in the second; and in No. 3 in the third. Yet so little is Mr. Stallo aware of this that the whole chapter is devoted to showing that these three sections are inconsistent with each other and with fact, *assuming that the word "atom" has the same sense in all three.* One instance is sufficient, especially as it has been especially singled out for comment in The Engineer. The fact that the various chemical elements have different specific weights is cited as clearly contradictory to the idea that the ultimate atoms are all alike. Now no physicist would lay it down as an axiom that the ultimate atoms are all alike; but if he did there would of course be no contradiction. The atom of the chemist is not merely a group of ultimate atoms, but a group of groups of ultimate atoms; and we do not know either how many ultimate atoms make up the first group (or the physical atom), or how many physical atoms may make up the second group. There is room here for any amount of divergence in the weights of different chemical atoms.

It would not be hard to show that Mr. Stallo's attacks on such doctrines as the wave theory of light or the kinetic theory of gases are no less illusory than his statement of first principles; but from this I must abstain. In parting from him I cannot refrain from expressing my admiration for his vigour and acuteness, mingled with my regret at the way in which he has chosen to damage his own cause. Mr. Stallo has a quarrel with what he calls the atomo-mechanical, and I should call the collision theory of the universe—a quarrel in which I entirely sympathise, and in which, if he needed it, I would stand by him to the last. That quarrel he has prosecuted with rare vigour and success. I quite agree with the reviewer in The Engineer that physicists who hold the above theory are bound to answer Mr. Stallo or implicitly own themselves in error. But those physicists are the gentlemen who talk of action at a distance as "unthinkable," and teach that all the facts of the universe must be explained by the bumpings of very minute marbles. The leaders of science teach nothing of the kind. It is simply impossible to find greater living names in physical science than those cited above by Mr. Stallo and myself; and I have shown that their deliberate assertions, made not in "Speculative Ideas Respecting the Constitution of Matter,"[*] but in the formal treatises on which their reputation is based, are both harmonious with themselves and directly contradictory of the doctrines imputed to them. If any doubt this, let him refer to their works before he pronounces an opinion. Mr. Stallo, partly for want of defining his terms, partly, I suppose, for sheer love of fighting, has chosen wilfully to include among his enemies a number of men far more eminent than himself, who would have been his best friends; and the result is to impair, if not destroy, the whole efficacy of his own work. For when a first-rate physicist takes up a work in which he finds himself credited with a number of opinions which he does not hold, and deductions from those opinions which are founded on obvious confusion of terms, his impulse is by no means to sit down and write a general disclaimer or reply; his impulse is simply to throw the book down; and that I fear is the reason why Mr. Stallo's work has met with so little recognition, and made so little stir, among those who are really the best qualified to judge of its value.

Walter R. Browne.

Westminster, November 13th.

THE GLADSTONE.

Sir,—You say 17½in. diameter are the largest inside cylinders that can be got in, properly designed, with slide valves between, whereas it is a well-known fact that more than one railway company, after using and having experience of the working of that size, have enlarged, and now use cylinders 18in. diameter, and still keep the valves between, and that hundreds of such engines are at work in this country. You also say that the size of the coupled wheels is at least 2ft. higher than usually deemed right. Well, wheels 5ft. 6in. diameter, coupled in front, can be seen in abundance, both north and south; and I know that 6ft., coupled in front, worked passenger trains into Carlisle many years ago. So much for that part of novelty in the design; and with regard to the valves under the cylinders, engines have been working on the Great Northern Railway so arranged for several years, the diameter of cylinders being 19in. Most points of design about this engine, so far as I can see, have been used, and in many instances abandoned, on other railways; and I venture to predict that 6ft. 6in. wheels, coupled in front, will not extend to other main line express engines. I trust you will give this letter space in your next issue. It is really wonderful how history repeats itself, and with what parade, too.

Engineer.

Springburn, Glasgow, Nov. 19th.

GOLD MINING MACHINERY.

Sir,—My attention has been drawn to an article in your issue of the 26th ult., on the Madrid Exhibition, in which your correspondent states that our model of a battery of Californian gravitation stamps is of antiquated design. This statement we cannot allow to pass unnoticed, as we do not consider it a fair one. During the last three years we have made gravitation stamps to that design, and modifications of it, for eighteen of the leading gold mining companies, and we must give the consulting engineers of those companies credit for not passing our designs if antiquated. We may add that recently we have given these stamps our special attention, and we have taken care to obtain particulars of any improvements that have been introduced by those having the daily sepervision of them.

Frank Taylor,
Manager.

The Sandycroft Foundry and Engine Works Company,
Limited, Hawarden, Chester, Nov. 16th.

RAILWAY SPEED.

Sir,—In your issue of the 16th inst., your correspondent Mr. Stretton appears to be very positive, and I think rather heated, in his assertions. He says that "it is perfectly impossible for me to have travelled by the Midland 5.15 a.m. train from London to Sheffield without changing at Trent;" and he repeats that I have incorrectly stated the "distances," &c. I have, however, no hesitation in again assuring him that I have frequently travelled from St. Pancras to Sheffield by that train without any change whatever at Trent. And I have already referred him to "Bradshaw's Railway Guide"—from which my information was derived—where he will find the distance of Leeds from St. Pancras given as 204 miles. If, however, your correspondent possesses superior knowledge on the subject, I would suggest that it might be of advantage if he were to communicate with the proprietors of "Bradshaw's Guide," as otherwise it may be misleading to others as well as myself.

M. M.

London, November 17th.

THE STRENGTH OF LEAD PIPES.

Sir,—Seeing in your last impression that bursting of lead pipes used as mains by Pintsch's Lighting Company is attributed to English made lead pipes, and that only German make will answer the purpose, we beg to say that we, as patentees of apparatus for the lighting of railway and other coaches with compressed oil gas, have thousands of feet of English lead pipe in use for the same purpose without fracture.

W. Pope and Sons.

Gotha Engineering and Boiler Works,
Slough, Bucks, November 17th.

Naval Engineer Appointments.—The following appointments have been made at the Admiralty:—James Roffey, C.B., chief inspector of machinery, additional, to the Pembroke, vice Hodd; Charles W. G. Chambers, chief engineer, to the Superb; John F. Price and Edward Price, engineers, to the Superb; James Brown, engineer, additional, to the Alexandra; Edward J. Edgar, assistant engineer, to the Superb; John G. Fussell, assistant engineer, additional, to the Excellent.

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[*] In his pamphlet on "Speculative Science," p. 7, Mr. Stallo attempts to defend this position by asserting that all the properties of matter, except inertia, are modes of motion, and that inertia is the same thing as mass. I do not see why inertia itself may not be described as a mode of motion, since it is nothing more or less than the property of only being moved at a finite rate; but in any case there must remain the something that moves and that has inertia, and this something is matter. Mr. Stallo says, "The physicist who knows what he is talking about" speaks of mass, not matter. It is sufficient to reply that Thomson and Tait speak of matter and also of mass.

[†] So Dubois Raymond, quoted by Mr. Stallo, p. 22:—"The resolution of all changes in the material world into motion of atoms caused by *their* constant central forces would be the completion of natural science."

[*] Mr. Stallo seems to use the word in yet a third sense, namely, to express "that which has inertia." This, I believe, is peculiar to himself—at least, at the present day.

[*] This is the title of a paper by Wundt, actually cited by Mr. Stallo (p. 35) to show the deliberate views of scientific men!

SWISS LAKE STEAMER, HELVETIA.

MESSRS. ESCHER, WYSS, AND CO., ZURICH, ENGINEERS.

(*For description see page* 396.)

Fig. 2.

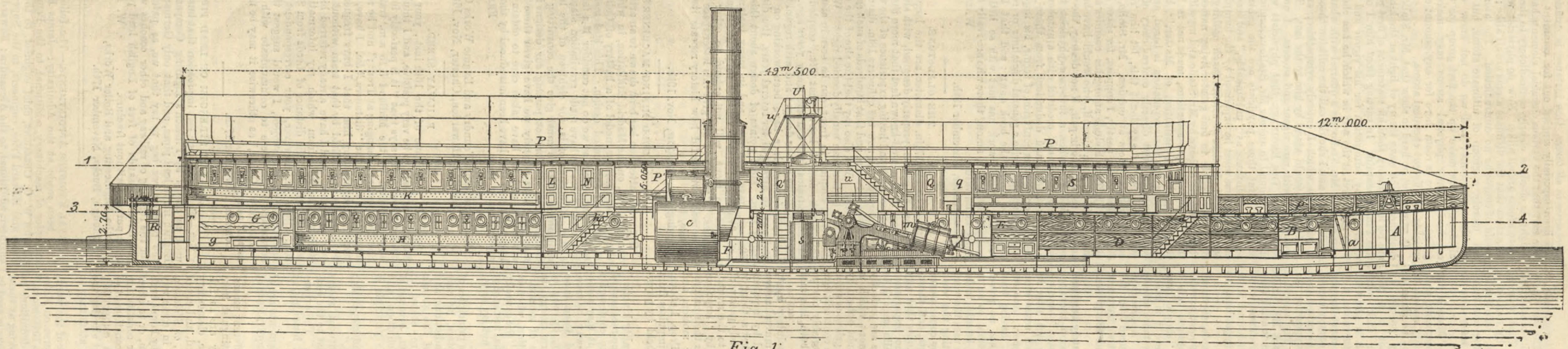


Fig. 4.

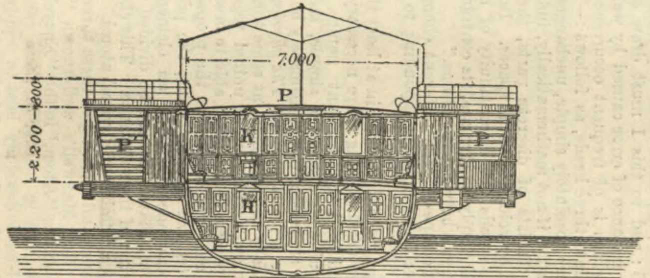


Fig. 1.

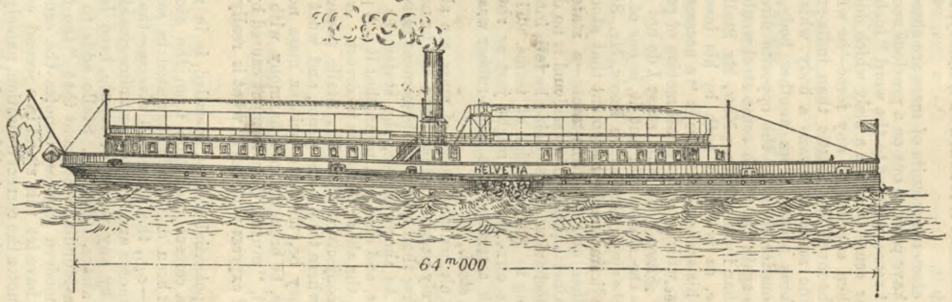


Fig. 5.

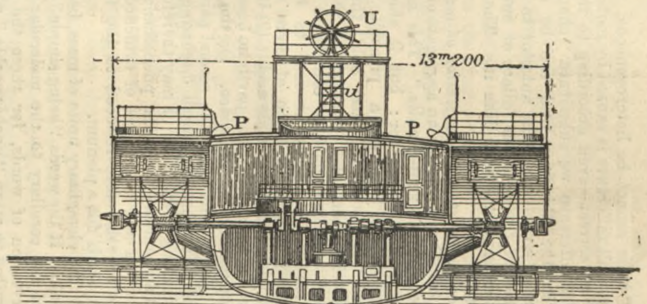
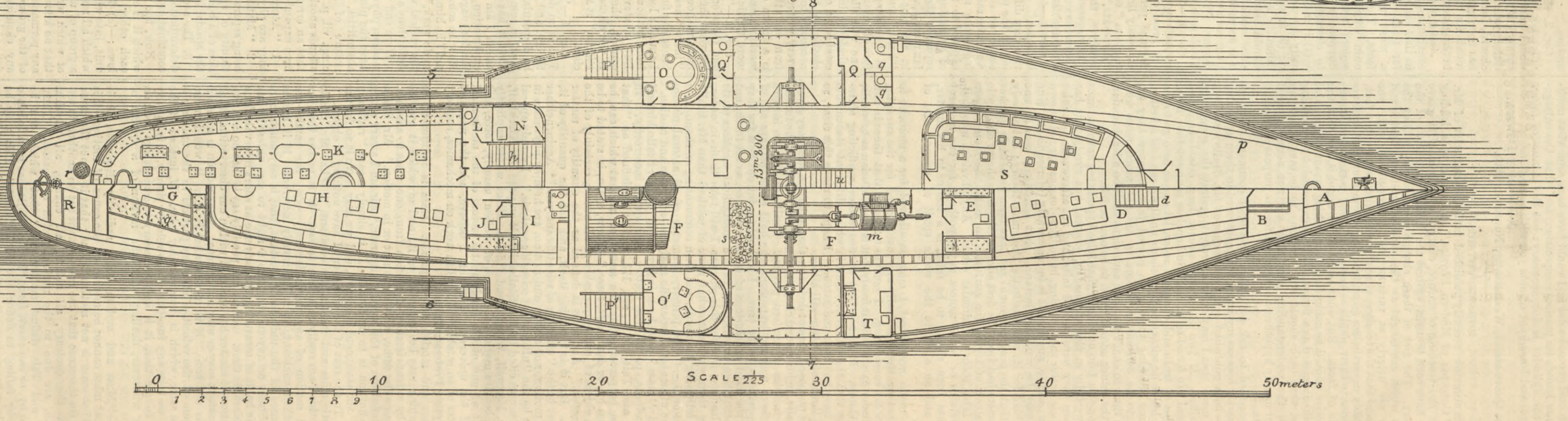


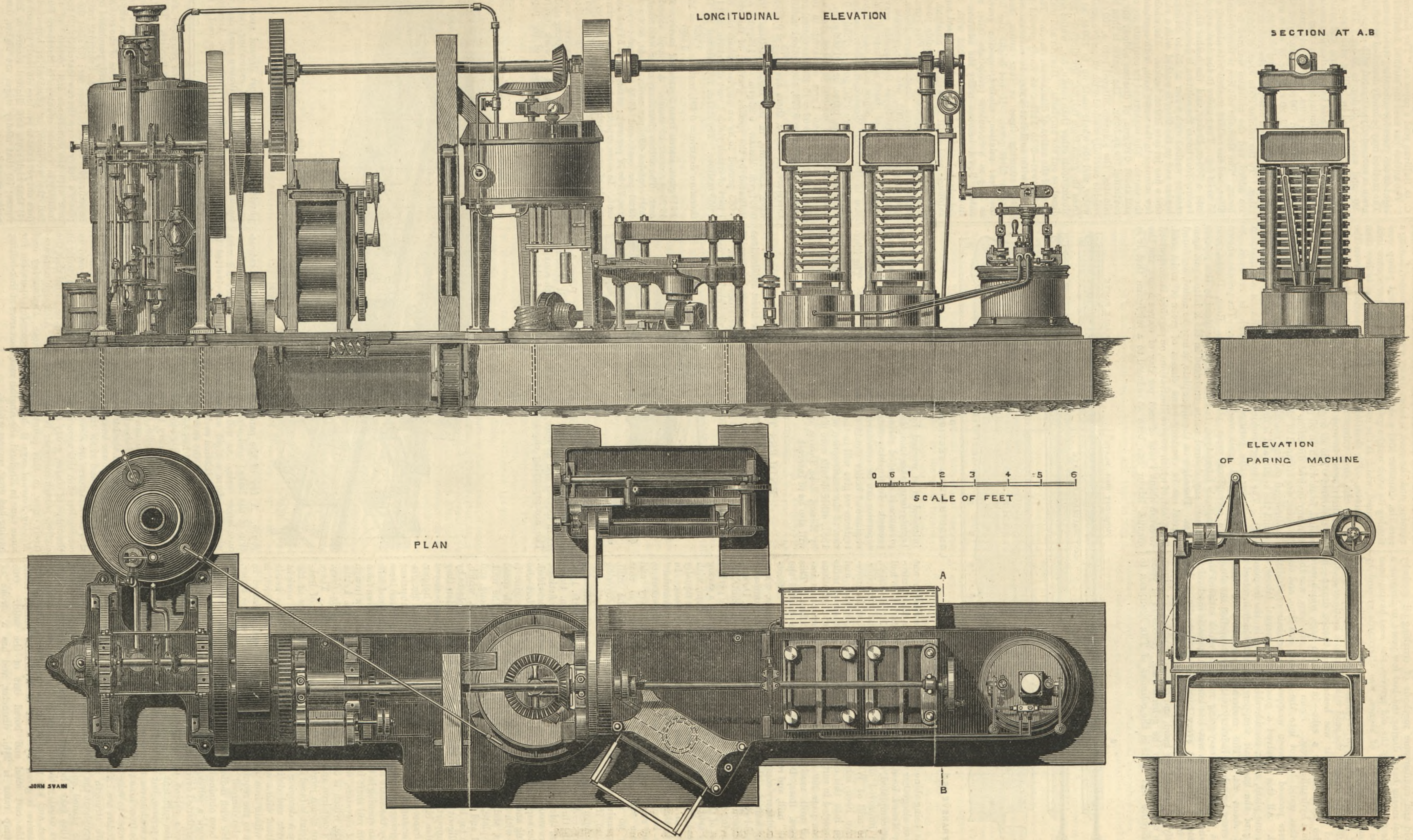
Fig. 3.



COLONIAL OIL MILL.

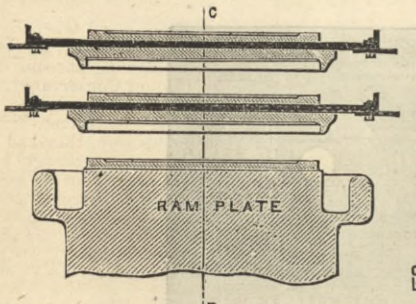
MESSRS. ROSE, DOWNS, AND THOMPSON, HULL, ENGINEERS.

(For description see page 400.)

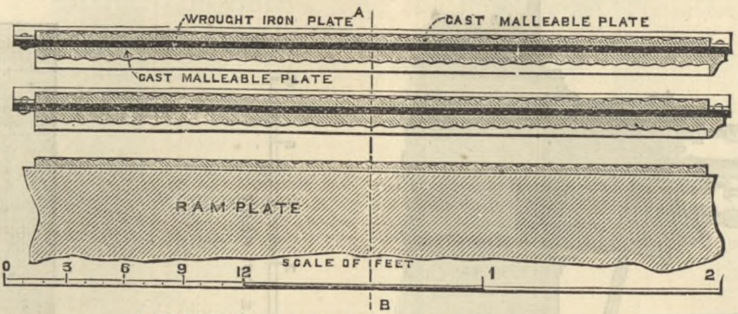


IMPROVED OIL MILL ON THE ANGLO-AMERICAN PRINCIPLE.

THE old and cumbersome methods of crushing oil seeds by mechanical means have, during the last few years, undergone a complete revolution. By the old process, the seed having been flattened between a pair of stones, was afterwards ground by edge stones, weighing in some cases as much as 20 tons, and working at about eighteen revolutions per minute. Having been sufficiently ground, the seed was taken to a kettle or steam jacketted vessel, where it was heated, and thence drawn—in quantities sufficient for a cake—in woollen bags, which were placed in a hydraulic press. From four to six bags was the utmost that could be got into the press at one time, and the cakes were pressed between wrappers of horsehair or similar material. All this involved a good deal of manual labour, a cumbersome plant, and a considerable expense in the frequent replacing of the horsehair wrappers, each of which involved a cost of about £4. The modern requirements of trade have in every branch of industry ruthlessly compelled the abandonment of the slow, easy-going methods which satisfied the times when competition was less keen. Automatic mechanical arrangements, almost at every turn, more effectually, and at greatly increased speed, complete manufacturing operations previously performed by hand, and oil-seed crushing machinery has been no exception to the general rule. A couple of years back reference was made in the columns of THE ENGINEER to what was being done in this direction, and a description was given of an altogether new departure from the old method introduced by Messrs. Rose, Downs, and Thompson, of Hull, who had then just completed, at Wateringbury, Kent, for Mr. R. Leigh, M.P., an improved oil mill on the Anglo-American principle. Since the mill at Wateringbury was built, further improvements have been introduced by Messrs. Rose, Downs, and Thompson into this class of machinery, and a number of mills has been erected in various parts of the world. The illustrations we give on page 399 represent the latest devolopment in improved oil mill machinery introduced by this firm. This mill, Messrs. Rose, Downs, and Thompson have named the "Colonial" mill, and recently we had an opportunity of inspecting the machinery complete before shipment to Calcutta, where it is being sent for the approaching exhibition. As compared with the old system of oil seed crushing, Messrs. Rose, Downs, and Thompson claim for their method, amongst other advantages, a great saving in driving power, economy of space, a more perfect extraction of the oil, an improved branding of the cakes, a saving of 50 per cent. in the labour employed in the press room, with also a great saving in wear and tear, while the process is equally applicable to linseed, cottonseed, rapeseed, or similar seeds. In addition to these improvements in the system, the "Colonial" mill has been specially designed in structural arrangement to meet the requirements of exporters. The machinery and engine are self-contained on an iron foundation, so that there is no need of skilled mechanics to erect the mill, nor of expensive stone foundations, whilst the building covering the mill can, if desired, be of the lightest possible description, as no wall support is required. The mill consists of the following machinery:—A vertical steel boiler, 3ft. 7in. diameter, 8ft. 1½in. high, with three cross tubes 7½in. diameter, shell $\frac{5}{16}$in. thick, crown ⅜in. thick, uptake 9in. diameter, with all necessary fittings, and where wood fuel is used extra grate area can be provided. This boiler supplies the steam not only for the engine, but also for heating and damping the seed in the kettle. The engine is vertical, with 8in. cylinder and 12in. stroke, with high speed governors, and stands on the cast iron bed-plate of the mill. This bed-plate, which is in three sections, is about 30ft. long, and is planed and shaped to receive the various machines, which, when the top is levelled, can be fixed in their respective places by any intelligent man, and when the machines are in position they form a support for the shafting. The seed to be crushed is stored in a wooden bin, placed above and behind the roll frame hopper. The roll frame has four chilled cast iron rolls, 15in. face, 12in. diameter, so arranged as to subject the seed to three rollings, with patent pressure giving apparatus. These rolls are driven by fast and loose pulleys by the shaft above. After the last rolling the seed falls through an opening in the foundation plate in a screen driven from the bottom roll shaft by a belt. This conveys the seed in a trough to a set of elevators, which supply it continuously to the kettle. This kettle, which is 3ft. 6in. internal diameter and 20in. deep, is made of cast iron and of specially strong construction. There is only one steam joint in it, and to reduce the liability of leakage this joint is faced in a lathe. The inside furnishings of the kettle are a damping apparatus with perforated boss, upright shaft, stirrer and delivery plate, and patent slide. The kettle body is fitted with a wood frame and covered with felt, which is enclosed within iron sheeting. The crushed seed is heated in the kettle to the required temperature by steam from the boiler, and it is also damped by a jet of steam which is regulated by a wheel valve with indicating plate. When the required temperature has been obtained the seed is withdrawn by a measuring box through a self-acting shuttle in the kettle bottom, and evenly distributed over a strip of bagging supported on a steel tray in a Virtue's patent moulding machine, where it undergoes a compression sufficient to reduce it to the size that can be taken in by the presses, but not sufficient to cause any extraction of the oil. The seed leaves the moulding machine in the form of a thick cake from nine to eleven pounds in weight, and each press is constructed to take in twelve of these cakes at once. The press cylinders are 12in. diameter and are of crucible cast steel. To ensure strength of construction and even distribution of strain throughout the press, all the columns, cylinders, rams, and heads are planed and turned accurately to gauges, and the pockets that take the columns, in the place of being cast, as is sometimes usual, with fitting strips top and bottom, are solid throughout, and are planed or slotted out of the solid to gauges. The pressure is given by a set of hydraulic pumps made of crucible cast steel and bored out of the solid. One of the pump rams is 2½in. diameter, and has a stroke of 7in. This ram gives only a limited pressure, and the arrangements are such as to obtain this pressure upon each press in about fourteen seconds. This pump then automatically ceases running, and the work is taken up by a second plunger, having a ram 1in. diameter and a stroke of 7in., the second pump continuing its work until a gross pressure of 2 tons per square inch is attained, which is the maximum, and is arrived at in less than two minutes. For shutting off the communication between the presses, the stop valves are so arranged that either press may be let down or set to work without in the smallest degree affecting the other. The oil from the presses is caught in an oil tank behind, from which an oil pump, worked by an excentric, forces it in any desired direction. The cakes, on being withdrawn from the press, are stripped of the bagging and cut to size in a specially arranged pairing machine, which is placed off the bed-plate behind the kettle, and is driven by the pulley shown on the main shaft. The paring machine is also fitted with an arrangement for reducing the parings to meal, which is returned to the kettle, and again made up into cakes. The presses shown have corrugated press plates of Messrs. Rose, Downs, and Thompson's latest type, but the cakes produced by this process can have any desired name or brand in block letters put upon them. The edges on the upper plate, it may be added, are found of great use in crushing some classes of green or moist seed. The plant, of which we give illustrations, on page 399, is constructed to crush about 4 tons of seed per day of eleven hours, and the manual labour has been so reduced to a minimum that it is intended to be worked by one man, who moulds and puts the twenty-four cakes into the presses, and whilst they are under pressure is engaged paring the cakes that have been previously pressed. In crushing castor oil seed, a decorticating machine or separator can be combined with the mill, but in such a case the engine and boiler would require to be made larger. The illustrations we give will in themselves furnish a pretty full explanation of the construction of the mill, but in our issue of May 6th, 1881, other details were given in connection with the mill erected by Messrs. Rose, Downs, and Thompson, at Wateringbury, which will also be of interest.



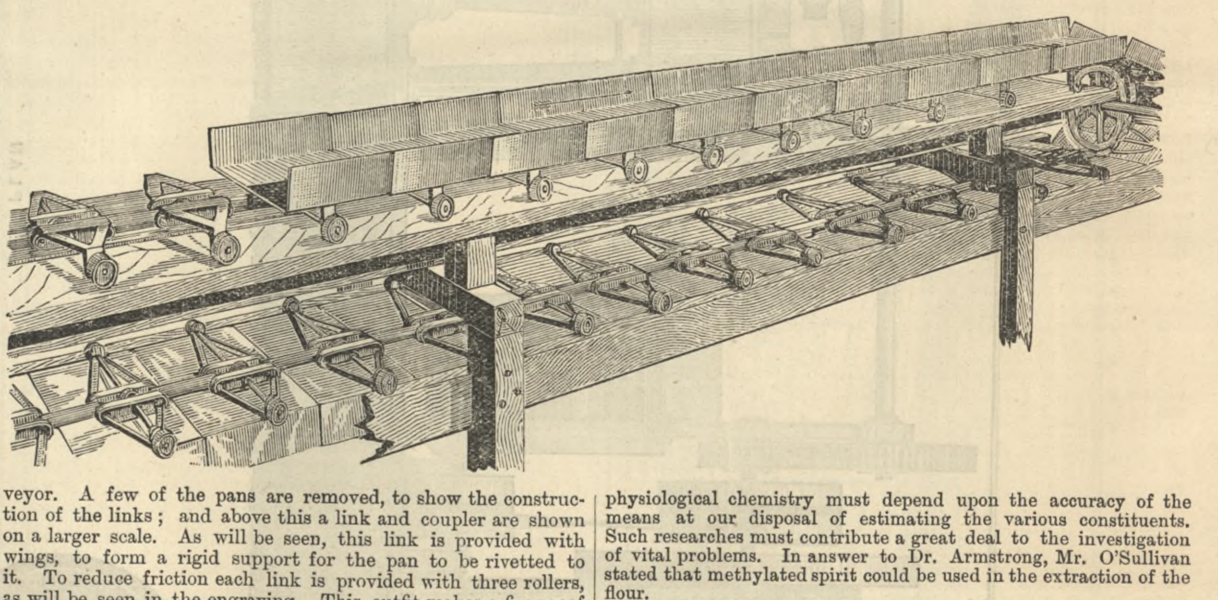
TRANSVERSE SECTION THRO. A.B



LONGITUDINAL SECTION THRO. C.D

ENDLESS TROUGH CONVEYOR.

THE endless trough conveyor is one of the latest applications of link-belting, consisting primarily of a heavy chain belt carried over a pair of wheels, and in the intermediate space a truck on which the chain runs. This chain or belt is provided with pans which, as they overlap, form an endless trough. Power being applied to revolve one of the wheels, the whole belt is thereby set in motion and at once becomes an endless trough conveyor. The accompanying engraving illustrates a section of this conveyor. A few of the pans are removed, to show the construction of the links; and above this a link and coupler are shown on a larger scale. As will be seen, this link is provided with wings, to form a rigid support for the pan to be rivetted to it. To reduce friction each link is provided with three rollers, as will be seen in the engraving. This outfit makes a fire-proof conveyor which will handle hot ore from roasting kiln to crusher, and convey coal, broken stone, or other gritty and coarse material. The Link-belt Machinery Company, of Chicago, is now erecting for Mr. Charles E. Coffin, of Muirkirk, Md., about 450ft. of this conveyor, which is to carry the hot roasted iron ore from the kilns on an incline of about one foot in twelve up to the crusher. This dispenses with the barrow-men, and at an expenditure of a few more horse-power becomes a faithful servant, ready for work in all weather and at all times of day or night. This company also manufactures ore elevators of any capacity, which, used in connection with this apparatus, will handle perfectly anything in the shape of coarse, gritty material. It might be added that the endless trough conveyer is no experiment. Although comparatively new in this country, the American *Engineering and Mining Journal* says it has been in successful operation for some time in England, the English manufacturers of link-belting having had great success with it.



ESTIMATING STARCH IN CEREALS.

AT the meeting of the Chemical Society on November 15th, Mr. C. O. Sullivan read a paper on "The Estimation of Starch."

The author has used the method described below during the last eight to ten years for estimating starch in cereals and malted grain. The method may be briefly described as follows:—The finely ground grain is successively extracted with ether, alcohol—specific gravity ·90—and water at 35 deg. to 38 deg. The starch in the washed residue is gelatinised by boiling with water cooled to 60 deg., and converted by diastase into dextrin and maltose; if a quantitative determination of these two products be made, the starch originally present can be calculated. The author describes the method as follows:—About 5 grms. of the finely-ground flour are introduced into a wide-necked 100 cc. flask, and just saturated with alcohol, specific gravity 0·82, 20 to 25 cc. of ether are added. After standing several hours, with occasional shaking, the ethereal solution is decanted through a filter, and the residue in the flask washed with ether. To the residue 80 to 90 cc. of alcohol, specific gravity 0·90, are added, and the moisture warmed to 35 to 38 deg. for a few hours. The alcoholic solution is then decanted through the same filter, and the residue washed with alcohol, specific gravity 0·90, at 35 to 38 deg. The residue in the flask and on the filter is washed into a 500 cc. beaker, and the beaker filled with water; in about twenty-four hours the solution is decanted through a filter, and the residue washed with water at 35 to 38 deg. The residue in the beaker and on the filter is washed with a short camel hair brush, and a fine jet into 100 cc. beaker. The whole is then boiled for a few minutes in the water bath, with constant stirring, to gelatinise the starch. The beaker and its contents are cooled to 62 to 63 deg., and about 0·03 grm. of diastase added; the digestion at 62 deg. is continued for an hour. The beaker is then boiled for eight to ten minutes, the solution filtered into a 100 cc. measuring flask, the residue carefully washed with successive small quantities of boiling water, and the whole made up to 100 cc. at 15·5 deg. The ether frees the grain from fat, &c., the alcohol—·90—removes the sugars, albumenoids other than casein, &c., whilst water at 35 to 38 deg. dissolves out the amylams. Dextrin and maltose are the sole products of the action of diastase on starch. The diastase is prepared as follows:—2 to 3 kilos. of finely-ground pale barley malt are mixed with sufficient water to saturate and cover the whole. After standing three or four hours, the mass is squeezed with a filter press. If not bright the liquid is filtered. To the clear solution, alcohol, specific gravity 0·83, is added, as long as a flocculent precipitate falls; as soon as the supernatant liquid becomes milky the addition of alcohol is discontinued. The precipitate is washed with alcohol 0·86 to 0·88, dehydrated with absolute alcohol, pressed and dried in vacuo over sulphuric acid until its weight is constant. Diastase thus prepared is a white, friable, easily soluble powder, which retains its activity for a considerable time. Five grms. of barley flour thus treated with 0·03 grm. diastase gave 100 cc. at 15·5 deg., having specific gravity 1·01003, which represents 25·39 grms. of solid matter; taking 1·00395 as the specific gravity of a solution containing 1 per cent. of starch products—9·178 grms. of this solution reduced 0·241 grms. cupric oxide, and 200 mm. of it gave a deviation in the Soleil Wentzke-Scheibler saccharimeter of 21·1 divisions. Thus we have 0·241 grm. × ·7256 = 0·1748 grm. maltose in 9·178 grms.; in the 100 cc. or 101·003 grms. there are 1·923 grms. maltose; 1 grm. of maltose in 100 cc. gives a deviation in 200 mm. of 8·02 division, and 1 grm. of dextrin in 100 cc. gives 11·56 divisions. So 1·923 × 8·02 = 15·422, the optical activity of the maltose; and 21·1 – 15·422 = 5·678, the optical activity of the dextrin; therefore, in 100 cc. there are $\frac{5\cdot678}{11\cdot56} = 0\cdot491$ grms. of dextrin. We have, therefore, in the 100 cc. maltose 1·923 grms. of dextrin, 0·491 grm. diastase, 0·03 grm. = 2·444 grms. out of 2·539 solids, as indicated by the specific gravity; of this deficiency of 0·095 grm. 0·083 proved to be an amylam which had not been washed out. 1 part of starch yields 1 part of dextrin, and 1 part of starch yields 1·055 maltose. The starch represented by the above numbers is therefore dextrin = 0·491, maltose $\frac{1\cdot928}{1\cdot055} = 1\cdot822$, or a total of 2·313 grms. starch from 5 grms. of barley. Barley thus contains 46·26 per cent. of starch. A second experiment gave 46·38 per cent. The author gives many other determinations in detail; barley malt contains 39·9 per cent.; wheat, 55·4 per cent.; wheat malt, 43·26 per cent. and 43·53 per cent.; rye, 44 to 46 per cent.; rice, 75 to 77 per cent.; maize, 54 to 58 per cent.; oats, 35 to 38 per cent. In some experiments the author estimated the starch in a sample of pure starch containing 89·36 per cent. of dry starch. He obtained 87·72 per cent. and 89·54 per cent. The author states as the result of his experience with the method that the difference in results obtained by any two observers need not exceed 0·5 per cent. of the total starch. Dr. Armstrong said the paper was one of great value, and the amount of work involved was not by any means represented by the length of the paper. The progress of physiological chemistry must depend upon the accuracy of the means at our disposal of estimating the various constituents. Such researches must contribute a great deal to the investigation of vital problems. In answer to Dr. Armstrong, Mr. O'Sullivan stated that methylated spirit could be used in the extraction of the flour.

AT "Reddich, Germany," the *Scientific American* says, 14,000 persons are engaged in making needles. The total production of needles in the world is 200,000,000 per week, or 10,000,000,000 per year.

SILK MANUFACTURE IN ENGLAND.—A correspondent writes from Lucerne:—"Would you kindly open your columns to the consideration of all the aspects of the question why silk manufacture has no position in England, the home of the cotton spinning industry The raw material can be as easily purchased by the English as by others, from Northern Italy, and shipping freights are cheap. The impediments stated out here are: (1) That the British Government places a heavy tax on the raw material; (2) that we have no workmen with the experience and 'touch' of those engaged in the industry in various countries in Southern Europe; (3) that if we had the workmen, or educated or imported them, the art taste does not yet exist to produce similarly elegant and refined patterns; (4) that high rents and limited tenure in England are opposing forces; (5) that money wages are higher, due in part to the preceding cause."

RAILWAY MATTERS.

It is expected that the inner circle completion will be finished in the early part of next year. The tunnel is practically finished, and stations are being pushed forward.

In a report on a collision which occurred on the 6th ult. at Aldeburgh, on the Great Eastern Railway, Major Marindin remarks that the driver appears to have discovered that he was running too fast when he was still over 300 yards from the buffer stops; and, therefore, if he had had a continuous brake at his command he might easily have averted the collision.

The railways of South Australia bring in a total revenue of £469,000, yet the actual net receipts to be set against the interest on cost of construction is only £146,000. The *Colonies and India* says economical management might make these railways indeed a splendid property, equal in value perhaps to three-quarters of the national debt. But as things are at present it can only be said that they pay about half the interest on their cost of construction.

The directors of the Oregon and California Railway have received advices from their English engineer at Oregon, stating that the completion of the line to a junction with the Central Pacific is being rapidly proceeded with, and out of a total of 178 miles from Roseburg, about 140 miles to Ashland will be in working order by January next. The last section of 38 miles, including the tunnelling of the Siskiyou Mountains, is also in active progress, and is expected to be completed by the close of 1884.

A Parliamentary paper has been published, giving the report by the Board of Trade on the applications made in the year 1882, under the Railways Construction Facilities Act, 1864, and of their proceedings under that Act and the Railways—Powers and Construction—Acts, 1864, Amendment Act, 1870. A second return contains a report on the applications made during the year 1882 under the Railway Companies' Powers Act, 1864, and of the proceedings of the Board of Trade with respect thereto.

A large new signal-box, on the Great Western Railway at Ruabon, had been constructed to contain about fifty levers, when a landslip in the embankment behind, on Monday, swept down the entire structure into the railway, with a large quantity of earth and a massive stone wall. The signal-box was completely wrecked, and a foreman and two workmen were buried beneath the *débris*. Some thirty or forty workmen in the station yard hearing the crash hurried to the spot, and dug out the men before they were suffocated.

The Swansea Harbour Trust has decided that, while the London and North-Western Railway Company go to Parliament next session for powers to extend its line from Blackpill to the Mumbles' Head, the Trust will also go for powers to make a deep water pier 500 yards long, so as to accommodate the great steamship traffic for passengers and goods which will be created between Wales and Devonshire, Cornwall, &c. This line will give a new and direct through route between Wales and the north and south-west of England. It is looked upon as a project of the greatest importance to the district and the Bristol Channel generally, as it will enable steamers of the largest capacity to load and unload at any state of the tide without docking. One-sixth of the whole of England's shipping yearly enters the Bristol Channel.

During a recent visit to Darjeeling, writes a *Times* correspondent, "I was much impressed by the great advance visible in the prosperity of the station and district since they were brought into connection with the Indian railway system two years ago. Within a few days' march of the terminus of the mountain railway lines is the richest and most populous part of Tibet, inhabited, not like the trans-frontier districts of the Punjab, by Mahomedan cut-throats, but by a peaceable and trade-loving people. At present the bulk of the trade between India and Tibet is obliged to follow a most circuitous route, through Nepaul, and it is charged duty on entering and leaving that country. Notwithstanding these difficulties, the trade continues to increase. The direct route lies unquestionably through Darjeeling, and goods can now be conveyed by rail to within a week's journey from the frontier. The removal of the existing restrictions would open new and enormous markets for tea, indigo, tobacco, and other Indian products, as well as for hardware and the cotton goods of Manchester. This market would supply us in return with inexhaustible quantities of the finest wool, and with musk, borax, &c." Cheap railway extension works would, it would appear, promise a good future return.

At the Petty Session at Watford on Tuesday, Frederick Ridgway, aged thirty years, signalman, surrendered to his bail in answer to a charge of manslaughter, in causing the death of Joseph W. Longstaffe, engine driver, who died from the injuries received in the collision on the London and North-Western Railway at Watford, on October 31st. Ridgway wrote a statement, in which he expressed his regret at having forgotten that three empty coaches detached from the 5.40 train were standing on the up fast line waiting to be shunted, when the 2.5 Liverpool express dashed into them. It appeared from the evidence of a witness named Griffin, who was acting as station-master on the evening of the accident, that at 6.14 there were obstructions on seven of the lines, which delayed the shunting for some little time. He thought, however, that the carriages might have been shunted at 6.32 if a down goods train at Bushey had been kept back. It was admitted that the shunting engine and empty carriages were at a distance of about 170 yards from the signal-box when the accident occurred, and that there was no red light shown at the rear of the vehicles as required by the rules supplied to the company's servants. At the conclusion of the evidence, Mr. Robert Pryor, the chairman of the bench of magistrates, said the case was one of great public importance. The magistrates had given it their most careful consideration, and they came to the conclusion that Ridgway had not been proved to be guilty of manslaughter.

The Arlberg Tunnel was completed on November 19th. The ceremony was completed on the eastern or Tyrolese side, at the village of St. Anton, at the foot of the mountain. After an address to Baron Pino, the Minister of Commerce, had been read, and replied to by him, the guests, among whom was the Governor of the Tyrol, Herr von Widman, went to the entrance of the tunnel, which was decorated with pine branches, and near which an altar had been erected. A *Te Deum* was chanted. The miners, carrying the green and white flag of St. Barbara, their patron saint, stood round the carved wooden altar, while thousands of workmen listened bareheaded. After the service had been concluded, the guests dressed themselves in long frocks and mounted the train, four being placed in each truck. The train at once entered the tunnel. At 1 a.m. the guests on the west, or Voralberg side, had assembled in a body at the entrance of the tunnel, where also an altar had been erected, over which Mass was said. Over the entrance of the tunnel three large flags floated, with the Imperial eagle. Two medallions were also affixed bearing the inscriptions, "Commenced June, 1880," and "Pierced November, 1883." The train disappeared into the tunnel, moving to meet the other. In the meantime, the train from the east had made its way into the tunnel. All along fires were burning, but they could scarcely light up the gloom. In places there were transparencies with the Imperial arms. The passage took 55 minutes to the last change, and thence the party went on foot to look at the sheet of rock 170 centimètres thick, which, though pierced with a hole for communication, still intervened between the two passages. The Minister, by an electric apparatus, fired a mine, and a deep, rumbling noise announced the final piercing of the Arlberg Tunnel. The workmen took away the *débris* and joined the rails on both sides. The chief engineer next delivered an address, expressing satisfaction at the completion of the work, and pointed out the importance of the new line of communication. The Minister replied, and distributed the commemoration medal. It shows two female figures, Tyrol and Vorarlberg, who join hands.

NOTES AND MEMORANDA.

The density of the new standard pound weight made of platinum, under order by the Board of Trade, is 21·3857, the air being at a mean temperature of 12·77 deg. C., and the water in which it was weighed 10·81.

Recent experiments give the coefficient of cubic expansion of bronze as used in the Mint as 0·00005322 per deg. C., and of brass 0·00005166, the linear coefficients being consequently 0·00001774 and 0·00001722. The cubic expansion of white glass is given at 0·00002658, the linear coefficient being 0·00000886.

The Board of Trade "Report of Proceedings under the Weights and Measures Act, 1878," gives tables showing the maximum pressure of aqueous vapour at temperatures from 0 deg. C. to 30 deg. C.; of the density of air; of the density of water at different temperatures; table of corrections on the gallon of water for temperatures from 50 to 75 deg. F. in brass and in glass measures; the same for litre of water, and tables of specific gravities, coefficients of expansion, and on petroleum testing.

According to report, the exploring party in the Accrington pit have discovered the source of the fire-damp whence resulted the explosion. Among the numerous contrivances proposed for preventing the recurrence of such calamities, it is curious how little is said of the use of fire-damp itself as a warning of danger. There is an apparatus, familiar in most chemical laboratories, constructed on the principle that 134 volumes of fire-damp will diffuse through a porous plate as quickly as will 100 volumes of air. This being so, the increased volume within the vessel is used to raise a column of mercury, so as to make contact with a battery, and then to ring a warning bell.

A German mile—about five English miles—contains 25,856ft.; a square German mile contains therefore 668½ million square feet. The superficial area of the Lake of Constance being 8½ German square miles, therefore contains 5682 million square feet. There are living on the surface of the globe at this moment, in round numbers, about 1430 million human beings. Let every man have 4 square feet allotted to him, and if it were frozen over, the whole human family might find standing room upon the surface of the lake. Should the weight prove too great, the ice break, and the whole human race be submerged, it would only raise the level of the lake about 6in. This seems incredible, but figures prove it.

In the monthly report to the Water Examiner, Metropolis Water Act, 1871, Messrs. William Crookes, William Odling, and C. Meymott Tidy say:—"With respect to the frequently considerable variations with season, in the always small amount of organic matter met with in London water, it results from our experiments that the mean amount of organic carbon in the water furnished during October by the companies taking their supply exclusively from the Thames, was just 0·100 part in 100,000 parts of the water, the average amount for the past six months having been 0·116 part, corresponding to about two-tenths of a grain of organic matter per gallon. With the coming on, however, of winter, the low amounts of organic carbon, and consequently of organic matter, present in the water for so many months past can scarcely any longer be expected."

A Belgian bye-law was recently published instituting a diploma for electrical engineers which will be conferred on engineers after a year's special study according to a programme which also considers students in engineering and those foreigners who have been engaged with success in electrical engineering. Programme A relates to those who may gain the diploma at the end of one year's studies, which are to include—theory of electricity, electrotechnics, including the various applications of electricity; laboratory work in electricity, and revision of projects in various branches of electrotechnics. Programme B includes theory of electricity, electrotechnics, applied mechanics, industrial physics, with thermodynamics, industrial architecture, design and operation of machines, laboratory work, and the English or German language. Programme C includes electrotechnics, working of railways, industrial architecture and design, electrical laboratory work, revision of electrical projects, and one or other of the above languages.

In a Board of Trade "Report of Proceedings under the Weights and Measures Act, 1878," just issued, Mr. H. J. Chaney remarks on his visit to the Paris Bureau, that "there can be no doubt that, in the construction and arrangement of the comparing rooms, and in the design and use of the comparing apparatus, the office at Sèvres has made important advances towards that high accuracy of work which science now demands. With the means there provided it is possible, for instance, to ascertain a difference between two kilogram weights so small as 0·000000003 kilog., or less than a three hundred millionth part of the whole weight. In the comparison of two metres, a difference so small as 0·1 micron (0·0001 mm., or 0·0000039in.) could be determined. At the Standards-office, which is perhaps as well equipped as the best offices of other Governments, it is at present not possible, with the microscopic apparatus alone, to ascertain differences in kilogram weights smaller than 0·00000005 kilog., or the twenty millionth of the whole quantity weighed; or the difference between two measures of length to less than 0·0000095in."

At the meeting of the Chemical Society on the 1st inst., a paper was read "On the Alleged Decomposition of Phosphorous Anhydride by Sunlight," by Messrs. R. Cowper and V. B. Lewes. In a paper read before the Southport meeting of the British Association by the Rev. A. Irving, the author stated that phosphorous anhydride, prepared by passing a slow stream of dry air over molten phosphorus, decomposed when exposed to sunlight into amorphous phosphorus and phosphoric anhydride. The authors have repeated this experiment, and analysed the sublimate obtained in the manner described by Irving—it consisted of 78·2 per cent. of phosphoric anhydride, 4·7 per cent. phosphorous anhydride, and 17 per cent. of phosphorus. On exposing this white mixture to sunlight it became red, the phosphorus being converted into the amorphous variety. In another experiment the air, after passing over the melted phosphorus, bubbled through carbon disulphide. After some time the bisulphide was allowed to evaporate on blotting paper, when enough phosphorus was left behind to give dense fumes.

In his recent lectures on "Transmission of Energy," Professor Osborne Reynolds said:—"In a revolving shaft, neither the stress nor the velocity are uniform over the section, both varying uniformly from nothing in the middle to their greatest value on the outside; so that their mean product is exactly half the product of the greatest values. The greatest power per square unit of section a shaft can transmit is half the product of the greatest stress into the velocity at the outside of the shaft. Taking, then, the greatest safe working stress of steel at 15,000 lb. on the square inch, taking what is the greatest practical velocity at the surface, 10ft. per second—the speed of railway journals—the work transmitted is 75,000 foot-pounds per second per square inch of section—135-horse power; so that we should have to have a shaft of upwards of 7 square inches in section to transmit 1000-horse power, that is, a shaft of over 3in. diameter. The friction between such a shaft and lubricated bearings is well known, ·04; so that, calculating the weight of the shaft 24 lb. per foot, we have power spent in friction about 52,000 foot-pounds per mile, that is one-tenth the total power the shaft will transmit. That is, if we put 1000-horse power into a 3in. shaft, making 500 revolutions per minute, we ought, at the end of a mile, to be able to take 900-horse power out of it. If we had to go farther, the size of the shaft might be diminished, so that in the next mile we should again lose a tenth, and if we repeat this process seven times we shall, at the end of seven miles, have left about half the original power put in. It will be thought, perhaps, that a 3in. shaft is very small to transmit so large a force; this is because the speed of 500 revolutions per minute is inconveniently high for purposes of employing the power; but if it were merely a question of transmission, it would be about the best speed. This, then, shows the limit of the capacity of shafts as transmitters of work."

MISCELLANEA.

The construction of the Highgate Hill steep grade tramway is now being energetically pushed all along the line.

The petition for the winding up of the Jablochkoff Electric Lighting Company has been withdrawn.

The West Metropolitan Tramways Company has issued Parliamentary notices with the view of introducing a Bill next Session empowering the company to extend its tramway system from Hammersmith to Victoria.

The Moorfield Pit, the scene of the recent explosion, where sixty-seven lives were lost, was partially reopened on Tuesday, several coal-getters being set to work. The other parts of the mine are being got ready for work.

Messrs. Raylton Dixon and Co. have launched from their yard the steamer named the Welcombe. Her length is 285ft.; breadth, 38ft.; depth moulded, 25ft. 3in.; and she is estimated to carry a dead weight of 3150 tons. The engines, which will be of 200-horse power, are being built by Messrs. T. Richardson and Sons.

Hadfield's Steel Foundry Company, our Sheffield correspondent writes, has been awarded the only gold medal for its collection of steel castings, varying in weight from a few pounds up to several tons each, at the International Exhibition held at Madrid this year. This was the only gold medal granted for steel castings, thus rendering the award of even more special merit and value. Also the fact of it being in the face of severe competition from German, French, and other continental manufacturers, is somewhat encouraging, as sustaining the reputation of Sheffield steel abroad.

At the Staines Petty Sessions proceedings were taken by the Thames Conservancy against the Staines Local Board, in respect of the pollution of the Thames by drains flowing through their district. Mr. G. Payne, solicitor to the Thames Conservancy, who appeared in support of the summons, reminded the Bench that since notice was served upon the Board, in September, 1879, to put a stop to the pollution of the river in this way, they had been five times convicted of allowing it to continue, and though heavy penalties had been imposed nothing had yet been done to remedy the evil. As it was estimated that the outlay upon a general sewage system, such as Mr. Hawkesley recommended, would amount to £32,000, Mr. Engall urged that this was a very serious question for a population numbering only 5000. The Bench decided, under the circumstances, to impose a mitigated penalty of £1 1s., and £5 5s. costs in this case.

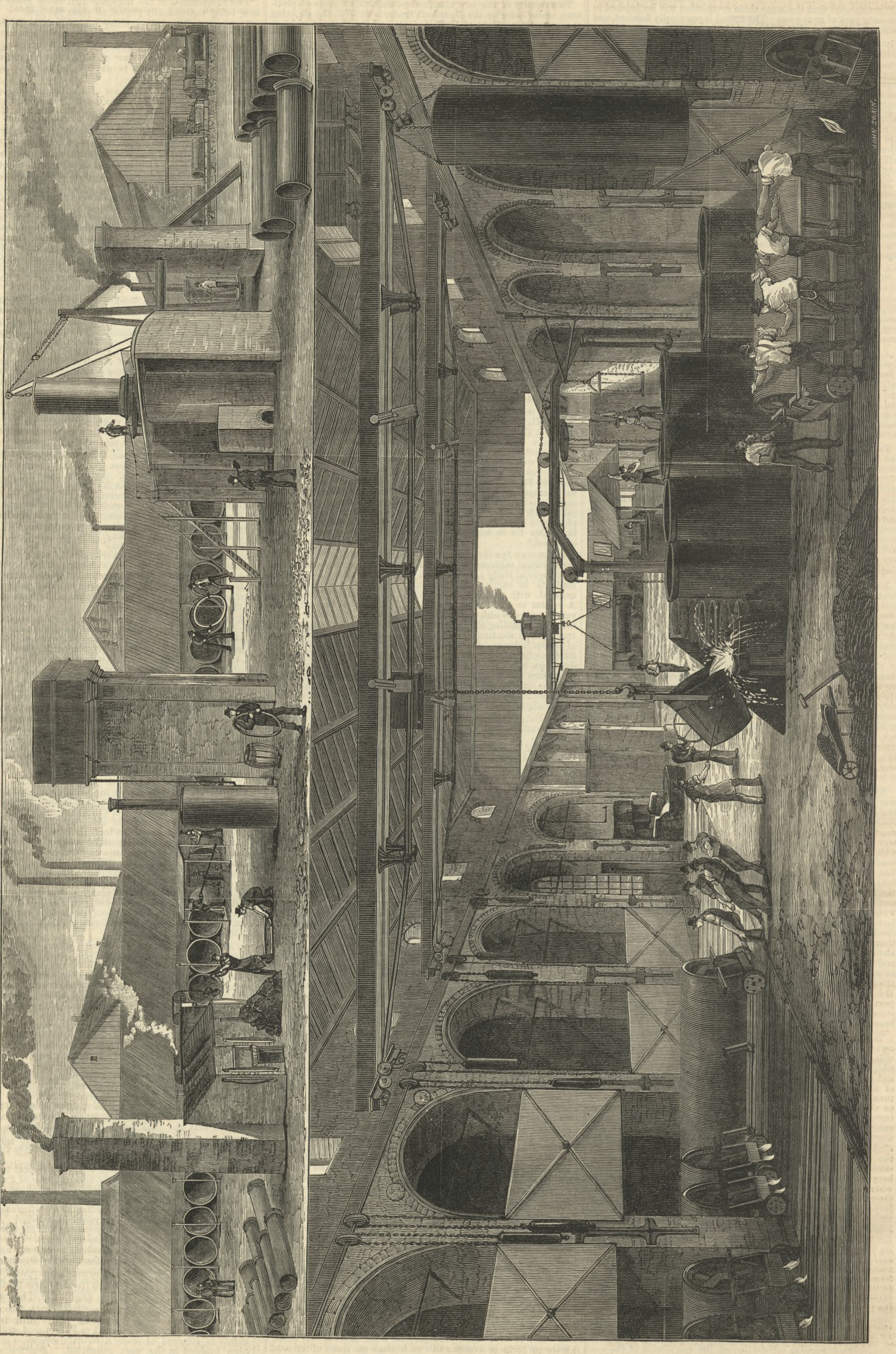
A strike of moulders has this week begun at the Cornwall Works, Birmingham, of Messrs. Tangye's. It involves a principle of considerable importance. Hitherto the firm have had two foundries in operation—one at the Cornwall Works, and another at Winson-green—but the inconvenience of the separation and the increasing demand for their work have led to the erection of a new and extensive building adjoining the Cornwall Works, sufficiently spacious to supply the whole of the castings. The moulders at Winson-green were non-society men, but those at the Cornwall Works were all in the Moulders' Union; and the preparations for putting them to work together under the same roof originated a difficulty. Sixty moulders have struck against an attempt by the firm to introduce a uniform system of piecework, whereby every individual moulder is made responsible for the manner in which he performs his work, and the firm is able to ascertain the exact cost of the work he produces.

A large twin screw hopper dredger, built and engined by Messrs. W. Simons and Co., was launched on the 17th inst., complete from their works at Renfrew. It is the property of the Queensland Government, and has been constructed under the direction of Mr. G. G. Dick, their engineer. It is named the Platypus, and it will dredge to 30ft. depth, and carry 800 tons of its own dredgings at a speed of nine miles an hour. It is fitted with two independent sets of compound engines of 500-horse power, and an awning deck for shelter in hot weather. It is besides fitted with an engineer's workshop and tools, driven by steam power, and steel has been used everywhere. In this vessel has been adopted the traversing bucket girder and every appliance conducive to the economy and efficiency of one of the most complete and powerful dredgers afloat. This is the eighteenth hopper dredger Messrs. Simons have constructed, and its place will be occupied by two duplicate vessels for the Spanish Government.

The low prices which are known to have regulated the big contracts recently placed in Birmingham for copper wire for the new cables were quoted on Thursday afternoon on 'Change as an additional illustration of the fineness to which profits have to be cut in every department of business. The prices accepted are reported to have been quite a half-penny per lb. under the market quotation for wire of the specified quality. The latest contract, for 400 tons of copper wire for a new cable to North America, has been shared by Messrs. Jno. Wilkes and Sons, Thos. Bolton and Sons, and Elliott's Metal Company. This contract follows upon the one secured by the two first-named firms a few weeks back for the new cable to Brazil. Execution is urgent, and the North American order is, it is believed, being rolled off at the rate of nearly sixty tons a week. Copper wire makers cherish the expectation that at least one other similar contract may before long be added to those now in hand.

The great difficulties which were encountered in the earlier stages of the Lorne Graving Dock, Quebec, have now been entirely surmounted. The whole of the dock works, except a portion of the caisson chamber near the entrance, is founded upon rock, but at this place we understand that sand, to a considerable depth, was unexpectedly discovered, which necessitated extra works being carried out within a confined space inside the cofferdam before the water could be excluded, and previous to getting in the foundations of the entrance works. As work of this nature in Canada can only be carried on for six months in the year, owing to the severity of the winter season, the progress made up to the present time may be considered very satisfactory. The result of the suggestions made by the engineers, Messrs. Kinipple and Morris, to overcome the difficulties which have arisen has proved most successful, and the works are now expected to be completed by the end of next year. The graving dock is 530ft. in length on the floor, 100ft. in width at coping, and 84ft. at bottom, with 25ft. 6in. depth of water on the sill. It is believed that the dock, when finished, will be the finest on the American Continent. The resident engineer is Mr Woodford Pilkington, M.I.C.E., and the contractors are Messrs. Larkin, Connolly, and Co., of Canada.

The principle already carried out with respect to the technical examination for engineers by the Governments of Prussia, Saxony, and Baden, has now been adopted in Wurtemburg. According to a decree lately issued in that country, there have been two State examinations introduced in addition to a preliminary test of proficiency in mathematical and physical knowledge. Attendance at a technical school is a necessary preparation for candidates. The State examination is divided into two parts. The first includes practical geometry, the mechanical theory of heat—including aerostatics and aerodynamics—the theory of building construction and of building materials, mechanical and chemical technology, the building of railways and of iron bridges, steam boilers and the legislation affecting them, and, finally, motors and transport machines. The second examination is more specially intended to test the practical knowledge of the candidates. A duly prepared plan has to be drawn up in accordance with a programme which is issued, and as this has necessarily to be prepared at home, the candidate is required to make a formal declaration as to his having been unaided in the work submitted. Written and *viva-voce* examinations on technical subjects are also included in the scheme. These tests are specially designed for mechanical engineers, and the titles conferred on successful candidates bear special reference to skill in the construction of machinery.



PIPE FOUNDRY OF THE WIDNES FOUNDRY COMPANY, WIDNES.

(For description see page 393)

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PARIS.—Madame Boyveau, *Rue de la Banque.*
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TO CORRESPONDENTS.

*** *In order to avoid trouble and confusion, we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must, in all cases, be accompanied by a large envelope legibly directed by the writer to himself, and bearing a* 1d. *postage stamp, in order that answers received by us may be forwarded to their destination. No notice will be taken of communications which do not comply with these instructions.*

*** *We cannot undertake to return drawings or manuscripts; we must therefore request correspondents to keep copies.*

*** *All letters intended for insertion in* The Engineer, *or containing questions, must be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever will be taken of anonymous communications.*

T.—*Apply to the Clerk of Contracts, Board of Admiralty, Whitehall.*

J. M. G.—*You had better write to the inventor—to* 50, *Trafalgar-road, Old Kent-road, S E.*

C. L. H. L.—*Further reference cannot be made to the invention to which your communication relates*

Milano.—*We cannot tell what the power of the engine is without diagrams Probably it is about* 300-*horse power indicated*

A. R.—*Illustrations of the Viking war ship will be found in the "Transactions" of the Institution of Naval Architects.*

H. W. S.—*You can obtain a circular containing full information by applying to the Marine Department of the Board of Trade, Whitehall.*

A. B. (Huddersfield).—*Such a belt was used at the Crystal Palace by Messrs. Gwynne, of Hammersmith. They may be able to supply the information you require.*

R. J. (Gainsborough)—*The differences between the valve chest and boiler pressure are due to the position of the regulator, which was in some cases partly closed, in others full open.*

W. D. (Manchester)—*The nearer the throttle valve is to the cylinder the better, but we cannot undertake to say that moving the valve will do good in your case. Unsteady running in hydraulic machinery may have many causes.*

Ignoramus.—*Whether the crane will pull with more effect when the jib is at* 45 *deg. than when it is at* 25 *deg. depends on the nature of the resistance offered by the weight If it is a question of mere hauling, then the crane will be more efficient at* 25 *deg; but if it is a question of lifting and hauling, then it will probably be more efficient with the jib at* 45 *deg.*

Errata.—*Page* 383, *middle column, line* 4 *from bottom, for "the* 0·25 *of one second," read "the* 0·12 *of one second" Page* 373, *first column, first paragraph, line* 8 *from end, for "result of no* mechanical *investigations," read "result of no* mathematical *investigations.'*

PORTLAND PUMPS.

(*To the Editor of The Engineer.*)

Sir,—We shall be obliged to any of your readers who can tell us where Portland pumps are to be had.

L. L. and Co.

BELT TENSIONS.

(*To the Editor of The Engineer.*)

Sir,—Will any reader of The Engineer inform me how to obtain the tensions in the tight and slack sides of a belt transmitting power?

London, November 19th. J. L.

WATERPROOF VARNISH.

(*To the Editor of The Engineer.*)

Sir,—Can any of your readers inform me of a good varnish for wood or iron that will not allow the growth of fungi, and suitable for fish propagating tanks?

F. G. U. S.

London, November 15th.

RUSSIAN SHEET IRON.

(*To the Editor of The Engineer.*)

Sir,—I should be glad to know from whom thin sheets of Russian iron, similar to that used for covering the Westinghouse brake pump cylinders, can be obtained.

J. P.

Peterborough, November 20th.

THE TREATMENT OF BELTS.

(*To the Editor of The Engineer.*)

Sir,—I am interested in a manufacturing concern in India where the consumption of belting is most serious owing to the rotting effect of the climate. Cotton does not appear to resist this any better than leather. Can any of your readers tell me of anything that will keep strapping from perishing?

Koihai.

CONTINUOUS GIRDERS.

(*To the Editor of The Engineer.*)

Sir,—In going through my article on "Continuous Girders" which appeared in your issue of the 9th inst., I find I have to make the following correction. Lines 18 and 21 from the end should be as follows:—

$$e = -\,0·000176\text{ft.}$$

$$P = 7·56 + 3194\,e \text{ and } Q = 3·52 - 2553\,e$$

M. am Ende.

3, Westminster-chambers, Victoria-street, S.W.,
London, November 19th.

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Advertisements cannot be Inserted unless Delivered before Six o'clock on Thursday Evening in each Week.

Letters relating to Advertisements and the Publishing Department of the paper are to be addressed to the Publisher, Mr. George Leopold Riche; all other letters to be addressed to the Editor of The Engineer, 163, *Strand.*

MEETING NEXT WEEK.

The Institution of Civil Engineers.—Tuesday, Nov. 27th, at 8 p.m: Ordinary meeting. Paper to be read with a view to discussion, "The New Eddystone Lighthouse," by Mr. W. T. Douglass, Assoc. M. Inst. C.E.

THE ENGINEER.

NOVEMBER 23, 1883.

THE COAL TRADE.

The condition of the coal trade of Great Britain is now, and has been for some time past, very anomalous. Coal is used to a greater extent than it ever was before, and sales can be readily effected; but the prices obtained in England and Scotland are so low that next to no profit is realised by the coalowner, and an enormous strike is impending because the wages of miners cannot be raised. On the 5th day of December next, if the colliers keep in their present mood, 90,000 miners will take to self-enforced idleness to secure an advance of 15 per cent. in their wages. This number will be in South and West Yorkshire and North Derbyshire. If Lancashire and other counties join, probably the figures will be nearer 160,000. Dependent on these breadwinners are at least three times the number of wives and children. A serious question suggests itself—how are they to be supported? Several of the miners are frugal and have saved some money, but as a rule they live from hand to mouth, and the first question asked at the Rotherham conference was on this point. It is said that the union officials told the delegates plainly there were no funds sufficient to maintain them. One member reminded the conference of a balance of £3000 at the credit of the Yorkshire Miners' Association. "Yes," is said to have been the reply of the president, "there is £3000; that is just one shilling to eighteenpence each for each of you, and I shall take care you have the whole of it the first day you are out." The public are not likely to respond readily to appeals from the miners, and the number on strike will put it out of the power of other trade unions to support them. There is an idea among the men that after they have been out a week or a fortnight the masters will be glad to make terms; but there is no likelihood of this taking place. Arrangements have been in progress ever since the advance was mooted for resisting it; and at this moment the iron and steel companies have heavy supplies of coal stacked on their premises, while the gas companies have had large deliveries made to tide them over the time of difficulty. Ironworkers will generally be put on half time, and as all contracts are taken subject to a strike clause, no attempt will be made to complete deliveries which cannot possibly be effected. At present there is every prospect of the struggle being severe, and as there never yet was a strike which paid the working man the amount of wages he lost in fighting for an extra shilling or two per week, it is as certain as anything in the future can be, that the present dispute, while it will seriously cripple capital and commerce, cannot assist labour, and will most assuredly entail widespread suffering in every mining village to which it extends.

In marked contrast with all this is the condition of affairs in South Wales. There there is a brisk demand for coal at remunerative rates, and the men appear to be tolerably well contented with their wages. The colliery proprietors make no complaints. What is the cause of this? So far as can be seen, it is a result, for one thing, of the fact that South Wales coal can be transmitted to the consumer at a less rate than Midland or North-country coal; but there is more than this; and it appears to us that both men and masters in England would do well to consider carefully the precise nature of the conditions under which the coal trade is carried on. It is possible that information might be obtained in this way which might be valuable. It may, no doubt, be said that colliery owners and miners know all that is to be known. From this, however, we dissent. The men, to judge by their actions, are not well informed; and the masters appear in too many cases to take a circumscribed and localised view of their position with regard to the consumer. Nothing is more likely to be injurious to the interests of masters and men than this. Unless a grasp can be taken of the coal trade as a whole, grave mistakes will be made. To draw conclusions, for example, from what takes place in Durham, and to apply them to Staffordshire and Scotland, is to proceed on an entirely wrong principle, and it is still worse to assume that what holds good of one colliery must hold good of a great many in various parts of the country; and not only should the position and relations to the consumer of the capital and labour employed in coal winning be considered, but also the relation and position of the consumer to the rest of the world. Thus, for example, to assume, as too many miners do, that the shipbuilder must have plates, and the ironmaker must have coal, is to make a radical mistake. For the building of ships and the making of plates depend at present very much on the price at which coal can be bought. Unless ships are cheap they will not be purchased, and this fact of course affects everything connected with ships.

If we put on one side abnormal and short-lived rises in price, such as those which occurred about a dozen years ago, it will be found that the value of coal has not altered much for a comparatively long period, but the alterations have been on the whole rather up than down. It is quite certain, however, that the conditions under which coal is obtained are not the same as those which prevailed thirty or forty years ago. The pits are deeper. Seams are now worked which had not hitherto been touched because they were so deep. All the plant and machinery about a modern colliery is much better and more expensive than such machinery used to be. The capital expended is greater than at any previous time. The interference of Parliament has to a certain extent hampered men and masters. All these things must be taken into account. As far, however, as the expenditure of capital is concerned, the masters alone suffer. The men are better off than they ever were before. If the life of a working collier and his family in 1883 is compared with that of the collier and his family in 1833 or even in 1853, it will be found that their positions have been greatly ameliorated. They are better fed, better housed, have shorter hours of labour, and they work in mines uniformly better ventilated. Wages, too, have risen; and it is at least as cheap to live now as it was when every necessary of life save meat was much dearer than it is now. It may be said that capitalists have also derived advantages from improvements in the method of winning coal adopted, and we are not disposed to deny that this is true to a certain extent; but after every allowance has been made, we think it is tolerably clear that the actual cost of getting coal is in many cases much greater than it ever was before. Of course there are exceptions to this; but, as we have tried to explain, it is essential that this subject should be dealt with on an extended basis, and large deductions must not be drawn from exceptional cases. We do not, however, assert positively that the getting of coal has augmented materially in cost. What we do assert is that it is advisable that the truth on this point should be ascertained and made public; but so far as we are aware, no trustworthy statistics applying to large districts have ever been prepared. The total ostensible value of the coal raised in Great Britain every year can be obtained from the mining records; but it is at least doubtful whether the value has been properly estimated, and it is certain that it does not set forth the price paid per ton in money for putting the coal on bank. If it can be shown that this cost has risen by degrees in a larger proportion than the price, then the colliers who demand more wages will be deprived of one argument at all events; and here the question presents itself, Is it not possible that some collieries have cost a great deal more than they are worth? Some men seem to hold that no matter how great is the depth to which a shaft has to be sunk, if only coal is reached, a profit must be made on the capital expended. To us this seems to be an absurd argument. The deep mine will have in any case, to compete with the shallow, and it is clear that a colliery which has absorbed a capital of £100,000 must be worse off—other things being equal—than a coal mine costing half that sum. We have no doubt whatever that the enormous capital charges on some pits render it impossible for the proprietors to realise a profit while coal remains at 8s. to 10s. a ton at the pit's mouth. The cost of working very deep pits is also much greater than the cost of working shallower mines; the expense incurred for pumping and winding must obviously be larger.

We need hardly point out that the relations of the railway companies to both the consumer and the raiser of coal have a very important influence on the prosperity of the country. It appears, for example, that beyond all question an enormous profit is made on the conveyance of coal by rail to London. It may be added that were the cost of carriage reduced, a still larger profit would be made, but in a somewhat different way. But the railway companies are deaf to all reasoning on the subject. They say it is useless to ask them to reduce rates, they have now more coal to carry than they can deal with; if they cut down their tariffs they would not be able to get on at all; and no doubt the companies are, on the whole, right. Much the same thing applies in the manufacturing districts, and it is well known that the railway companies are often called upon now to carry more coal than they are able. Of course they will not cut down prices under the circumstances. From all this it appears that more mineral railways are wanted, and much would be gained if the consumer and the producer were brought, virtually, closer together.

In dealing with this question it must not be forgotten that we have now to compete with the foreigner under conditions much more severe than those which existed some years ago. For better or for worse, protective duties have stimulated the growth of the iron trade on the Continent to an enormous extent. The machinery and appliances used in France, Belgium, and Germany are equal to anything of the same nature to be found in Great Britain. A rail mill in France will turn out as much as a rail mill in Sheffield. Labour costs less on the whole than in this country, and if it were not for the war taxation which exists abroad, we could not compete at all for the custom of the world. Iron can be put into London from Belgium cheaper than Sheffield or Birmingham can send it. The fact is worth notice. The coal trade is an immense industry in Great Britain, but it resembles in some respects a gigantic pumpkin. Its very existence is imperilled by such strikes as that now contemplated. The miners say it is not worth while to be a collier, wages are so small; masters say it is not worth while to be a colliery proprietor, profits are so small. When all concerned are disposed to condemn a trade, it does not seem that it can be worth much. We hope that such utterances as we now hear daily are at least a little exaggerated; but it is none the less clear, we think, that masters would do well to try and ascertain what is really the cost of winning coal in Great Britain as a whole, and whether it is or is not possible to reduce that cost. This is a case in which concerted action is essential to success; and it is above all things necessary that the miners should be placed, whether they like it or not, in possession of the facts. Strikes are very frequently due to the reticence of masters and the consequent ignorance of the men. In the present case no pains should be spared to let the men know the true position of the capitalist.

MARINE BOILERS AND THE BOARD OF TRADE.

Steamers making long voyages must of necessity carry a great deal of coal under any circumstances, but the less they have to carry the better. Thus it happens that engines economical enough for the Atlantic trade are not the best for Australian or Indian commerce. For this reason every nerve is being strained by engineers to produce more and more economical machinery, and the march of improvement is just now all in the direction of higher pressures and three-cylinder engines. The yacht Isa, built some six years ago, was fitted with three-cylinder engines, designed by Mr. Taylor, and built by Messrs. Douglas and Grant, of Kirkaldy. The ordinary high-pressure cylinder is fitted with a third cylinder standing over it on three legs, the two pistons being on one rod. The pistons are respectively 10in., 17in. and 24in. diameter, with a stroke of 24in. The working pressure is 120 lb.; the indicated horse-power about 200. This was, we believe, the first successful marine engine with three expansions; and the pressure was, with one or two exceptions, the highest ever carried at sea. Subsequently the Millicent was built and fitted with engines of similar type —illustrated in our impression for February 2nd, 1883— by Messrs. Wigham, Richardson, and Co., Newcastle-on-Tyne. There are now several engines of the kind at work and giving satisfaction. A considerable time after the Isa's engines were made, other firms turned their attention to triple expansion engines. The Aberdeen's machinery, an engraving of which will be found in our impression for April 28th, 1882, illustrates this type. To do this class of engine justice a pressure of about 150 lb. ought to be carried. The difference in the consumption of fuel between the three-cylinder and the double-cylinder compound engine is not much, but it is sufficiently great to be worth having. If we say that the ordinary compound burns 2 lb. of coal, and the triple expansion engine 1·7 lb. per horse-power per hour, we shall not be very wide of the mark. It has been stated that a consumption of 1·3 lb. only has been attained, but the figures we give are, we fancy, more consonant with practice. With a power of 2000 horses this means, in round numbers, a reduction in the consumption of coal by the three-cylinder as compared with the two-cylinder engine of 5 cwt. per hour, or 6 tons per day, or 180 tons on a month's steaming. When it is borne in mind that at such places as Aden coal is seven or eight times as dear as it is in England, it will be understood that the more economical of the two types of engine has strong claims on the shipowner, and what was done in a small way to begin with, is now being done on a very large scale indeed.

On Tuesday week the steamship Tamaulipas arrived in the Mersey, having run from the Clyde at the rate of nearly sixteen knots an hour. She is built of steel, is classed 100 A1 at Lloyd's, is 400ft. long, 44ft. wide, and 32ft. 6in. deep; her gross tonnage is 4150; her engines indicate 500-horse power, and steam is supplied by four double-ended steel boilers 13ft. 6in. diameter, 15ft. long, with 24 corrugated furnaces. The working pressure is 140 lb. The cylinders are 40in., 64in., and 92in. diameter, with a stroke of 5ft. The ship has been built and engined by Messrs. R. Napier and Sons, Glasgow, and is the first of three ordered by Senor Claudio A. Martinez for the Compania Mexicana Transatlantica. These three ships are the pioneer vessels of a fleet intended to carry passengers and mails between Liverpool and Vera Cruz, under a subvention with the Mexican Government. It is worth notice that the Tamaulipas is the first large steamer ever owned by Mexico. Her engines resemble those of the Aberdeen, which ship has steamed 95,000 miles, without engines or boilers needing an outlay of one penny for repairs—a circumstance which bears high testimony to the workmanship and materials of the machinery. The Tamaulipas sails under the Mexican flag, and requires no Board of Trade certificate. We lay special stress on this fact, because the ship could not be sailed under the English flag, for the oppressive rules of the Marine Department of the Board of Trade would not permit a pressure of 140 lb. to be carried in her boilers. Boilers built to carry 150 lb. will not be certified for more than 95 lb., and so on. It might be supposed that the difficulty arises about the furnaces, but this is not the case. Exception is taken by the Department to the shells of the boilers, which, it is insisted, must have a thickness which practically prohibits their use on board ship. It would be easy to supply instances to illustrate the extraordinary fashion in which the Department does its work. One will suffice. Certain limits are laid down for steel; but engineers are informed that if plates not conforming to these requirements should get into a boiler "by accident," they need not be cut out. This is one of the most remarkable Government enactments we ever met with.

The collapse of furnaces is by no means an unknown thing at sea; but we think we are correct in stating that there is no instance of the explosion of the shell of a marine boiler of the modern type. There have been scaldings and even deaths caused by the giving way of corroded plates in the shells of badly-kept small marine boilers, in tug-boats and such like, but the shells of boilers in sea-going vessels have never, so far as we know, given way with explosive violence. The catastrophes on board H.M.S. Thistle and Thunderer really prove nothing to the contrary. The main point at issue between the engineers and shipowners and the Board of Trade takes the shape of the question, What is to be the factor of safety? The Board of Trade insists that thick boilers shall have a factor of safety of 5, while Lloyd's are contented with a coefficient of 4·7 for shells above $\frac{3}{4}$in. thick, and it is with such shells we are now dealing. It seems to be quite clear that the coefficient for thick shells may be less than that for thin shells. Once a boiler has been tested and found strong enough, no danger is to be apprehended until it is weakened by corrosion, but corrosion will tell more on a thin than on a thick boiler, and we ourselves see no reason why boilers properly made—and we write now of no others—should have a higher coefficient than one-fourth. No coefficient can be too high to secure safety with a bad boiler. It is asserted by engineers and shipowners that the Board insist on an absurdly high factor; thus, locomotives carrying 120 lb. would not be passed by the Board for more than 47 lb. to 50 lb. If the Board had control over locomotive boilers, railway travelling under existing conditions would be impossible. We find that Mr. Trail and Mr. Macfarlane Gray set themselves up against the engineering opinion of Great Britain, and while all the great marine engineering firms assert that a given boiler is quite strong enough to carry, say, 125 lb., Lloyd's Registry being willing, we may note, to certify for that pressure, the officers of the Marine Department condemn the boiler to carry less than 90 lb. Either of two deductions may be drawn. The Board of Trade pronounces, by its action, the engineers who differ from it, either rogues or fools. In other words, it asserts that those who wish to carry the higher pressures are willing in pursuit of gain to risk the lives of passengers and crews, or else that they do not know the difference between a safe and an unsafe boiler. If it was certain that the gentlemen who constitute the Marine Department of the Board of Trade were specially skilful and experienced engineers we might feel disposed to accept their decision; but it is not for a moment to be supposed that the combined talent of the Department can bring knowledge to bear on this subject not possessed by men who have been building and working marine boilers all their lives. The result of the operation of the law as it stands is that foreigners like Senor Martinez can obtain more economical ships than it is possible for Englishmen to produce, or rather to use; and if this is once generally understood our supremacy as ocean carriers will be lost, for the moderately economical ship cannot compete with the most economical ship. Thus for example, English firms could not compete with the Mexican owners of the Tamaulipas. It may be thought that we take an exaggerated view of the importance of this question, but we only repeat the words of shipowners and engineers in all parts of the country when we say that the Board of Trade rules concerning boilers may do incalculable mischief. The Department seems to forget that progress is being made, and that engineering will not stand still to please Government officials. A set of rules has been drawn up which represent, not the opinions of those best qualified by experience and training to judge, but of at most a couple of men. It is time that these rules were revised; and the pressure of public opinion will, it is to be hoped, be sufficient to procure their revision. The department will do well to be warned in time, and to make a graceful retreat from a false position before it is ignominiously driven out of it.

RIVETTED JOINTS.

The literature of the strength of rivetted joints is already extensive; we have no intention of augmenting it. What we are about to say concerning them at present bears relation to workmanship, and not to proportions. No doubt workmanship affects the strength of structures joined by means of rivets; but the fact is not taken too much note of by those who carry out experiments and tabulate results for the benefit of engineers. It is very commonly assumed that a rivetted joint is a rivetted joint, and that suffices. As a matter of fact, however, there are wide differences in the qualities of rivetted joints, and more attention should be paid than is paid to the circumstance. Thus it is very commonly assumed that a single rivetted joint properly proportioned has a strength of 56 per cent. of that of the solid plate. We have ourselves seen machine-rivetted seams tested, which broke with less than 30 per cent. of the strength of the plate, albeit that externally, the seam was to all appearance a good and well made seam; and we believe that in practice seams with a strength equal to that given for them in text-books such as Fairbairn's are rarely met with except in the very best class of work. Attention has been called to the subject by more than one correspondent; and the discussion now being carried on in our correspondence columns by practical men may be expected to elicit some information which will usefully supplement that acquired with the testing machine. Our purpose in writing this article is to direct the discussion in question, and to call to the minds of our readers those points which most deserve consideration.

Rivetted work may be classed under three heads: First, work such as suffices for bridges and girders, the joints of which need not be water or steam tight; second, a superior kind of rivetting, such as that employed in iron shipbuilding; and, third, boiler rivetting, which ought to be as good as possible. Now as regards the first, there appears to be a general consensus of opinion that nothing can be better for it than the hydraulic rivetter, but it does not appear that the machine can be used with sufficient facility in the actual erection of iron structures to enable hand rivetting to be wholly dispensed with. No doubt many of our readers have used the hydraulic system, and can tell exactly what percentage of work can be done under it, and what percentage must be done by hand; and to simplify matters, and so keep discussion as useful as possible, we would suggest that a typical bridge be had in mind—let us say a railway bridge, with one span of 180ft. and two spans of 75ft. each, plain lattice girders, the larger 16ft. deep and the shorter 7ft., the whole to be floored with flat iron plates, the rails to be carried on longitudinal timbers supported by cross-girders. What proportion of machine rivetting is possible on such a bridge, if put up in England, say, ten miles from a town? Concerning ship work there can be no doubt that the use of the machine system is rapidly extending, and there is now hardly a hole or corner in a ship's hull into which the machine will not find its way. Despatch is the great object had in view in this class of work; but no one has yet supplied much information concerning the places where hand rivetting can be done as well and more quickly than machine rivetting. It seems to be tolerably plain that such do exist, and that there are places where a couple or three men can begin and finish a seam of rivets in the time that would be occupied in fixing a machine in place. No doubt there will be differences of opinion on this point—the advocates of machine rivetting holding one thesis, and the supporters of the old system another. It is more than probable that the truth lies between the two. The results of practical experience can alone be relied on to settle the point.

When we come to deal with boilers we get on very delicate ground. It is not to be denied that many men who are very particular about the workmanship of their boilers will not have machine rivetting at any price. They rely entirely on skilled labour, and no doubt a thoroughly well made locomotive boiler is the most beautiful and perfect specimen of hand rivetted work that can he had. Such boilers as made in this country require no caulking. The workmanship is exquisite, and one result is that the strength of the seams in locomotive boilers are often in excess of that laid down in text-books, the 75 per cent. for a double rivetted seam rising to as much as 78 per cent., or a little more. It is urged that machine rivetting cannot produce such results; it is far too inflexible; it takes no account of the heat of a rivet, or its quality, whereas an experienced man knows exactly what to do with a rivet, and feels his way, so to speak, along a seam in a way that the machine cannot do. As bearing on this point, we may say that cold rivetting has been extensively practised in the United States. The high-pressure boilers used on the muddy rivers consist of wrought iron tubes, seldom more than 3ft. in diameter, $\frac{3}{8}$in. thick, and about 30ft. long. These are arranged side by side, with a large furnace at one end, and in many cases a flash flue running straight to the chimney. Such boilers will work with water far too dirty to be used in a tubular boiler. They carry pressures of about 150 lb., and the seams are made up with cold rivets of a peculiarly soft and ductile iron. It is said that these joints stand far better than any hot rivetted joint that could be made, and we have no reason to doubt that this is true of the very thin plates used. Going to the other end of the scale, we have the modern marine boiler, with plates $1\frac{1}{8}$in. thick and rivets $1\frac{1}{4}$in. It is asserted by one party that such rivets cannot be closed by hand in a satisfactory fashion, and that the aid of machinery must be called in; but, on the other side, it is pointed out that boiler fronts have always to be put in by hand, and that this hand rivetting is quite as good as the machine work, and it is also contended that machine rivetting is so far from securing tightness that every rivet head has to be caulked inside the boiler, to make certain that it will not leak. Many able engineers hold views entirely opposed to these, and assert that the best kind of boiler work cannot be produced at all without the aid of machinery. The arguments they urge in favour of machine rivetting, as a matter of workmanship, are that it compels the rivets to fill the holes, and effectually closes the plates on each other. The arguments against it are that split heads are apt to be produced, and that the rivets not only fill the holes, but now and then burst the plate; and that in most cases, unless unusual care and vigilance are employed, the iron will be severely strained, and a bad, instead of a good, boiler produced. Nothing of this kind can, however, be urged against the machine system, when several plates have to be joined, as in bridge work, because the great length of the rivet permits it to give way without straining the plates.

On none of the points we have stated as open to discussion do we at present express any opinion; that diverse views are held by experienced practical men is, however, indisputable, and we must beg our readers, no matter which side they take, to bear in mind that there is another side, and that impartial men will like to hear both before arriving at a conclusion as to which is best. It is most desirable that facts, not opinions, should be adduced. Opinions have held sway long enough; it is time that definite statements of results obtained in practice, as to cost and efficiency, should be made public.

THE SLIP AT BLACK ROCK.

In a recent article on the subject of the Brighton beach we referred to a serious slip which had occurred on the chalk cliffs which succeed to the high protecting wall at Kemp Town. We have recently had an opportunity of examining this, and thereby of forming some opinion as to how far such a casualty is likely to extend, the results which would probably follow such extension, and of the means which appear to us to be necessary to check the further inroad of the sea at the threatened point. As regards the last, although we have met those who deem that the fall of the cliff is due to causes other than that of the undermining of its base by the waves, we cannot say that we can see in their argument anything to justify such a conclusion. That high chalk cliffs are liable to slips even when situated inland we have of course ample experience to show; but such rarely occur in what may be termed the "solid" chalk. As a rule, it is only when the chalk is veined by a lighter stratum, such as clay, that slips of a serious character are common in this formation. In such cases the combined action of wet and frost causes a swelling of the less solid material which forces away overlying masses of chalk, but there are none of our readers, perhaps, who have not observed how very slight is the natural wear of the face of those deep railway cuttings so common on our southern lines. Were, therefore, we hold, the cliffs to the immediate east of Brighton left unattacked by any more destructive agency than the weather, they, being free from any of the clay strata or pockets above alluded to, would stand unaffected probably for centuries.

But in the case of these Brighton cliffs, those whose memory of the locality reaches back but a very few years have seen a great change in their configuration. Indeed scarcely a twelvemonth has passed without some slips more or less serious, having been observed, and these have for the greater part, taken place just beyond where the protecting works erected by the Brighton authorities cease, and where, consequently, the action of the sea has become concentrated in its force. It has been fortunate for the comparative past immunity which has been experienced, that, stretching seaward from the base of the cliffs under reference, there is a ledge of rock which has, without doubt, done much to break the force of the incoming rollers before they strike the vertical walls of chalk; but the destructive process, though slow, has nevertheless been sure, and our examination of the locality the other day showed the danger to be becoming of a critical character. Apparently, those responsible for the safety of visitors and others who make a walk of the paths along the edge of the cliff take but few precautions to warn such of the danger they run in continuing to follow their favourite promenade. It is true that when first quitting the permanent walks of the parade a notice-board is observable, which calls attention to the dangerous condition of the still well-followed path, but it would be easy to pass this without noticing it, and the slight barriers which mark the site of the latest slip are scarcely sufficient, to our judgment, to hinder children from pursuing their course into a fearful danger. That, however, is a matter which concerns alone the parties who would be held responsible in the event of an accident occurring. Our object is to consider how far it is safe to allow the present condition of things to continue, and the results that will probably follow should no steps be taken to prevent further damage arising.

Quite independently of the difficulty in which the town will be placed, should further slips occur, as regards the blocks of buildings which have of late years been erected in near proximity to the site of the recent slip, there is an important matter to be considered which we have not seen or heard in any way referred to, but which is one, as it appears to us, which sooner or later may be disagreeably forced on the attention of the Brighton ratepayers. Some years ago a very extensive and admirably-designed system of drainage was carried out, and along the whole line of the town frontage there was constructed a main intercepting sewer by which the entire sewage of the town was conveyed by gravitation to a point some miles beyond its eastern end, and there discharged by an outlet pipe extending a long distance below low-water mark, the discharge into the sea occurring at such a level as ensured free exit and the non-return of floating matters along the town frontage. At the point where the slip under reference has occurred, this intercepting sewer was laid below the centre of the now-threatened Rottingdean-road, and we should say that at the present time the recently exposed face of the cliff cannot be more than some 20ft. from the line followed by that sewer. It is true, we believe, that at this particular spot this is laid 8ft. below the level of the beach at the foot of the cliff, and there are those who argue upon that fact that perfect immunity from danger is secured for it. Such a conclusion does not appear to us to be satisfactorily based. As we have said, there can be no doubt that the falls which have taken place have been due to the undermining which has been steadily going on. It will be safe to predict that but a few years more of its present rate of destructive progress will cause the entire disappearance of the Rottingdean road, and when that happens the site of the sewer itself will be laid bare and the sea will roll in over it. How long it might take to disintegrate the 8ft. of covering material between the sea and the brickwork of the sewer it is of course impossible to say; but sooner or later it would probably be so reduced as to afford but slight protection. Long before entire denudation could occur, however, it is extremely probable that the arched work would yield to the thundering force of the breakers expending their strength above its crown.

To this danger therefore we desire to call early attention. It may not, it is true, develope itself in a critical form for some years to come, but it is a question of economic polity to consider whether it is desirable to wait until the course of events we have pointed out results in making the difficulty one of far greater expense to deal with than it is at present. If delay be permitted there can be no doubt that the works necessary to meet the danger will have to be of a very extensive character. To this case the old adage of "a stitch in time" applies most strongly. On examining the works which have from time to time been erected to protect the foreshore opposite to the Black Rock Gasworks, we find them to consist of a low base wall, from which short and low timber groynes project into the sea for the purpose of accumulating shingle. This system appears to have acted efficiently, and if its extension be at once undertaken it will probably arrest any further tendency of the cliff to fall. But at the same time those slips which have occurred have so broken the line of that cliff that the breaches formed have become lines of drainage, and it was evident to us that if that drainage be permitted to continue unchecked, its action must sooner or later lead to further falls. It seems a most important desideratum that this should be at once attended to. A guard wall should be erected, which for public safety would constitute the small space which still remains between the road and the edge of the cliff a "no man's land." Within that reserve should be cut a drain, which should receive the drainage water now finding its way through the breaches down the face of the chalk, proper outlets being provided to stay its disintegrating action. It is true that the amount of such drainage water is small; but though its resulting action is consequently slow, it will nevertheless be certain. The outlay required to give effect to our suggestions, if they or some similar measures be early given effect to, will be comparatively trifling; but we have seen enough to satisfy ourselves that if they be much longer neglected the Brighton ratepayers will have to face a very large expenditure, and even then will not secure the continuous line of frontage which it is most desirable should be maintained.

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NORTHERN SHIPBUILDING.

There are indications that the briskness in the shipbuilding industries of the North that has been known for four years is now being checked, though some of the builders have orders that will keep them employed for four or five months to come, and though in the next few months it is to be expected that the rate of progress will be less rapid. But at some of the northern ports there are idle berths. On the Tees the number of vessels in course of construction is less than it was a year ago, and on the Wear there are now only about fifty ships on the stocks, instead of sixty-four, as there were at the beginning of the year. There is, moreover, less pressure for orders, and that naturally, because the steamships at work earn less than they did, and because the immediate prospects in the freight market are not most promising. This slackening of the great briskness is likely to bring about the cure. Winter is the season for loss of vessels, and also for slower construction of new ships, so that it may be expected that there will be after the winter a lessened production of new tonnage, and a levelling up in the freight market, as the loss and the lessened output make themselves felt. The shipbuilders in the North of England should obtain orders as long as there are any in the market, because they have the materials produced in their district, and because they have cheap fuel and skilled labour. But it is to be expected that there will be a falling off even this year in the tonnage of vessels built; and so far as can be foreseen, a still more marked falling off in the tonnage to be turned out next year. For the present, the rush of capital into shipping has stopped, and that capital will have to be more productive than it now is before there is a further large supply. The equalisation of demand and supply is now commencing, the rate of construction is being reduced, and the drop in freights will speedily cease. So soon as freights begin to rise —and the growth of trade, the development of new trades, and possibly the construction of vessels of other kinds will aid in the movement—so soon we may expect that there will be a return of activity to our shipyards; whilst, in the meantime, the orders for replacement, renewal, and repairs may prevent anything like positive stagnation.

LITERATURE.

Graphic and Analytic Statics. By R. H. Graham, C.E. Crosby Lockwood and Co. 1883.

This book follows the novel plan of interspersing the graphic methods of investigation with the more ordinary methods of analytic algebra and the differential and integral calculus. We entirely approve of bringing these various methods to assist each other and co-operate towards the solution of practical problems. But here we find very much the same problems treated in different parts of the book by the two different methods, and we hardly see what the resulting advantage is. Few or no examples are given showing how in working out a practical problem part of the work may be most easily and rapidly done by the one method, while the rest is best performed by the other. About one-third of the book is devoted to graphic methods; the rest to ordinary analytic investigations in statics. The volume will no doubt be useful to many, the number of those anxious to master the new graphic processes being always on the increase. One very commendable feature of the work is that at the conclusion of several chapters there is given a large number of exercises to be worked out, the data for which are in many cases taken from structures actually built. In these the problem and the data are stated, and the numerical answer is also given, the student being left to work out this answer without aid or explanation. Such explanation might have been given with advantage in very many of these exercises, and we are afraid that without such assistance students will often find it difficult to arrive at the desired results. For example, early in the book, before any word has been said about the proper treatment of redundant structures, we find exercises in such structures set. The student cannot reach any accurate result in such cases, because the sections which form part of the requisite data for the correct solution of this class of problem are not given. Later on the author shows his own method of solution, which, we may say, is one very commonly followed in practice. This consists in supposing removed certain bars of the structure so as to reduce it to non-redundancy, and making the calculation on the supposition that these bars do not exist. Then these are supposed replaced, another set of similar bars supposed removed, and the calculation made over again. The mean of the two results for each bar is taken. This method gives an approximation to the true stress in the most important parts of the structure, but it is capable of giving results very largely at variance with truth in the sheer-members—in the diagonals of a lattice girder for instance. The general unreliability of the method is most easily recognised by observing that in a roof or girder of only moderate complexity there is a large number of different ways in which the structure could be reduced to non-redundancy. Those who use this method pick out only the two most obvious of these numerous ways, and proceed as if there were no others.

The book is well illustrated, the diagrams being carefully drawn and nicely engraved. We observe that the author has not adopted the extremely simple and useful method of lettering introduced into practice by Bow. Mr. Graham seems not to appreciate the peculiarity of this system which makes it superior to all others, and in fact, this peculiarity is overlooked by too many. It not only possesses the theoretical advantage of exhibiting the general mathematics of reciprocal figures in a singularly clear and easily comprehensible manner, but it also possesses the immense *practical* advantage of showing at a glance for each bar in the diagram whether it is in tension or in compression. Mr. Graham explains at page 16 the only rule for finding out this that is possible with his system of notation. In practical work it is awkward to use, more especially so for joints where no loads act. Mr. Graham uses figures instead of letters, and something may no doubt be said in favour of this, as it avoids the use of such indices as A_1 A_2 A_3, and so on, when all the letters of the alphabet are used.

Thus, although we find much merit in the book, we cannot say that it is free from blemish. For instance, at page 6 the proposition on which rests the whole of graphic statics, so far as it depends on the properties of reciprocal figures, is intended to be proved; but this proof is introduced by the words, "As a premise to the proof it will generally be admitted," and then follows, as "generally admitted," what in reality contains the whole gist and difficulty of the proof, and what, in fact, is a pretty hard nut to crack for the elementary geometrician. Again, we find it difficult to reconcile the statement that the laws of graphic statics are only applicable to figures which are made up of triangles and to which applies the rule that the number of links is less by three than double the number of joints, with the actual application in the book of graphic constructions both to unstiffened and also to redundant linkworks.

As minor matters we may point out that at page 26 the calculation of the supporting force at the foot of the crane post is omitted, and that the simple link-polygon introduced is really unnecessary in this example; and that in example, Fig. 23, at page 27, the joint *l k j* M is missed out. Fig. 168, page 29, gives an example of what we have already mentioned, namely, an exercise, the method of treatment for which has not been explained, and we could multiply illustrations of the same sort of omission. At pages 45 and 48 Mr. Graham follows a habit which has become rather common of late among some engineers, namely, that of finding fault with Rankine. No doubt Rankine must have occasionally made a mistake, although he must always be venerated as the father of modern scientific engineering; and it is distinctly advantageous to the engineering public to have whatever mistakes he may have made pointed out. But in the two instances in which Mr. Graham differs from Professor Rankine, it is quite certain that Professor Rankine is strictly accurate and Mr. Graham is quite wrong. Again, we would suggest that the treatment of the truss, Fig. 58, is unsatisfactory. There is also much inexactness of language throughout Part IV., entitled, "Comparative Statics." For example, what can we think of the statement at page 119, that the algebraic sum of the forces being zero "implies the absence of rectilinear movement of translation," where, of course, movement—or possibly velocity?—is confused with acceleration of velocity? A similar confusion between rotation and acceleration of rotational velocity occurs on the same page. In explaining moment diagrams at page 178, it is very distinctly said that the moment is to be read to the scale of which the polar distance (EO) is unity. Now exactly the reverse is true. The larger EO is taken the smaller is the scale to which the moment is to be read. The unit of the scale is *inversely* proportionate to EO. The treatment of the arch is also unsatisfactory, the lines of the two abutment re-actions being assumed to have equal inclinations to the horizontal with the load unsymmetrically distributed. The chapter on deflection of beams contains some useful explanations regarding the distribution of shearing stress which is, unfortunately, not commonly met with in English text-books, but it also is blemished by error and confusion of ideas. The strangely mistaken idea that each particle of the beam reacts in the direction of its *displacement* is followed out throughout several pages, leading to this false conclusion, among others, that a beam cannot be kept in equilibrium if there is any longitudinal force applied to its end section. It is also not true that each deflected transverse section—originally in the unstrained condition perpendicular to the axis—remains perpendicular to the deflected axis. If this were true there would evidently be no shear strain. At page 262 an error in differentiation leads to a supposed, but incorrect, correction of the ordinary formula for shearing force in terms of bending moment. The correction is really infinitesimally small in the strict mathematical sense of the term. At page 327 the reader will find two very useful tables obtained from French sources bearing on bridge loads. The portion from page 345 onwards, upon allowances for the weights of girders in the calculations of their requisite dimensions, deals correctly with a very important matter. We are the more glad to find this correctly explained because it is a subject not commonly understood. As late a volume of the "Proceedings" of the Institution of Civil Engineers as the 72nd contains a paper on the same subject by Mr. Buck, which is altogether wrong. In illustrating his equations, however, Mr. Graham falls into remarkable error. He calculates that a beam 30ft. long, of material weighing ·288 ton per cubic foot—which, by the way, is $1\frac{1}{3}$ times as heavy as wrought iron—of circular section, and bearing a useful load of $\frac{1}{9}$ ton per foot run, would require to be exactly 12in. diameter to be stressed to 4 tons per square inch; and furthermore, finds that if the weight of the beam itself were neglected in the calculation, the required diameter would be $11\frac{1}{2}$in., or only $\frac{1}{2}$in. less. There is evidently something wrong here, as the beam according to the result weighs more than $2\frac{1}{2}$ times the useful load. Three ponderous pages are filled with the solution of a cubic equation in order to arrive at this result. Now, any cubic equation can be solved in about two minutes' time by writing down some half-dozen lines of figures extracted from a table of cubes and squares, such as is found in Molesworth. The correct diameter in the above example is 2·02ft., instead of 1ft.

In a future edition we trust the author may find it practicable to improve his book in the directions we have indicated. We have thorough sympathy with all attempts to forward the study of modern methods of calculation, and we therefore trust that the friendly criticism in which we have indulged may not be without result in future rectifications. We believe we have pointed out all the errors, and from this it may be gathered that Mr. Graham's book is one which will find a place wherever graphic and analytic statics are used or studied.

CHARLES WILLIAM SIEMENS.

The death of Sir Chas. William Siemens will have been learned from the daily newspapers by our readers with real regret. His remarkable ability had made him a leader of thought and progress in so many branches of science and of science applied in arts and manufactures, that his name is familiar to people in every walk in life, and every one will experience the feeling that a great and unexpected loss has taken place in the ranks of the modern leaders of men and makers of great industries. Science loses by his death one of its most remarkable thinkers. In him was found that most unusual combination, orginality, guided by accurate and diverse knowledge, and backed by executive ability and untiring energy in the pursuit of any piece of work from its inception to its completion, from the birth of an invention to its commercial success. His death occurred last Monday, the 18th inst., as the result of an injury to the heart caused by a fall while walking home on the afternoon of the 5th inst. from a scientific meeting.

Charles William Siemens was born at Lenthe, in Hanover, on the 4th of April, 1823. He descended from an old German family, the motto on whose coat-of-arms freely translated signifies "through energy I will succeed." He became an English subject in 1850. He was educated at the Gymnasium at Lübeck, afterwards at the Polytechnic School at Magdeburg, and finally at the University of Göttingen. Here he studied under Wöhler and Himly. In 1842 he became a pupil in the engine works of Count Stolberg, where he laid the foundation of the engineering knowledge which he afterwards turned to such practical account. He was one of a family of able men, and as nearly all are inventors, it is difficult to apportion their shares in the many inventions with which the name of Siemens is associated. There is, however, no doubt that the four brothers—Werner, William, Carl, and Frederick—always worked harmoniously together—an idea suggested by one being taken up and elaborated by another—so that it is difficult to award to each his own proper credit for his joint labour. In electrical work William and Werner were principally associated, while the regenerative furnace is due not only to William, but also to Frederick.

It was, as Siemens himself told when speaking at the Birmingham and Midland Institute in 1881, to introduce to the English public a joint invention of his own and his brother Werner in electro-gilding that he first came to England in 1843. On the above-mentioned occasion he gave an interesting account of the difficulties which not unnaturally beset the young foreign inventor. It was due to the discrimination of Mr. Elkington, who perceived that certain processes described in some of own patents could only be carried into effect by the improvements of Messrs. Siemens, that William was able to dispose of his invention so successfully as to be induced in the following year to come back again on a similar errand. This time it was his chronometric governor, of which we shall speak further on. Though not very successful commercially it introduced him into the engineering world, and was really the cause of his settling in this country. The chief use of this apparatus, intended originally for steam engines, has been found in its application to regulate the movement of the great transit instrument at Greenwich. His studies in the dynamical theory of heat led him to pay special attention to preventing its loss in various engineering and manufacturing processes. The first result was in the regenerative steam engine which he set up in 1847 in the factory of Mr. Hicks at Bolton. In this superheated steam was employed, but its use was attended with certain difficulties which have prevented the commercial introduction of the invention. The Society of Arts awarded Mr. Siemens a gold medal in the year 1850 for his regenerative condenser, and at the Institution of Civil Engineers in 1853 a paper, of which we shall speak again, on the conversion of heat into mechanical effect, gained him the Telford premium and medal.

Siemens' activity in a practical sense did not prevent his making use of his pen to record his discoveries and inventions, and hence the "Journals" and "Transactions" of the several learned societies of which he was a member afford a good index to the subjects which successively occupied his attention. Amongst his engineering papers mentioned in the Royal Society catalogue is one on a "Regenerative Condenser for High and Low Pressure Steam Engines," read before the Institution of Mechanical Engineers in 1851. In this he described at some length, but with much clearness, a form of condenser in which an arrangement of regenerator, after the manner of that used in his hot-air engine, was employed to condense the whole or a part of the exhaust steam; usually only a part would be condensed, and so the regenerative effect was only obtained with respect to that part, and the regenerative surfaces could only increase the efficiency of the engine in proportion to their area. Hence large areas would be required, and as the condenser seems not to have been much used, it would appear that what was gained by the use of the combination of surface and injection which the condenser really was, was not so great as could be obtained by the use of a larger quantity of water and larger surfaces in a surface condenser which would receive and condense the whole, and not a part, of the exhaust steam.

The next paper interesting to engineers appeared in *Dingler's Journal* in 1853, and in the "Journal" of the Franklin Institute in 1852, and was on the "Expansion of Isolated Steam and the Total Heat of Steam." Another, on the "Conversion of Heat into Mechanical Effect," appears in the "Proceedings" of the Institution of Civil Engineers, vol. xii., 1852-3, of which he was then an Associate. In this paper he gave a brief *résumé* of what had been done in mechanical engineering thermo-dynamics, and though this is chiefly with a view of describing his theory and invention with reference to the hot-air, or caloric engine, as it was then more generally called, the paper is a valuable one as having given at this distant time some very clear ideas on a subject with which few were at all familiar, and as showing the author's grip of the whole subject. It follows two papers, the one by Mr. Charles Manby, and the other by Mr. James Leslie, on the caloric engine, and on the principle of the caloric or heated air engine, and all are grouped under the general head, "heated air engines;" but Siemens' paper is the only one of the three showing a really scientific knowledge of the principles involved. In the paper on isolated steam he describes experiments which corroborated those of Regnault, conducted with very complicated apparatus, and showed that Watt was not quite right when he said that the total heat of steam was the same at all temperatures, and that Southern was also not quite right in his statement that the latent heat was the same at all pressures, the truth lying between the two. He gave here his views, based upon experiments described on the expansion of steam in engine cylinders, and a reason for expecting that the mean pressure of steam so expanded would be greater than could follow from Watt's law, although Watt's law is quoted in one of our best text-books on heat published at this date. His chronometer governor is described in its several forms in the "Proceedings" of the Institute of Mechanical Engineers for 1853, and his water meter in several forms in the "Proceedings" of the same institution for 1854.

The regenerative steam engine idea seemed to have taken a hold on his fancy, for he read a paper on this in 1856 before the Royal Institution. From this date his attention seems to have been turned again more to electrical subjects and on the regenerative gas furnace. His bathometer, or instrument for measuring the depth of the sea on board ship without submerging a line is described in the British Association "Report," 1863, and affords another illustration of the wide reaching character of his studies and mental grasp of physical science in all its aspects. This instrument depended upon the difference, which he conceived must be observable, in the attractive power of the earth over land and where covered by great depths of a comparatively light coating material like sea water. He found this difference to be $\frac{1}{8200}$ of the total gravitation effect for each 1000 fathoms depth, and constructed a recording instrument which was also proposed for use in measuring heights.

With his brother Werner he wrote a number of papers on electrical, electro-chemical, and other subjects, and his own paper on the "Conversion of Dynamical into Electrical Force without the Aid of Permanent Magnetism," appeared in the "Proceedings" of the Royal Society in 1867, this being the important paper describing the now well-known Siemens' armature. The description of this invention, which was made by Werner Siemens, was received on the 4th February, 1867, while the paper by Wheatstone on the "Augmentation of the Power of a Magnet by the Reaction thereon of the Currents Induced by the Magnet Itself," was received on the 14th February, and follows that of Siemens. These are two of the most important papers in the history of the dynamo-electric machine.

His first paper, in 1847, was on the "Mercaptan of Selenium," published in Liebig's *Annalen der Chemie*, and sufficiently indicative of the lines of thought in which his mind had been directed at Göttingen. In 1857 William Siemens, in connection with his younger brother and then pupil Frederick, turned his attention to regenerative furnaces for metallurgical purposes. The regenerative gas furnace, as it is certainly the greatest invention due to the Siemens, so it is the one in which William Siemens is believed to have had the greatest share. The first successful application of these furnaces was in 1861. The principle of the regenerative furnace is tolerably well known; it may suffice to say that its main features consist in an arrangement by which the waste heat of the products of combustion is utilised by being imparted to the air and to the gaseous fuel by which combustion is supported. This is effected by causing the products to pass through chambers in which the heat is taken up by masses of brickwork, and afterwards passing the incoming currents of air and gas among the heated brickwork. The earlier applications of this principle to steel and glass making have been followed by its extension to many other industrial purposes in which great heat is required, the power of the furnace being only limited in practice by the nature of the materials of which it can be constructed.

The application of the furnace to the making of iron and steel naturally led the attention of its inventors to other improvements in the same manufacture. In 1862 he endeavoured to reduce to practice the result of Reaumur's experiments in making steel by fusing malleable iron with cast steel. After some years' experimenting, the Siemens process of steel-making was perfected, and a little later still the Siemens-Martin process. In the latter scrap iron is melted in a bath of pig iron on the hearth of the furnace; in the former ore is reduced. The production of steel in this country under Sir William Siemens' process was over 340,000 tons in 1881.

The history of the production of cast steel by dissolving malleable scrap in molten cast iron without the use of crucibles is concisely given in Bauerman's "Metallurgy of Iron." "The process," he remarks, "was patented by Heath in 1845, and a similar method in 1855 by Price and Nicholson. The first actual fusion of cast steel in the bed of a reverberatory furnace was effected by Sudre, in France, in 1860, when quantities of tool steel up to two tons at a time were run into ingots from a furnace analogous to that used in iron melting, the heat being intensified by a forced draught under the grate, with the result of rapidly destroying the furnace. The introduction of the regenerative furnace, in which the highest temperature can be obtained without strong draught or cutting flame, has, however, furnished the required solution of the problem, and in 1862 it was applied by Attwood, of Towlaw, and Martin, of Sireuil, in France, and subsequently with improvements and modifications in the furnaces and the modes of manipulation by Siemens, Pernot, and others. As it was first worked on the large scale by Messrs. Martin, the name Martin-Siemens process is generally used on the Continent; the modification, using iron ore instead of scrap iron, is known as the Siemens process; and latterly the general name of open-hearth process has come into use for both." Bauerman also describes the process as follows:—"In the Siemens process, with iron ore, the bath of pig iron is decarburised by the addition of rich pure hematite or magnetite, in about 2in. lumps. This causes a violent boiling, which is kept up until the metal is nearly soft enough, when it is allowed to stand for a short time to allow the iron to clear from the slag, a small quantity of limestone being added at intervals to throw down some of the iron. The spiegel is then added, about 1 per cent. more being used than in the scrap processs. From 20 cwt. to 24 cwt. of ore are used in a 5-ton charge; about one-half the metal is reduced and passes into the steel, so that the yield in ingots is from 1 to 2 per cent. in excess of the weight of pig metal and spiegeleisen charge. The consumption of coal is rather larger than in the scrap process, or from 14 cwt. to 15 cwt. per ton of steel. The two processes are often combined, both scrap and ore being used in the same charge. The latter is obviously of value as a tempering material."

The perfection of the regenerative furnace was undoubtedly his greatest single work, yet for this invention Germany refused him a patent, on the grounds that the system of heating buildings used in old Rome constituted an anticipation. The objection was, of course, an absurd one, as must be the decision on the merits of new things by examiners whose judgment is formed simply upon a literary knowledge of things apparently of the same character.

Experiments were carried out by him for some time with a view to the use of basic linings for the open hearth furnaces at the Landore Steel Works, which are so well known as the chief seat of the production of Siemens steel. Some time since, when some changes were made at Landore, his experiments in this direction had resulted in obtaining basic bricks which would withstand the work, but we have not learned that much has been done in the matter since. It is probably in the history of the manufacture of steel that Siemens' name will most be known, for already it occurs on every page of that history so far as it relates to modern iron and steel.

The address as President of the British Association at Southport, which will be found in our impression for the 25th August, 1882, was one of very considerable interest, and may be said to give a picture of the diversified bent of the author's mind. It dealt largely with electricity, electrical applications, and electrical units, chemistry in the arts, thermodynamics, metallurgy of of iron and steel, deep sea sounding, chemistry applied to explosives, and solar physics, the general tendency of the whole address being to show that "in the great workshop of nature there are no lines of demarcation to be drawn between the most exalted speculation and common-place practice." He much objected to the separation of the pursuit of science from its application, his idea being that that man of science does most for mankind who shows the world how to make use of the results of his scientific investigations. "The time was," he said, "when science was cultivated only by the few who looked upon its application to the arts and manufactures as almost beneath their consideration; this they were content to leave in the hands of others who with only commercial aims in view, did not aspire to further the objects of science for its own sake." "Progress could not be rapid under this condition of things, because the man of pure science rarely pursued his inquiry beyond the mere enunciation of a physical or chemical principle, whilst the simpler practitioner was at a loss how to harmonise the new knowledge with the stock of information which formed his mental capital in trade." This extract shows Siemens' views on science and practice, if his life's work had not. It is quite clear, however, that he allowed in his consideration of this subject but very little for the different circumstances under which men lived in days gone by and more recently. Education itself was pursued by the few, mostly well-to-do men. It has now become the property of men who are not wealthy, but who have to make use of their mental capital to get a living. This has produced workers who combine scientific culture with ability and energy to direct its practical application in the arts or manufactures. But after all this is rather rare. The man who has pursued science because it is very attractive to him, is not unfrequently a man who would, as much as any one, like to receive the most substantial rewards for his work of this kind. There are, however, many who can pursue science in the laboratory, and mature valuable inventions there, but their energy and interest in the things have gone when the things leave the laboratory door. The inventions often fail to come before the world, because they cannot be brought into commercial shape for want of the help of the inventor. Siemens could go into the laboratory, and with the results of his labour there, he could, to use a homely illustration, go to market, and he would work at it until the market believed in it. The market part of it is just where many otherwise very able men break down.

In telegraphs the Siemens Brothers were leaders, their most prominent work in this branch being probably the Direct United States Cable, laid in 1874. To carry out this work Siemens designed the special ship which is so well known as the Faraday, a ship full of special appliances and fitted with twin screws on converging—not parallel—shafts; so set with a view to get the greatest manœuvring power, so that any order rendered necessary by cable laying and grappling exigencies might be rapidly complied with. With electric lighting the name of Siemens is synonymous, his firm having carried out a large quantity of work of which little has been said, though the Siemens system of machines and arc lamps have long been familiarised by exhibitions in England, France, Austria, and Germany. The Siemens firm did not come before the world with an incandescent lamp but always used Swan's, nor did Siemens produce a secondary battery, though he made some very important experiments in this direction. In the electrical transmission of power it must be admitted that the Siemens stood first, especially as relates to electrical tramways, two of which were shown at work in 1880, one being in the grounds of the Düsseldorf Geological Gardens, used in that year for the Düsseldorf Exhibition. Since that time the Siemens Bros. have laid several electrical tramways, the most recently completed being that at Portrush, which is worked by a waterfall.

It would be impossible within the space at our disposal to enter into anything like a complete account or even mention of all his work. We have been only able to mention the most salient, and had almost forgotten the process of "anastatic printing," a process superseded by recent advances in photographic processes. This was due to William and Werner Siemens. It was described by Faraday in 1845. Reference must also be made to his improvements in calico printing, and the invention of a double-cylinder air pump. Among more recent inventions may be noted his electrical furnace, described in our pages, his electrical thermometer and pyrometer, his rotary furnace for the production of iron and steel by the direct process, his deep-sea electrical thermometer, and his regenerative gas burner.

Sir William Siemens was elected a Fellow of the Royal Society in 1862, and in 1869-70 he served as one of the Council. He became a member of the Institution of Civil Engineers in 1854, and has been on its Council for some years. He was the first president of the Society of Telegraph Engineers, and served a second time in that capacity. He has been president of the Institution of Mechanical Engineers, of the Iron and Steel Institute, and of the British Association, and in April last, in recognition of his eminent services to science generally, he received the honour of knighthood. He was chairman of the Council of the Society of Arts, and was to have delivered the opening address of that Society's session on Wednesday.

Honours and awards have been conferred upon him by every English society of importance, and by foreign societies and Governments. Those who knew him well respected him most for his kindness and generosity, and it is said of him that while he was very ready to overlook imperfect knowledge, he hated the superficial talk which in some places passes for science.

How great were the inventive resources of Sir William is well shown by the saying common in his workshops, that as soon as any particular problem had been given up by everybody as a bad job, it had only to be taken to Dr. Siemens for him to suggest half-a-dozen ways of solving it, two of which would be complicated and impracticable, two difficult, and two perfectly satisfactory.

Early this year he published his volume, "On the Conservation of Solar Energy; a collection of "Papers and Discussions," in which his paper, sent the preceding year to the Royal Society, was examined afresh by himself and a number of scientific men at home and abroad. Whether from its novelty or as emanating from one not claiming to be an authority on the subject, the theory which he set forth met with not a little sharp criticism. Had its author lived a few years longer he would doubtless have laboured to strengthen it with yet further observation and argument. As it is, it must remain as a daring and original suggestion—the effort of a keen and sagacious mind to bring to fresh subjects the experience and the knowledge accumulated by work of a totally different kind.

Recent events, and the development of the use of the electric light, led him to speculations, if not research, on the nature of light. He made an extensive series of experiments on the effect of continual light on plants, by the use of electric light in a conservatory, and the last paper he wrote, read before the Royal Society in April last, was on the dependence of radiation on temperature.

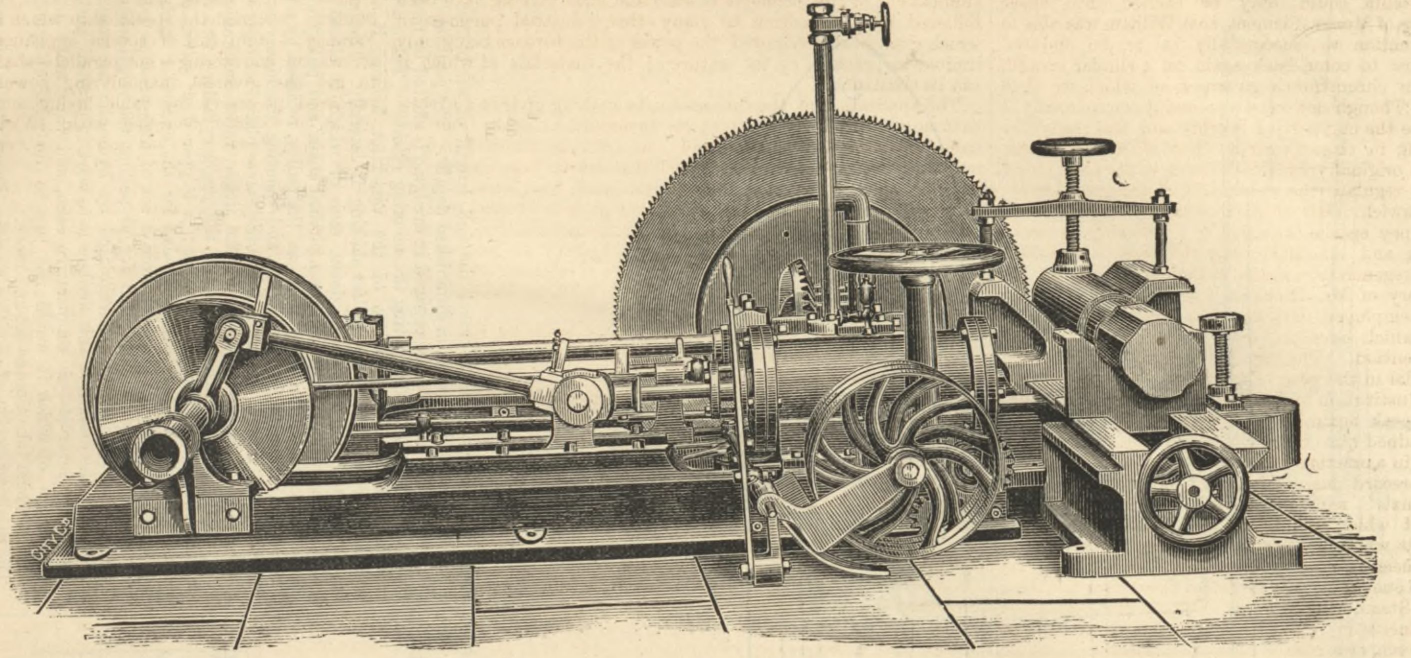
It has been suggested that Sir William Siemens should be buried in Westminster Abbey. The conflict of opinion which has characterised all recent proposals of this kind will no doubt express itself on this. There are, however, names which have become descriptive words, and posthumous honours can add little to the esteem in which the memory of Siemens will be held.

At the meeting of the Institute of Civil Engineers on Tuesday evening, the president, Mr. Brunlees, spoke as follows:—"It is with the deepest sorrow that I have to inform you of the death of our highly-valued and esteemed member of Council, Sir William Siemens, which took place last night after a short illness believed to be the result of a fall two or three weeks ago. Sir William was a man whose power of intellect and whose services in the application of practical science to almost every branch within the range of the profession of the civil engineer were universally appreciated. His fame was world-wide, as it deserved to be, and those who knew Sir William Siemens best will be the most ready to acknowledge that the qualities of his heart were not less conspicuous than those of his intellect. The Council are sure that they will best consult the feelings of all present by proposing to adjourn this meeting as a mark of respect to the memory of one who was so greatly honoured and beloved." The following resolution, which had just been passed at a meeting of the Council, was then read and adopted as the expression of the views of the members present:—"That this meeting desires to record the deep sense of the loss the Institution has sustained by the decease of their eminent and highly-esteemed colleague Sir William Siemens, and their sincere sympathy with Lady Siemens in her irreparable bereavement."

SATISFACTION is expressed by the sheet and hoop makers at the result of their interview upon the subject of the wire guage with the President of the Board of Trade. That they are not under any necessity to conform to the new standard, providing that they give notice to the Department, is information which they gladly welcome. In fact, this is practically all that they sought. The disarrangement of a complicated scale of wages based upon the old Birmingham gauge would have been very inconvenient, and foreign customers would not have understood the new gauge without much difficulty. The general opinion in Birmingham yesterday was that the branches named will continue working on the old guage, and not trouble the Department to establish a new standard.

CIRCULAR SAW FOR CUTTING HOT IRON

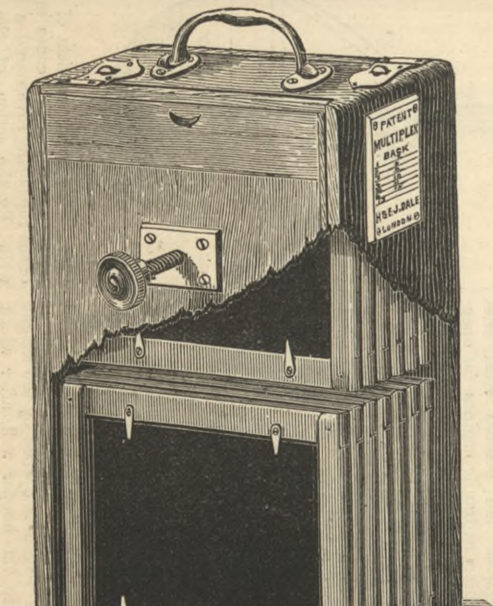
MESSRS. J. PICKLES AND SONS, HEBDEN BRIDGE, ENGINEERS.



THE above illustration represents an improved hot iron sawing machine, driven direct by a steam engine fixed upon the same bed-plate, and forming part of the machine. The iron to be sawn is laid in the V bearings, and held fast by a bridge and screw, as shown. The casting carrying it is mounted upon a strong bed, and is moved nearer or farther from the saw by means of the hand wheel and screw shown at the end of the bed. There is also a provision made for supporting the sweep ends of cranks when the webs have to be sawn out. The object to be sawn is therefore stationary, and the saw is advanced up to it by means of screw motion, actuated by spur and bevel gearing, which is driven by a belt, the pulley being driven by a counter crank, and by simply moving the hand lever the saw can be worked in or out. There is also provided a self-acting stopping motion, so as to prevent the machine being broken or damaged through the inattention of the operator. It is also fitted with a hand wheel for moving the saw up to its work by hand, which is sometimes of great advantage. The steam starting valve and hand motions are arranged close to where the operator stands, thus giving perfect control over the machine. The mode of its operation is as follows :—Upon the crank shaft is keyed a steel bevel wheel which drives another steel bevel wheel with a long boss or sleeve running in a bearing. Through this sleeve or boss slides a shaft with a groove formed upon it, and by a suitable feather key fixed in the long sleeve or boss it is driven, and yet free to slide backwards and forwards. At the other end of the shaft is keyed a steel bevel wheel giving motion to another steel bevel wheel which is keyed upon the saw spindle ; these work in suitable gun-metal bearings fixed upon a sliding saddle, movable upon suitable ways in the main casting. The feeding motion is driven from a pulley which derives its motion from the crank pin, and drives on to the pulleys at the other end of the machine, and the return motion is greatly accelerated. Every part is very strong, and well fitted for driving the saw at the proper speed. The saw used is 53in. diameter, and is capable of sawing large pieces of iron or steel. The approximate weight is 4½ tons. The machine is manufactured by Messrs. J. Pickles and Son, Royd Ironworks, Hebden Bridge.

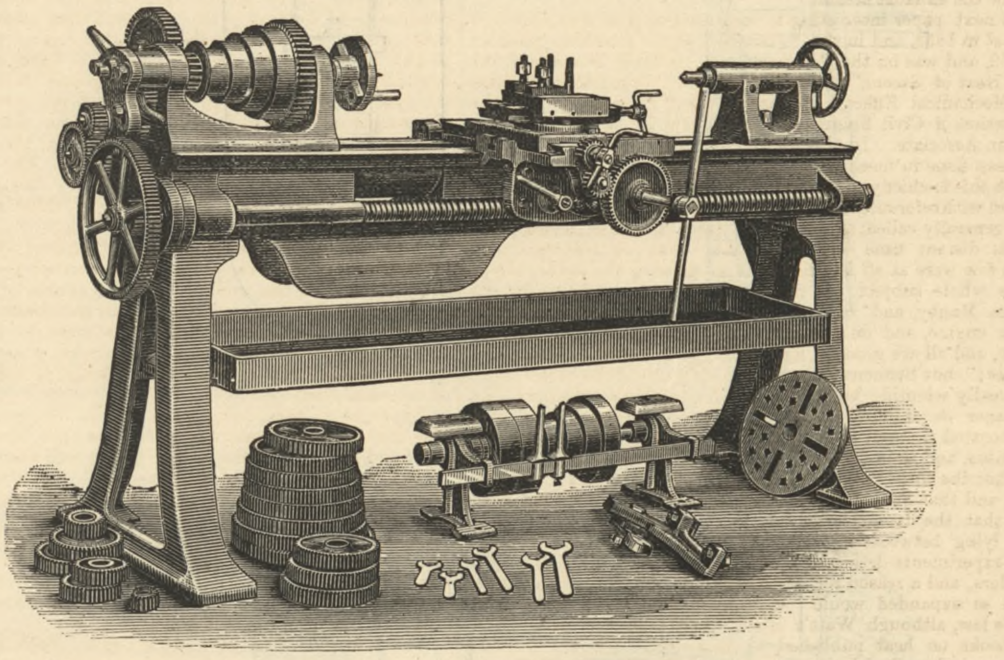
MULTIPLEX CAMERA BACK.

PHOTOGRAPHY is now so much used by engineers for various business purposes, and to some extent while on pleasure tours, that the photographic apparatus illustrated by the accompanying engravings may be of interest to many of our readers. The back is made for different sizes of camera, and contains its sensitised plates packed and held in such a way that they may be exposed as required without opening the case or in any way interfering with the plates. The risk of fogging through changing outdoors is thus avoided. The change of plates is effected by gravity, no springs being used, and any particular plate may be re-exposed by revolving the back until the number of that plate is seen in the window in the shutter. The apparatus is made by Messrs. H. and E. Dale, Ludgate-hill, and is shown as out of use, but partly in section below.



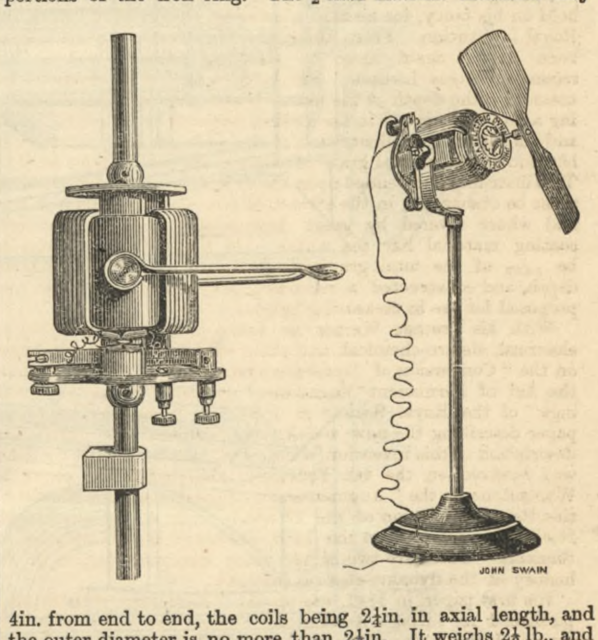
ASTBURY AND DAWSON'S STANDARD 6-INCH SELF-ACTING LATHE.

THE accompanying illustration represents a standard 6in. centre lathe, manufactured by Messrs. Astbury and Dawson, of Grantham, self-acting for sliding, surfacing, and screw-cutting, with a gap bed, the usual length of which is from 6ft. to 8ft. long, admitting in the former case 3ft. between the centres, and 1ft. 9in. diameter in the gap. This latter is provided with a movable bridge accurately fitted in, thus making the bed continuous when the gap is not in use. The headstock is double-geared and fitted with conical bushes of phosphor bronze; these are finished out to form a true bearing for the spindle; this is of mild cast steel and provided with suitable means for adjustment. An instantaneous reversing motion is fitted for right and left-hand sliding and screw-cutting and surfacing in either direction; the working parts of this motion are neatly covered in. The tailstock has a wrought iron poppet well fitted, and actuated by square thread screw and hand wheel in the usual manner. The saddle has long guiding surfaces and carries a compound slide rest arranged for turning conical, and surfacing either by hand or self-acting from the guide screw through a brass worm wheel and spur gear, with friction cone for disengaging the motion. The handles for actuating the slides, which it will be noticed are a departure from the ordinary kind, are convenient and have a pleasant action. When preferred, the lathe is arranged to slide and surface from an independent back shaft. Between the standards is an arrangement for catching the cuttings, oil, water, &c. A set of twenty-two change wheels, top driving apparatus, face plate, back stay, and set of screw keys are provided. This lathe is one of a series adopted by the makers as standard patterns, and made on the gauge and template system; they are designed specially for taking heavy cuts in iron or steel. The beds are very strong in section, and all the gearing, shafts, and screws are well proportioned. A variety of these lathes, from 5in. to 7in. centres, were exhibited at the recent Engineering Exhibition in the Agricultural Hall; the workmanship and finish of the tools shown was excellent.



THE GRISCOM MOTOR.

ONE interesting exhibit in the British section of the Rotunda of the Vienna Exhibition consisted of several of Griscom's small electro-motors, which were shown driving sewing machines, fan ventilators for household purposes, dentists' drills, and circular saws for use in surgery. These very neat and handy little motors have been in use for the last two or three years. The accompanying engraving shows two modifications, one for working a table fan; the other is a general motor. Exact electric measurements do not seem to have been made, and we, therefore, cannot say what the efficiency really is. Preferably the "half-man power" machine is driven by a six-cell bichromate zinc carbon battery, the six cells being coupled in series, a larger form rated at 1-man power requiring twelve similar cells. For convenience in household use all the electrodes are hung to a single bar which, by means of a lever and foot-treadle, can be lifted or lowered, so as to raise the plates either wholly or more or less out of the electrolyte. The armature of the dynamo is of the old Siemens form, with two broad pole pieces forming portions of a cylindrical surface, each extending through between one-quarter and one-third of the circle. Two tiny copper wire brushes send the current to this armature through a two-segment commutator. The field magnet surrounds the armature in the shape of a cylinder of wrought iron. Two opposite portions of this cylinder are wound after the manner of a Gramme ring. The current passes through these two coils in opposite directions, and thus opposite polarities are induced in the two opposite bare portions of the iron ring. The ½-man machine measures only 4in. from end to end, the coils being 2¼in. in axial length, and the outer diameter is no more than 2½in. It weighs 2½ lb., and can be fixed in any corner of a room by two or three screw nails.



SOUTH KENSINGTON MUSEUM.—Visitors during the week ending Nov. 17th, 1883 :—On Monday, Tuesday, and Saturday, free, from 10 a.m. to 10 p.m., Museum, 8852; mercantile marine, Indian section, and other collections, 2127. On Wednesday, Thursday, and Friday, admission 6d., from 10 a.m. to 4 p.m., Museum, 1332; mercantile marine, Indian section, and other collections, 129. Total, 12,440. Average of corresponding week in former years, 13,063. Total from the opening of the Museum, 22,576,700.

SMITH'S HYDRAULIC DREDGER.

MESSRS. CLARK, BUNNETT, AND CO., ENGINEERS, LONDON.

Fig.

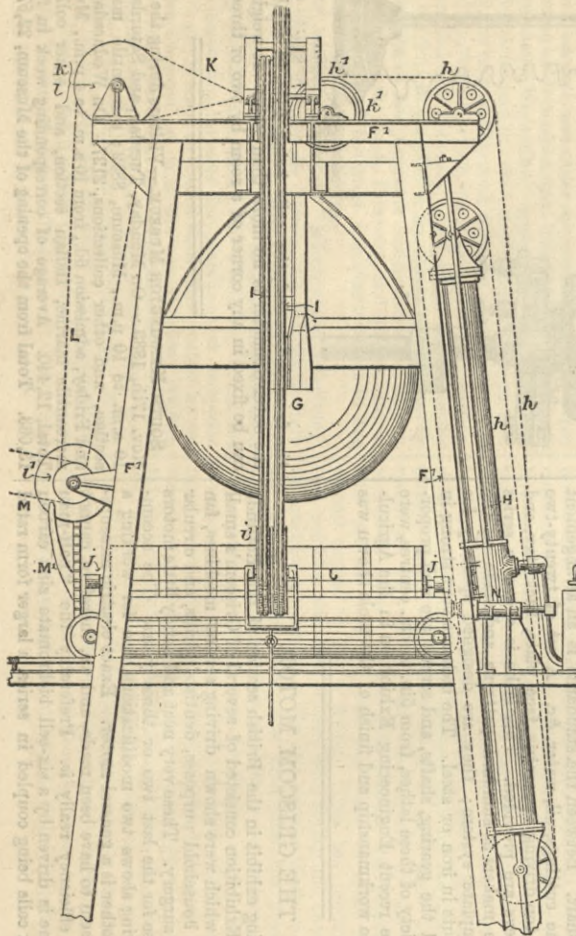


Fig. 4

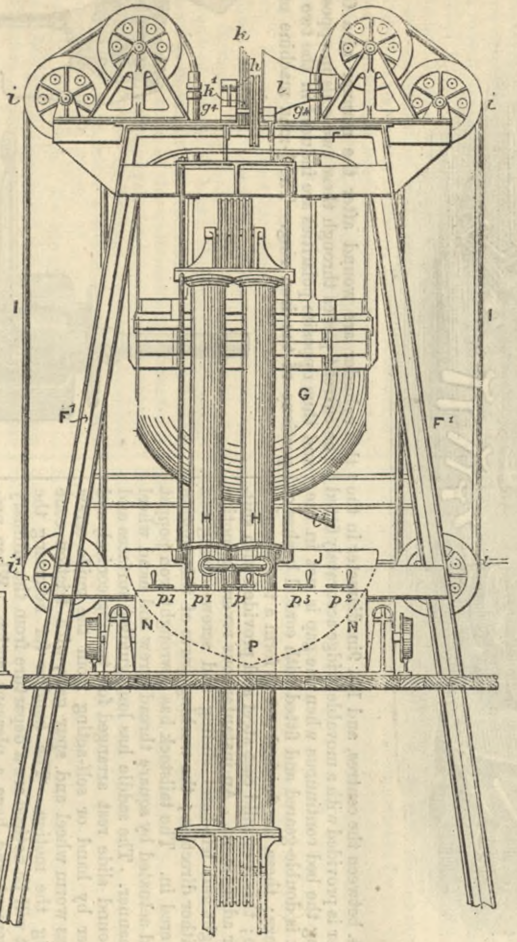


Fig. 7

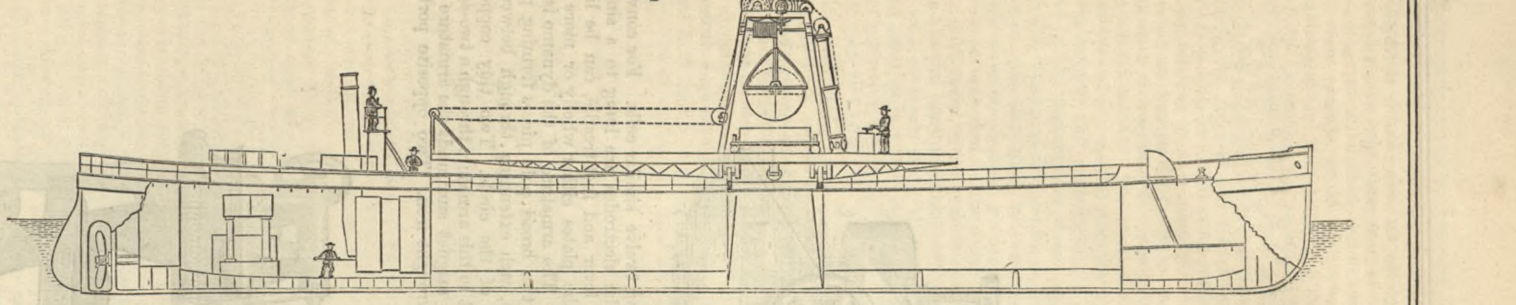
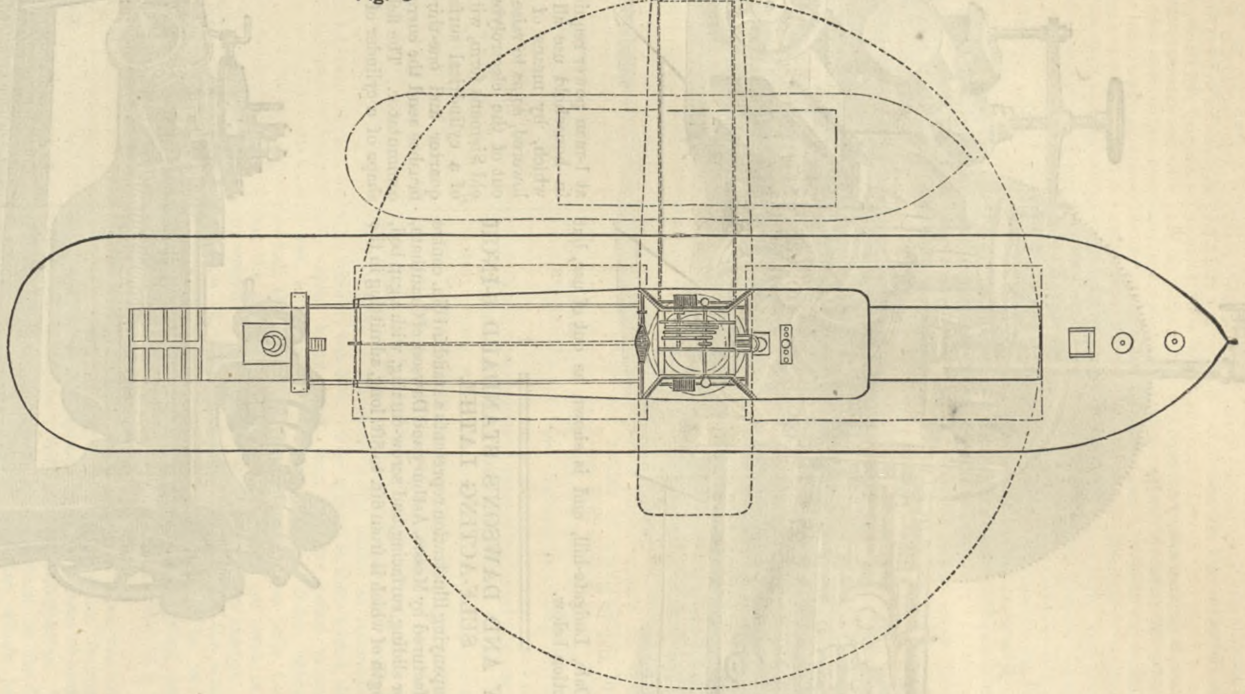


Fig. 8



In the recently closed Fisheries Exhibition, Messrs. Clark, Bunnett, and Co. exhibited an interesting working model of Smith's patent hydraulic dredger. This dredger is an adaptation of the principle of vertical dredging to the hopper dredger system, and combining the advantages of both arrangements, is expected to prove very economical.

The leading feature of the dredger is the combination of an excavator to dredge and raise the soil through a well in the vessel, with a wagon is a hemispherical bucket—see Figs. 1, 2, 5, and 6, the same letters show the same parts—formed of plates and pointed steel tines hinged in halves on a frame containing hydraulic engines for opening and closing the bucket. It is raised and lowered by a hydraulic to receive and distribute the soil over the hopper well. The excavator jigger mounted on a gantry frame, from which the excavator is suspended. The excavator descends open until it rests on the soil, and is closed by the admission of water under pressure to the cylinders in the excavator frame which forces the tines through the soil and fills the bucket.

Fig. 1

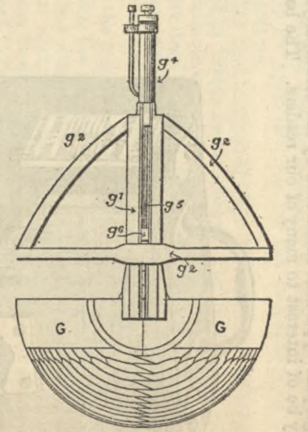


Fig. 2

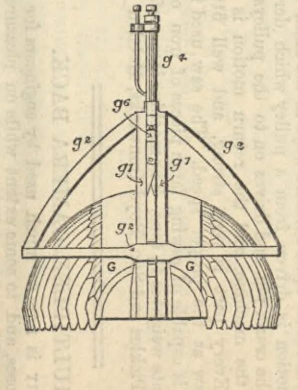


Fig. 5

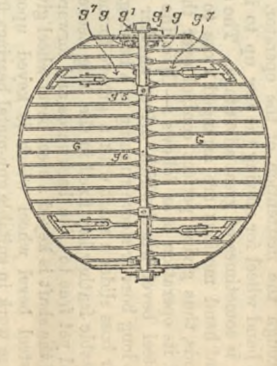
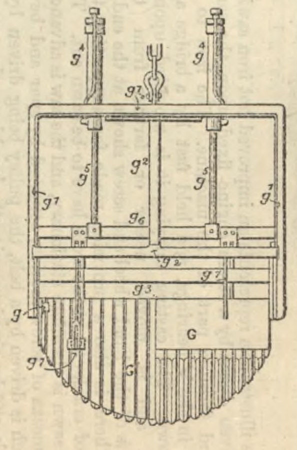


Fig. 6



The hydraulic power is conveyed to the hydraulic cylinders of the excavator by flexible hose pipes in two sets, which respectively communicate with opposite ends of the cylinders. Each set is wound on two sets of blocks and pulleys like tackle, so as to permit of the hose being paid out and wound in as the bucket is lowered and raised. In descending, the chain by which the excavator is suspended actuates gearing for hauling the distributing wagon outward from the excavator well over the hopper well, into which the contents of the wagon are dropped. On the excavator being raised by the hydraulic jigger its chain again actuates the gearing for hauling the wagon up to the excavator well simultaneously with the rise of the excavator, beneath which it comes when the latter reaches its highest position. The distributing—see Figs. 3 and 4—wagon is nearly semi-cylindrical in form, and made in two segments hung on centres, so that on tripping the catch, which holds the segments together, the wagon is opened by the weight of the soil, discharging the latter into the hopper well, after which the segments again close together by their own weight. The catch is tripped by a cam supported on wheels and run along the deck to the place where the soil is to be deposited in the hopper well. The hauling gear for the wagon consists of a steel wire rope, the ends of which are fastened to two speed cones mounted on the gantries frame, the bight of the rope being rove round a pulley at the outer end of the hopper well. By the action of the speed cones the wagon travels at its greatest relative speed when beneath the excavator, thereby reducing the height to which it is necessary to raise the excavator over the wagon. This arrangement, while reducing the height from which the soil drops from the excavator into the wagon, utilises the stroke of the excavator jigger to the best advantage for depth of dredging, and lowers the centre of gravity of the dredging barge. The speed cone shaft is driven by a pair of pulleys and chain and a set of toothed wheels and pinions, the latter geared by clutches to adjust the relative speed of the distributing wagon to travel the full length of the hopper well while the excavator dredges in diminished depths. The position of the dredger, Figs. 7 and 8, while engaged in dredging is shifted by means of two hydraulic capstans actuating the mooring chains. There are two mooring chains, one in the bow of the vessel for heaving it ahead, and the other athwart the vessel for shifting it laterally. The bottom of the hopper well consists of doors, each of which is closed by a hydraulic engine and kept shut by a pitched chain and pulley with a toothed ratchet on the same shaft as the pulley, retained by a pawl. The dredging, distributing, depositing, and mooring machinery is controlled by one man by means of hydraulic valves placed all together in a valve chest. These valves are:—The jigger valve communicating with the supply and exhaust pipes and the jigger cylinder; two valves for controlling the hydraulic capstans; a hopper door valve, and a double-acting supply and exhaust valve for the excavator cylinders. The hydraulic power is supplied from a set of high-pressure pumps, driven by the steam engines used for propelling the vessel when not dredging, and the pressure is regulated by hydraulic accumulators. An object in the design of this dredger is to work in exposed positions during short intervals of comparative calm, and thus make use of opportunities of which it would not pay to do with oblique-laden dredgers, which take time to set and move.

The dredging action of Smith's dredger, being vertical, is resisted by the weight and friction of the excavator, and places no strain on the moorings of the vessel, which are thus only used to guide the vessel while dredging, and are light enough to be managed with facility. The working model exhibited is made after the dredger constructed for the Aberdeen Harbour Commissioners to carry 156 tons of soil, and dredge at the rate of 200 tons per hour. The inventor also showed the design for an arrangement of his dredger which adapts it specially for the cutting of canals, where the soil is to be disposed of on the banks as well as taken away to sea.

VOLTA-ELECTRIC INDUCTION.*

By Willoughby Smith, Pres. Soc. Tel. Eng.

(*Concluded from page* 380.)

Now let us go more minutely into the subject by the aid of Figs. 4 and 5. In Fig. 4 let A and B represent two flat spirals, spiral A being connected to a battery with a key in circuit, and spiral B connected to a galvanometer; then, on closing the battery circuit, an instantaneous current is induced in spiral B. If a non-magnetic metal plate ½in. thick be placed midway between the spirals, and the experiment repeated, it will be found that the induced current received by B is the same in amount as in the first case. This does not prove, as would at first appear, that the metal plate fails to intercept the inductive radiant energy; and it can scarcely be so, for if the plate is replaced by a coil of wire, it is found that induced currents are set up therein, and therefore inductive radiant energy must have been intercepted. This apparent contradiction may be explained as follows:—In Fig. 3 let D represent a source of heat—a vessel of boiling water for instance—and E a sensitive thermometer receiving and measuring the radiant heat. Now if, for instance, a plate of vulcanite is interposed, it cuts off and absorbs a part of the radiant heat emitted by D, and thus a fall is produced in the thermometer reading. But the vulcanite soon becoming heated by the radiant heat cut off and absorbed by itself, radiates that heat, and causes the thermometer reading to return to about its original amount. The false impression is thus produced that the original radiated heat was unaffected by the vulcanite plate, instead of which, as a matter of fact, the vulcanite plate had cut off the radiant heat, becoming heated itself by so doing, and was consequently then the radiating body affecting the thermometer. The effect is similar in the case of induction, between the two spirals. Spiral A induces and spiral B receives the induced effect. The metal plate being then interposed cuts off and absorbs either all, or part of the inductive radiant energy emitted by A. The inductive radiant energy thus cut off, however, is not lost, but is converted into electrical energy in the metal plate, thereby causing it to become, as in the case of the vulcanite in the heat experiment, a source of radiation which compensates, as far as spiral B is concerned, for the original inductive radiant energy cut off. The only material difference noticeable in the two experiments is that in the case of heat the time that elapses between the momentary fall in the thermometer reading—due to the interception by the vulcanite plate of the radiant heat—and the subsequent rise—due to the interposing plate, tself radiating that heat—is long enough to render the effect clearly manifest; whereas in the case of induction, the time that elapses is so exceedingly short that, unless special precautions are taken, the radiant energy emitted by the metal plate is liable to be mistaken for the primary energy emitted by the inducing spiral. The current induced in the receiving spiral by the inducing one is practically instantaneous; but on the interposition of a metal plate the induced current which, as before described, is set up by the plate itself, has a perceptible duration depending upon the nature and mass of metal thus interposed. Copper and zinc produce in this manner an induced current of greater length than metals of lower conductivity, with the exception of iron, which gives an induced current of extremely short duration. It will therefore be seen that in endeavouring to ascertain what I term the specific inductive resistance of different metals by the means described, notice must be taken of, and allowance made for, two points. Firstly, that the metal plate not only cuts off, but itself radiates; and secondly, that the duration of the induced currents radiated by the plates varies with each different metal under experiment. This explains the fact before pointed out that the apparent percentage of inductive radiant energy intercepted by metal plates varies with the speed of the reversals; for in the case of copper the induced current set up by such a plate has so long a duration that if the speed of the reverser is at all rapid the induced current has not time to exhaust itself before the galvanometer is reversed, and thus the current being on the opposite side of the galvanometer tends to produce a lower deflection. If the speed of the reverser be further increased, the greater part of the induced current is received on the opposite terminal of the galvanometer, so that a negative result is obtained. We know that it was the strong analogies which exist between electricity and magnetism that led experimentalists to seek for proofs that would identify them as one and the same thing, and it was the result of Professor Oersted's experiment, to which I have already referred, that first identified them. Probably the time is not far distant when it will be possible to demonstrate clearly that heat and electricity are as closely allied; then, knowing the great analogies existing between heat and light, may we not find that heat, light, and electricity are modifications of the same force or property, susceptible under varying conditions of producing the phenomena now designated by those terms. For instance, friction will first produce electricity, then heat, and lastly light. As is well known, heat and light are reflected by metals; I was therefore anxious to learn whether electricity could be reflected in the same way. In order to ascertain this spiral B was placed in this position, which you will observe is parallel to the lines of force emitted by spiral A. In this position no induced current is set up therein, so the galvanometer is not affected; but when this plate of metal is placed at this angle it intercepts the lines of force, which cause it to radiate, and the secondary lines of force are intercepted and converted into induced currents by spiral B to the power indicated by the galvanometer. Thus the phenomenon of reflection appears to be produced in a somewhat similar manner to reflection of heat and light.

Fig. 4.

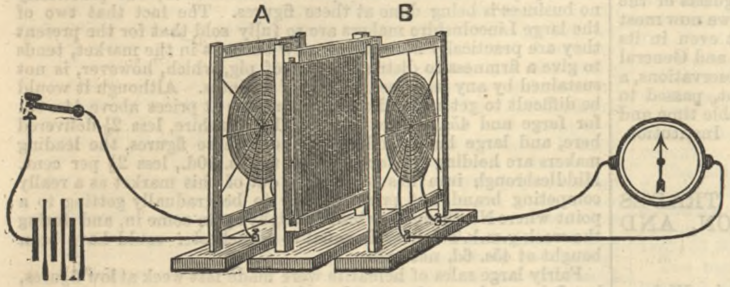


Fig. 5.

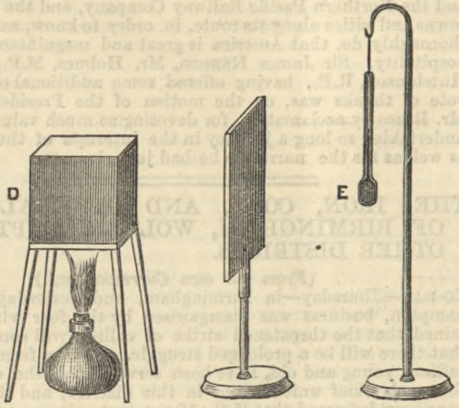


Fig. 6.

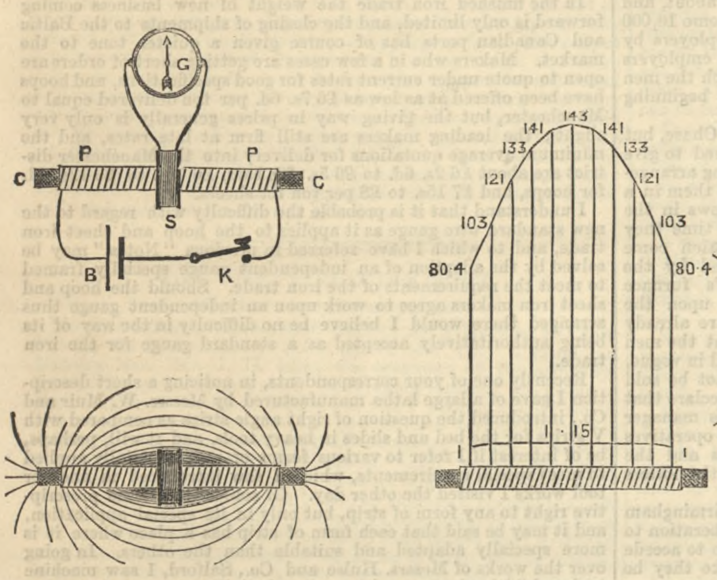


Fig. 7.

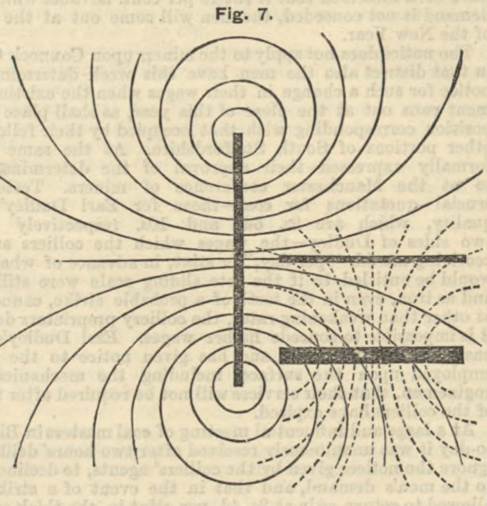
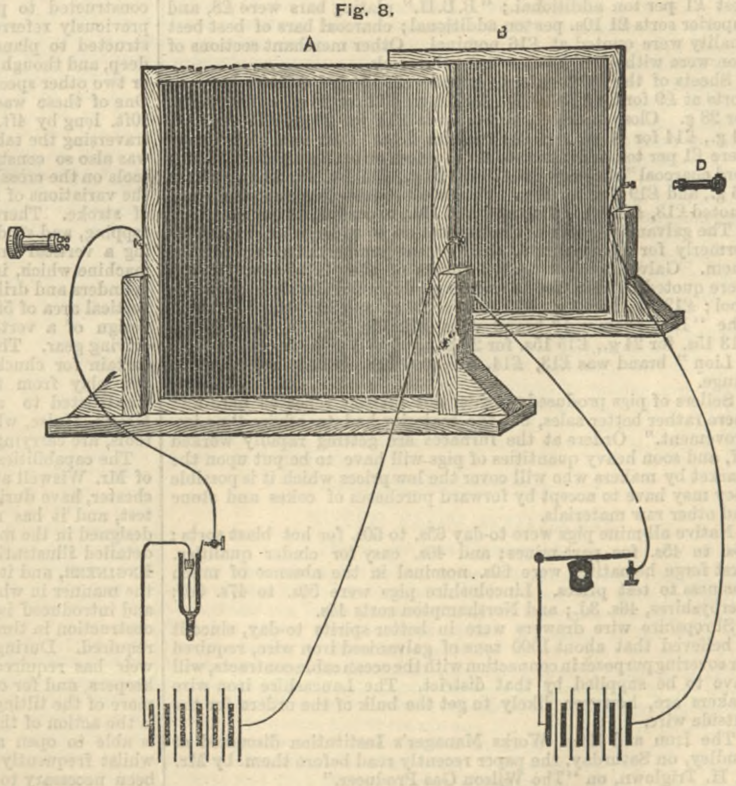


Fig. 8.



The whole arrangement of this experiment is as shown on Fig. 7, which I need not, I think, more fully explain to you than by saying that the secondary lines of force are represented by the dotted lines. Supported in this wooden frame marked C is a spiral similar in construction to the one marked B; but in this case the copper wire is ·044in. in diameter, silk-covered, and consists of 365 turns, with a total length of 605 yards; its resistance is 10·2 ohms. The whole is enclosed between two thick sheets of card paper. The two ends of the spiral are attached to two terminals, placed one on either side of the frame; a wire from one of the terminals is connected to one pole of a battery of 25 Leclanché cells, the other pole being connected with one terminal of a reverser, the second terminal of which is connected to the other terminal of the spiral. Now if this very small spiral which is in circuit with the galvanometer and a reverser be placed parallel to the centre of spiral C a very large deflection will be seen on the galvanometer scale; this will gradually diminish as the smaller spiral is passed slowly over the face of the larger, until on nearing the edge of the latter the smaller spiral will cease to be affected by the inductive lines of force from spiral C, and consequently the galvanometer indicates no deflection. But if this smaller spiral be placed at a different angle to the larger one it is, as you observe by the deflection of the galvanometer, again affected. This experiment is analogous to the one illustrated by Fig. 6, which represents the result of an experiment made to ascertain the relative strength or capability of producing inductive effects of different parts of a straight electro-magnet. C represents the iron core; P P the primary coil connected at pleasure to one Grove cell B by means of the key K; S a small secondary coil free to move along the primary coil while in circuit with the galvanometer G; the relative strength of any particular spot can be obtained by moving the coil S exactly over the required position. The small secondary coil is only cut at right angles when it is placed in the centre of the magnet, and as it is moved towards either pole, so the lines of force cut it more and more obliquely. From this it would appear that the results obtained are not purely dependent upon the strength of that portion of the magnet over which the secondary coil is placed, but principally upon the angle at which the lines of force cut the coil so placed. It does not follow therefore that the centre of the magnet is its strongest part, as the results of the experiments at first sight appear to show. It was while engaged on these experiments that I discovered that a telephone was affected when not in any way connected with the spiral but simply placed so that the lines of force proceeding from the spiral impinged upon the iron diaphragm of the telephone. Please to bear in mind that the direction of the lines of force emitted from the spiral is such, that starting from any point on one of its faces a circle is described extending to a similar point on the opposite side. The diameter of the circles described decreases from infinity as the points from which they start recede from the centre towards the circumference. From points near the circumference the circles or curves are very small. To illustrate this to you the reverser now in circuit with spiral C will be replaced by a simple make-and-break arrangement, consisting of a small electro-magnet fixed between the prongs of a tuning-fork, and so connected that the electro-magnet influences the arms of the fork, causing them to vibrate to a certain pitch. The apparatus is placed in a distant room to prevent the sound being heard here, as I wish to make it inductively audible to you. For that purpose I have here a light spiral which is in circuit with this telephone. Now, by placing the spiral in front of spiral C the telephone reproduces the sound given out by the tuning-fork so loudly that I have no doubt all of you can hear it. Here is another spiral similar in every respect to spiral C; this is in circuit with a battery and an ordinary mechanical make-and-break arrangement, the sound given off by which I will now make audible to you in the same way that I did the sound of the tuning-fork. Now you hear it. I will change from the one spiral to the other several times, as I want to make you acquainted with the sounds of both, so that you will have no difficulty in distinguishing them the one from the other. There are suspended in this room self-luminous bodies which enable us by their rays or lines of force to see the non-luminous bodies with which we are surrounded. There are also radiating in all directions from me while speaking lines of force or sound waves which affect more or less each one of you. But there are also in addition to, and quite independent of, the lines of force just mentioned, magnetic lines of force which are too subtle to be recognised by human beings, consequently, figuratively, we are both blind and deaf to them. However, they can be made manifest either by their action on a suspended magnet, or on a conducting body moving across them; the former showing its results by attraction and repulsion, the latter by the production of an electric current. For instance, by connecting the small flat spiral of copper wire in direct circuit with the galvanometer, you will perceive that the slightest movement of the spiral generates a current of sufficient strength to very sensibly affect the galvanometer; and as you observe, the amplitude of the deflection depends upon the speed and direction in which the spiral is moved. We know that by moving a conductor of electricity in a magnetic field we are able to produce an electric current of sufficient intensity to produce light resembling in all its phases that of solar light; but to produce these strong currents, very powerful artificial magnetic fields have to be generated, and the conductor has to be moved therein at a great expenditure of heat energy. May not the time arrive when we shall no longer require these artificial and costly means, but have learned how to adopt those forces of nature which we now so much neglect. One ampère of current passing through an ordinary incandescent lamp will produce a light equal to ten candles, and I have shown that by simply moving this small flat spiral a current is induced in it from the earth's magnetic field equal to ·0007 ampère. With these facts before us, surely it would not be boldness to predict that a time may arrive when the energy of the wind or tide will be employed to produce from the magnetic lines of force given out by the earth's magnetism electrical currents far surpassing anything we have yet seen or of which we have heard. Therefore let us not despise the smallness of the force, but rather consider it an element of power from which might arise conditions far higher in degree, and which we might not recognise as the same as this developed in its incipient stage. If the galvanometer be replaced by a telephone, no matter how the spiral be moved, no sound will be heard, simply because the induced currents produced consist of comparatively slow undulations, and not of sharp variations suitable for a telephone. But by placing in circuit this mechanical make-and-break arrangement the interruptions of the current are at once audible, and by regulating the movement of the spiral I can send signals which, if they had been pre-arranged, might have enabled us to communicate intelligence to each other by means of the earth's magnetism. I show this experiment more with a view to illustrate the fact that for experiments on induction both instruments are necessary, as each makes manifest those currents adapted to itself. The lines of force of light, heat, and sound can be artificially produced and intensified, and the more intense they are the more we perceive their effects on our eyes, ears, or bodies. But it is not so with the lines of magnetic force, for it matters not how much their power is increased, they appear in no way to affect us. Their presence can, however, be made manifest to our eyes or ears by mechanical appliances. I have already shown you how this can be done by means of either a galvanometer or a telephone in circuit with a spiral wire. I have already stated that while engaged in these experiments I found that as far as the telephone was concerned it was immaterial whether it was in circuit with a spiral or not, as in either case it accurately reproduced the same sounds; therefore much in the same way as lenses assist the sight or tubes the hearing, so does the telephone make manifest the lines of intermittent inductive energy. This was quite a new phenomenon to me, and on further investigation of the subject I found that it was not necessary to have even a telephone, for by simply holding a piece of iron to my ear and placing it close to the centre of the spiral I could distinctly hear the same sounds as with the telephone, although not so loud. The intensity of the sound was greatly increased when the iron was placed in a magnetic field. Here is a small disc of iron similar to those used in telephones, firmly secured in this brass frame; this is a small permanent bar magnet, the marked end of which is fixed very closely to, but not touching, the centre of the iron disc; now by applying the disc to my ear I can hear the same sounds that were audible to all of you when the telephone in circuit with a small spiral was placed in front of and close to the large spiral; to me the sound is quite as loud as when you heard it; but now you are one and all totally deaf to it. My original object in constructing two large spirals was to ascertain whether the inductive lines of force given out from one source would in any way interfere with those proceeding from another source. By the aid of this simple iron disc and magnet it can be ascertained that they do in no way interfere with each other, therefore the direction of the lines proceeding from each spiral can be distinctly traced. For when the two spirals are placed parallel to each other at a distance of 3ft. apart, and connected to independent batteries and transmitters, as

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* A paper read at the Society of Telegraph Engineers and Electricians, November 8th, 1883.

shown in Fig. 8, each transmitter having a sound perfectly distinct from that of the other, when the circuits are completed the separate sounds given out by the two transmitters can be distinctly heard at the same time by the aid of a telephone; but by placing the telephone in a position neutral to one of the spirals, then only the sound proceeding from the other can be heard. These results occur in whatever position the spirals are placed relatively to each other, thus proving that there is no interference with or blending of the separate lines of force. The whole arrangement will be left in working order at the close of the meeting, for any gentleman present to verify my statements or to make what experiments they please. In conclusion, I would ask, What can we as practical men gather from these experiments? A great deal has been written and said as to the best means to secure conductors carrying currents of very low tension, such as telephone circuits, from being influenced by induction from conductors in their immediate vicinity employed in carrying currents of comparatively very high tension, such as the ordinary telegraph wires. Covering the insulated wires with one or other of the various metals has not only been suggested but said to have been actually employed with marked success. Now it will be found that a thin sheet of any known metal will in no appreciable way interrupt the inductive lines of force passing between two flat spirals. That being so, it is difficult to understand how inductive effects are influenced by a metal covering as described. Telegraph engineers and electricians have done much towards accomplishing the successful working of our present railway system; but still there is much scope for improvements in the signalling arrangements. In foggy weather the system now adopted is comparatively useless, and recourse has to be had at such times to the dangerous and somewhat clumsy method of signalling by means of detonating charges placed upon the rails. Now, it has occurred to me, that volta induction might be employed with advantage in various ways for signalling purposes. For example, one or more wire spirals could be fixed between the rails at any convenient distance from the signalling station, so that when necessary intermittent currents could be sent through the spirals; and another spiral could be fixed beneath the engine or guard's van and connected to one or more telephones placed near those in charge of the train. Then as the train passed over the fixed spiral, the sound given out by the transmitter would be loudly reproduced by the telephone and indicate by its character the signal intended. One of my experiments in this direction will perhaps better illustrate my meaning. The large spiral was connected in circuit with twelve Leclanché cells and the two make-and-break transmitters before described. They were so connected that either transmitter could be switched into circuit when required, and this I considered the signalling station. This small spiral was so arranged that it passed in front of the large one at the distance of 8in. and at a speed of twenty-eight miles an hour. The terminals of the small spiral were connected to a telephone fixed in a distant room, the result being that the sound reproduced from either transmitter could be clearly heard and recognised every time the spirals passed each other. With a knowledge of this fact, I think it will be readily understood how a cheap and efficient adjunct to the present system of railway signalling could be obtained by such means as I have ventured to bring to your notice this evening. Thus have I given you some of the thoughts and experiments which have occupied my attention during my leisure. I have been long under the impression that there is a feeling in the minds of many that we are already in a position to give an answer to almost every question relating to electricity or magnetism. All I can say is, that the more I endeavour to advance in a knowledge of these subjects, the more am I convinced of the fallacy of such a position. There is much yet to be learnt, and if there be present either member, associate, or student to whom I have imparted the smallest instruction, I shall feel that I have not unprofitably occupied my time this evening.

THE INSTITUTION OF CIVIL ENGINEERS.

AT the opening meeting of the session on the 13th of November, Mr. Brunlees, President, in the chair, Mr. G. B. Bruce, Vice-President, gave an account of his recent visit to the United States of America as the representative of the Institution, on the occasion of the opening of the through line of the Northern Pacific Railroad. The invitation came from the president and directors of the railroad, through Lord Granville, and Mr. Bruce took the place of Mr. Brunlees, President of the Institution, who was unable, through other engagements, to go himself. Invitations were also given to departments of the Government of this and other countries, the representatives of all of which were received as guests of the company from the time of their leaving Europe until their return. The railroad is based upon a concession from the Government, the company making the road, and the Government giving 25,000 acres of land per mile of road constructed, in alternate sections, the Government holding one block and the company the next. The railroad lies mainly between the 46th and 59th parallels of north latitude, about 200 miles south from the boundary between Canada and the States, and 300 miles south of the Canadian Pacific railway. The distance between the termini, Lake Superior and Puget Sound, was about 2200 miles. Besides this, there was a branch from Brainerd on the main line to St. Paul on the Mississippi, which would probably be the chief route for traffic between the Northern Pacific towns and the eastern ports. Proceeding north-westwards from St. Paul, the country at first was chiefly under wheat; some distance after passing the Missouri it was mainly devoted to raising cattle. Mr. Bruce was particularly struck with the bridges on the line. The crossing of the Missouri at Bismarck was effected by an iron bridge 1450ft. long, having three spans of 400ft. each and two spans of 113ft. each, and was 50ft. above the highest level of summer floods. The large girders were about 50ft. deep. The majority of the bridges throughout the road were of timber, the most remarkable being among the Rocky Mountains. Here, too, were the steepest gradients on the line, the maximum being 116ft. to the mile. The crossing of the summits of the two ranges would be by two tunnels, each 1200 yards long; at present temporary roads had been laid over the mountains. Mr. Bruce considered the passage of the Columbia river through the Cascade Range the most imposing feature of the line. The road at this point, for a considerable distance, is carried along a ledge made by blasting away the almost perpendicular hill-side into the river below. The rails were of steel, 56 lb. to the yard; the road was well sleepered and reasonably ballasted; and there were all the elements of a good and substantial road, which in time will doubtless rank among the best in the United States. There was no signalling apparatus but great use was made of the telegraph. In one feature the American engineers seemed to be particularly distinguished, namely, in the arrangement of their work, and in the strictly systematic manner in which they carried it forward under very difficult and trying circumstances. The visitors were conducted in four trains of about ten Pullman carriages each. They all left New York, and were ready to start from Chicago on the 1st of September. They met with a hearty reception at the cities of St. Paul and Minneapolis which, though not forty years old, each contain a population of between 80,000 and 90,000, and are the centres of large industries. Notwithstanding the lack of timber over many hundreds of miles in the centre, the discovery of coal in that very locality would make it easy to supply the engines with fuel. The Westinghouse brake seemed to be in general use in America. The whole trip was carried out with very few mishaps; one or two slight accidents were the outcome of the running together of carriages from different lines the couplings of which did not correspond. The great ceremony of the occasion was driving the last spike at the "Garrison" station, at the foot of the eastern side of the Rocky Mountains, when about half a mile of track was laid in about half an hour. Mr. Bruce then alluded briefly to some things not connected with the Northern Pacific Railroad. He was struck with the much greater use made of the electric light in America than in England. In many little cities in the prairies, a high pole in the middle of the town with a light on it illuminated the whole place. He very much admired the steamboat accommodation in the United States, and remarked that the arrangements for landing in Liverpool, in a steam-tug without even a covering to keep off the rain, contrasted most unfavourably with it, and were a disgrace to our country and to the companies which perpetuated them. While at Chicago Mr. Bruce went to see the new works of the Pullman Car Company. There was now there a town of 7000 inhabitants, where three years ago there was nothing but an unoccupied stretch of country. The chief feature was in the surroundings of the works; everything had been done for the welfare and comfort of the workmen, and the whole had been a great financial as well as moral success. In conclusion, Mr. Bruce stated that he had been greatly impressed with the extraordinary hospitality of the American people. In Portland, Oregon, for instance, where there are few hotels, the members of the party were received into the private houses of the citizens and right hospitably entertained, and everywhere they went as opportunity offered they were received in the same way. We always knew that America was a great and magnificent country; great and magnificent in the extent of its territory; great and magnificent in what it has achieved in the past; great and magnificent in the future which lies before it. We knew all this upon ample testimony, because we had been told it by others and had read of it in books for ourselves. But it required us to cross the Atlantic, to brave all its storms and visit America as the guests of Mr. Villard and the Northern Pacific Railway Company, and the guests of the towns and cities along its route, in order to know, as we now most thoroughly do, that America is great and magnificent even in its hospitality. Sir James Hannen, Mr. Holmes, M.P., and General Hutchinson, R.E., having offered some additional observations, a vote of thanks was, on the motion of the President, passed to Mr. Bruce by acclamation, for devoting so much valuable time and undertaking so long a journey in the interests of the Institution, as well as for the narrative he had just given.

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(*From our own Correspondent.*)

TO-DAY—Thursday—in Birmingham, and yesterday in Wolverhampton, business was disorganised by the fear which is entertained that the threatened strike of colliers will come about, and that there will be a prolonged struggle. Notices from some 16,000 colliers, young and old, have been served upon the employers by the men's chief union agent in this district; and the employers have been informed that if the 10 per cent. advance which the men demand is not conceded, the men will come out at the beginning of the New Year.

The notice does not apply to the miners upon Cannock Chase, but in that district also the men have this week determined to give notice for such a change in their wages when the existing arrangement runs out at the close of this year, as shall place them in a position corresponding with that occupied by their fellows in the other portions of South Staffordshire. At the same time they formally expressed their approval of the determination come to at the Manchester conference of miners. Tested by the crucial quotations for coal—those for Earl Dudley's furnace quality, which are 9s. 6d. and 10s. respectively upon the two sides of Dudley—the wages which the colliers are already receiving are 5d. "per day," or stint, in advance of what the men would be entitled to if the late sliding scale were still in vogue, and as iron, even in the teeth of a probable strike, cannot be sold at other than weakening rates, the colliery proprietors declare that it is impossible to concede higher wages. Earl Dudley's manager has taken the initiative, and has given notice to the operatives employed upon the surface, including the mechanics and the enginemen, that their services will not be required after the notices of the colliers have expired.

At a large and influential meeting of coal masters in Birmingham to-day it was unanimously resolved after two hours' deliberation to ignore the notices given by the colliers' agents, to decline to accede to the men's demand, and that in the event of a strike they be allowed to return only at 3s. 4d. per stint in the thick seams, or a drop on the existing wages of 4d.

The demand for bars was fairly steady to-day, but there was no "push" in orders. Prices were very varied. Rounds and squares, of $\frac{1}{2}$in. to 3in., from the celebrated Bloomfield Works, were £7 10s., and £7 10s. was also the price for flats of 1in. by $\frac{1}{4}$in. to 6in. by $1\frac{1}{4}$in.; best bars and best scrap bars were £9, and best best £10 per ton; best angle, tee, and rivet iron was £9 10s.; and double best £1 per ton additional.; "B.B.H." plating bars were £8, and superior sorts £1 10s. per ton additional; charcoal bars of best best quality were quoted at £16 nominal. Other merchant sections of iron were without alteration upon the week.

Sheets of the "Woodford" brand were quoted delivered at outports at £9 for 20 g., £10 10s. for 24 g., £12 for 26 g., and £12 10s. for 28 g. Close annealed sheets were £11 for 20 g., £12 10s. for 24 g., £14 for 26 g., and £14 10s. for 28 g. Best annealed sheets were £1 per ton additional to these prices on each gauge. "Woodford charcoal" sheets were £16 for 20 g., £17 10s. for 24 g., £19 for 26 g., and £19 10s. for 28 g. Mild steel sheets close annealed were quoted £13, £14 10s., £16, and £16 10s., according to gauge.

The galvanisers were not in the market to so large an extent as formerly for black sheets, their recent purchases having satisfied them. Galvanised corrugated sheets of the "Red Star" brand were quoted £12 10s. for 18 and 20 g., delivered London or Liverpool; £13 10s. for 24 g., £15 10s. for 26 g., and £17 10s. for 28 g. The "Red Diamond" brand were £12 15s. for 18 and 20 g., £13 15s. for 24 g., £15 15s. for 26 g., and £17 15s. for 28 g. The "Lion" brand was £13, £14, £16, and £18 per ton, according to gauge.

Sellers of pigs produced outside this district reported here and there rather better sales, but the majority had to advise "no improvement." Orders at the furnaces are getting rapidly worked off, and soon heavy quantities of pigs will have to be put upon the market by makers who will cover the low prices which it is possible they may have to accept by forward purchases of cokes and stone and other raw materials.

Native all-mine pigs were to-day 65s. to 60s. for hot blast sorts; 55s. to 45s. for part mines; and 40s. easy for cinder qualities. Best forge hematites were 60s. nominal in the absence of much business to test prices. Lincolnshire pigs were 50s. to 47s. 6d.; Derbyshires, 46s. 3d.; and Northampton sorts 45s.

Shropshire wire drawers were in better spirits to-day, since it is believed that about 1000 tons of galvanised iron wire, required for covering purposes in connection with the ocean cable contracts, will have to be supplied by that district. The Lancashire iron wire makers are, however, likely to get the bulk of the orders for the outside wire.

The Iron and Steel Works Manager's Institution discussed at Dudley, on Saturday, the paper recently read before them by Mr. C. H. Triglown, on "The Wilson Gas Producer."

The latest move of the railway companies in the matter of freights is a notice which has been served upon the cycle manufacturers of Coventry, Birmingham, Wolverhampton, and Nottingham, that after January 1st cycles packed in parts and those sent whole will be charged at the same rate. At present, cycles in parts are charged less than whole cycles. This the Coventry manufacturers consider unfair, and they have determined to seek the co-operation of the other towns mentioned in their resistance of the impost.

The President of the Walsall Chamber of Commerce holds that "the anomalous railway freights on the carriage of wire from the Continent to Birmingham, and *vice versâ*, gives a fearful and absolute monopoly to the foreigner." Further, they compelled the manufacturers in the centre of England to pay four times as much for the conveyance of his goods as the foreigner paid.

NOTES FROM LANCASHIRE.

(*From our own Correspondents.*)

Manchester.—The weight of actual business doing in the iron trade of this district continues small, and there is very little change to note as regards prices. There are very few really pressing sellers in the market, most of the leading makers being fairly well off for work for the present, and rather than seek new business at less prices than the already very low basis, they prefer to work on as long as possible with existing contracts. Buyers, on the other hand, apparently anticipate a quiet winter's trade, and beyond covering absolute requirements, they are not disposed to give out orders except where there is some inducement in the shape of concessions upon current rates. Lancashire pig iron makers have deliveries on account of contracts which will see them over the present year, and the leading finished iron makers have also plenty of work in hand at present, but some of the local forges are getting rather short of orders. Ironfounders still complain of slackness of trade so far as the general run of work is concerned, and brass-founders report orders for engineers' and marine fittings falling off, with prices cut extremely fine to secure business.

There was only a flat market at Manchester on Tuesday, with very little business reported in either pig or manufactured iron. For local brands of pig iron prices were, if anything, a shade easier, sellers being now prepared to come down to 45s. as their minimum, with 45s. 6d. as their average quoted price, less $2\frac{1}{2}$ for forge and foundry qualities delivered equal to Manchester; but practically no business is being done at these figures. The fact that two of the large Lincolnshire makers are so fully sold that for the present they are practically not seeking new business in the market, tends to give a firmness to district brands of pig, which, however, is not sustained by any increased weight of business. Although it would be difficult to get any orders of importance at prices above 44s. 6d. for forge and 45s. 6d. for foundry Lincolnshire, less $2\frac{1}{2}$ delivered here, and large buyers offer 6d. under these figures, the leading makers are holding out for 44s. 10d. to 45s. 10d., less $2\frac{1}{2}$ per cent. Middlesbrough iron has long been out of this market as a really competing brand, but prices appear to be gradually getting to a point where North-country brands might again come in, and during the week g.m.b.'s delivered equal to Manchester could have been bought at 45s. 6d. net cash.

Fairly large sales of hematite were made last week at low figures, but I do not hear of any order of importance at present coming into the market.

In the finished iron trade the weight of new business coming forward is only limited, and the closing of shipments to the Baltic and Canadian ports has of course given a quieter tone to the market. Makers who in a few cases are getting short of orders are open to quote under current rates for good specifications, and hoops have been offered at as low as £6 7s. 6d. per ton delivered equal to Manchester, but the giving way in prices generally is only very slight; the leading makers are still firm at late rates, and the minimum average quotations for delivery into the Manchester district are about £6 2s. 6d. to £6 5s. for bars, £6 10s. to £6 12s. 6d. for hoops, and £7 15s. to £8 per ton for sheets.

I understand that it is probable the difficulty with regard to the new standard wire gauge as it applies to the hoop and sheet iron trade, and to which I have referred in previous "Notes," may be solved by the adoption of an independent gauge specially framed to meet the requirements of the iron trade. Should the hoop and sheet iron makers agree to work upon an independent gauge thus arranged there would I believe be no difficulty in the way of its being authoritatively accepted as a standard gauge for the iron trade.

Recently one of your correspondents, in noticing a short description I gave of a large lathe manufactured by Messrs. W. Muir and Co., introduced the question of right angle strips as compared with V strips for the bed and slides in heavy tools, and it will, perhaps, be of interest if I refer to various forms of strips specially applied to meet special requirements, which I saw introduced in another tool works I visited the other day. Of course there is no prescriptive right to any form of strip, but only in its special application, and it may be said that each form of strip has a place where it is more specially adapted and suitable than the others. In going over the works of Messrs. Hulse and Co., Salford, I saw machine tools exhibiting in some part or other both V strips and flat strips, same as in ordinary use, and others inverted, whilst in a large planer both flat and angular strips were used. In another planing machine just completed, there were six tools carried on what might be termed a telescopic cross slide, which, whilst it enabled the tools to be brought within so small a distance as 9in. apart, provided a sufficiently long bearing surface to keep the tools perfectly steady. This was a powerful machine, treble-geared, and constructed to plane 16ft. long by 6ft. wide. The large planer previously referred to, with flat and angular strips, was constructed to plane 18ft. longitudinally, 14ft. vertically, and 3ft. deep, and though so large a size, was self-contained. There were one or two other special tools at the works which I may briefly notice. One of these was a patent planing machine for taking in work 10ft. long by 4ft. wide, and so arranged that when required in traversing the table could be made to raise the cross slide, whilst it was also so constructed as to give a variable traverse to the two tools on the cross slide of from $\frac{1}{64}$in. to $1\frac{1}{2}$in. wide, varying by $\frac{1}{64}$in., the variations of feed being as readily made as the varying lengths of stroke. There were also a couple of machines for drilling, tapping, and studding work for marine engines, one of them covering a vertical area of 10ft. high and 16ft. long, and a smaller machine which, in addition, was arranged for milling the parts of cylinders and drilling the flanges of propeller couplings, covering a vertical area of 5ft. high by 10ft. long. There was also an improved design of a vertical drilling and boring machine as regards the driving gear. The table, which has compound slides and a grooved curtain for chucking work vertically, is raised by power, and all end play from the spindle is compensated. This machine is constructed to admit work 80in. diameter. I may add that Messrs. Hulse, who have orders in hand for exceptionally heavy tools, are carrying out an extension of their works.

The capabilities of the new tilting weir erected from the designs of Mr. Wiswell at Throstle Nest, on the river Irwell, near Manchester, have during the recent floods been put to a tolearbly severe test, and it has met the requirements for which it was specially designed in the most satisfactory manner. A full description, with detailed illustrations, of the weir has already been given in THE ENGINEER, and it will be of interest to add a short description of the manner in which it has done its work. The weir was designed and introduced in substitution of the old fixed weir, so as to be no obstruction in time of flood, and to be easily opened or closed when required. During the recent floods in September and October the weir has required no other attendants than the ordinary lock-keepers, and for one month the sluices were scarcely at rest, one or more of the tilting gates being constantly open. So easy, however, is the action of the gates, that when a flood is approaching one man is able to open as many as three of the sluices simultaneously, whilst frequently they have opened automatically, and it has only been necessary to wind up the slack chain. The weir, however, has never been left altogether to its automatic action, which is one of its special features, as the Bridgewater Navigation Company have undertaken to open the sluices in anticipation, but it has proved that in case of any possible night or sudden flood this automatic action would come into operation. As to the effectiveness of the weir in reducing the liability to flood to which some of the low-lying districts in Manchester were previously subject, I may add that observations of the recent flood line from Agecroft downwards, on the 17th October last showed that the flood was at the same height at the Douglas-green Weir, Agecroft, as the flood of December, 1880, when Lower Broughton was flooded and great damage done. The water on the 17th October at Lower Broughton was, however, 6ft. lower than during the flood of 1880, and at the crest of the Throstle Nest Weir was only 1ft. above the low-water level. The increased speed of the current, combined with special dredging, is also rapidly lowering the river bed, and thus creating a much larger sectional area in the river, with a consequent increased discharging power, so that the new weir, which Alderman Hopkinson, the ex-mayor, has referred to as a practical solution of the flood question by which the whole county might profit, is giving more relief now than it did when first opened.

In the coal trade the threatened strike is keeping up a considerable inquiry for forward delivery at present rates, but there is no actually great pressure upon the market, and except that sellers, where they have been taking orders at under list rates, are stiffening up to full quotations, no materially higher prices are being obtained. All classes of round coal are moving off freely, but the most noticeable feature is the increased demand for slack, which for some time past has been a drug in the market, but which is now going off without difficulty, many of the stocks having already been cleared away. At the pit mouth prices average 9s. 6d. to 10s. for best coals, 7s. 9d. to 8s. for seconds, 5s. 6d. to 6s. 6d. for common coals, 4s. 6d. to 5s. for burgy, 3s. 9d. to 4s. 3d. for best slack, and 3s. to 3s. 3d. for common sorts.

Shipping is quiet, with Lancashire steam coal not averaging more than 7s. 6d. to 7s. 9d. delivered at Garston or Liverpool.

It is expected that in West Lancashire the miners will send in their notices for an advance of 15 per cent. at the close of the present week, but that they will cease work when these notices expire is considered very doubtful.

Barrow.—I notice that very little business is being done in the hematite pig iron trade, and makers are receiving but few good orders. The business being transacted on both home and foreign account is not extensive, and there are no signs of an early change in the state of the market. The stocks warehoused at makers' yards have become very considerable, and are accumulating rapidly, as the deliveries are by no means equal to the output of metal, which up the present has been well maintained. I think that if the present bad trade continues much longer—and there is every sign of it doing so—it will be absolutely necessary for makers to blow out one or two furnaces and thus reduce the output. Prices remain very low, indeed they are now so low that makers do not realise any profits on their sales. A few buyers are offering orders at lower prices than those now ruling; but of course it cannot be expected that the makers will accept them. Although there is certainly, I think, this week a cheapening tendency all round, prices remain steady. No. 1 Bessemer is selling at 48s. per ton; No. 2, 47s.; and No. 3, 46s. per ton net at works, prompt delivery. Steel makers have been so far well employed, but they are not obtaining many large orders. The output in the rail and merchant departments has been large, and there are some good contracts on the books. The demand for mild steel has improved, and there is every prospect of this trade becoming one of great importance in the district. Rails are quoted at from £4 10s. to £5 per ton net. Shipbuilders are but indifferently employed, and there are but few inquiries. Iron ore is in fair demand at from 9s. to 11s. 6d. per ton at mines; stocks are heavy all round. Coal and coke steady, with a tendency to higher prices. Shipping quiet, with a scarcity of orders.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

An interesting gathering took place at the Atlas Steel and Iron Works, Sheffield—Messrs. John Brown and Co., Limited—on Monday last. Mr. J. D. Ellis, the chairman of the company, invited the puddlers and other ironworkers—indeed, the whole of their employés—to meet him in the No. 2 planing shop. About 1000 workmen—not one-third, as by a curious telegraphic error it appeared in the *Times*—accepted the invitation. There a mass of piled-up plates forming a platform, from which Mr. Ellis addressed a meeting under unusual and even picturesque surroundings. Perched upon Nasmyth hammers, peering through machinery, leaning against armour-plates, momentarily resting from the cut of the plane, and looking down from cranes high overhead were the men, while in front of them, on a lesser pile of plates, were Mr. Ellis's colleague in the management, Mr. S. Burridge, and a small army of managers and other officials.

Mr. Ellis's object was to put before the men the present position of affairs in regard to the threatened strike. After showing by figures that the coalowners could not possibly give the miners the 15 per cent. advance, he intimated that it was first feared it would be necessary to give the whole of the employés notice to leave their work. But, on second thoughts, they had decided not to take this step, but to put the men in possession of the precise condition of affairs, and tell them frankly what might be expected. The company had resolved to carry on its business as well as it could, and with that view they were buying coal in other districts so as to enable them to complete contracts to some extent. But they were paying a higher price for the coal; and it was not so good as their own. They would be unable to find full employment for the men—probably not half work—and he counselled them to make as much money as they could before the strike started, and to be prudent in the use of it while the miners were idle. Mr. Ellis stated that in low-priced iron, such as ship plates and boiler plates, a higher price for coal would cause that trade to leave Sheffield, and in such an event he did not believe it would ever come back again. The question of coal was more important as to iron than as to steel, but they could not make tires and axles without coal. At the moment the Germans were pushing tires into England and Scotland at a price which made it very difficult to compete with them. An addition of 15 per cent. upon the present price of coal would drive away a very considerable amount of the tire and axle and steel plate trade of Sheffield. Mr. Ellis closed by counselling the workmen if they had any influence with the colliers to use it in averting such a calamity, and his advice was well received.

Appearances, however, point to the strike taking place. Mr. B. Pickard has undoubtedly the ear of the men, who have sent in their notices with a unanimity which has rarely been seen in this district. The employers published a *verbatim* report of their conference with Mr. Pickard, Mr. Frith, Mr. Cowey, Mr. Parritt, and other officials and delegates, and circulated it among themselves. It would have done more good to have distributed that report among the miners. Not a single reason urged for the advance was sustained; in fact, there was no argument whatever on the side of the colliers' representatives, while the coalowners urged abundant cause why an increase in prices was not only not warranted, but would in the end injure none so seriously as the working man by driving trade out of the country; and yet the coalowners were content with circulating this report among themselves, when the perusal by the miners would have caused them to reflect before they drew out their tools in December. The coalowners are to hold another meeting at Sheffield on Monday, and there may yet be time to put the main facts in form for general distribution.

Prices are still tending downwards in iron and steel. In 1880 hematite pig iron was sold at £6 10s. to £7 per ton; now it is 52s. 6d.; common forge iron, which was then 65s. to 70s. per ton, is now 40s. to 42s.; foundry iron is 43s., 44s., and 45s. per ton; rails, now at £4 10s. to £4 16s. at works, were £16 to £20 per ton a few years ago; boiler plates—iron—are as follows:—B. quality, £8 per ton; B.B., £9; B.B.B., £10 10s.; steel boiler plates, £10 10s., all at works.

For railway material, as wheels, &c., there has been a fair demand of late. The Great Eastern Company has divided 500 sets of wheels between Messrs. Owen and Dyson, Rotherham, and the Leeds Wheel Company, Leeds; the Great Northern Railway Company has placed 400 sets of wheels with the Darnall Carriage Works, Sheffield—Messrs. Craven Brothers; and the Midland Company has given the order for 500 sets of wheels to the Ashbury Carriage Company, Manchester.

An order for 20,000 tons of steel rails for the London and North-Western Railway Company has been taken by a South Wales firm. The United States Government have at last decided, after testing compound armour and steel plates, in favour of compound armour for the turrets and look-out towers of the Miantonomah, and have placed the order with the Atlas and Cyclops Works.

The lighter departments are well employed on Christmas orders. Sheep shears are freely ordered for the United States, and there is an expectation that the Australian indents, which are expected every day, will be pretty gratifying. The Cape trade is scarcely worth mentioning. An order or two drops in occasionally, but nothing to indicate any decided improvement for a long time. The disastrous effects of the diamond speculations are still severely felt.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

Notwithstanding that prices were again lower at the Cleveland iron market held at Middlesbrough on Tuesday last, only a small amount of buying and selling was done. It is said that but few pig iron smelters can make a profit at the prices now obtainable, and, as a rule, only small quantities are offered for sale at the low rates. On Tuesday merchants were willing to sell No. 3 G.M.B. at 37s. 1½d. per ton for prompt delivery, but asked 37s. 3d. for forward delivery. The usual quotation by makers was 37s. 6d., but some were not above accepting orders at 37s. 3d. per ton. The demand for No. 4 forge iron is not so great as it was. The price usually quoted was 36s., but the sales actually made were mostly at 35s. 9d.

There is nothing doing in warrants, as makers' iron can be had at lower rates.

The stock of Cleveland pig iron in Messrs. Connal's Middlesbrough store amounted, on Monday last, to 63,895 tons, being a reduction of 650 tons for the week.

The shipments of pig iron from the Tees continue excellent. Large quantities are being sent to Germany and other foreign countries. Up to Monday night 70,793 tons had been exported. In the first nineteen days of October 59,045 tons; in November, 1882, 37,901 tons were sent away in a corresponding period of time.

The manufactured iron trade is in a fairly steady condition, most of the works having orders which will keep them going to the end of the year. For prompt delivery prices are fully maintained, and are about as follows:—Ship plates, £6 per ton; shipbuilding angles, £5 12s. 6d.; and common bar iron, £5 15s., all free on trucks at makers' works, less 2½ per cent. Puddled bars are £3 12s. 6d. per ton net at works. For forward delivery makers are not willing to take lower rates, and consequently no business is done. Orders for steel rails are very scarce, and ordinary sections can be bought for £4 5s. per ton.

The North-Eastern Railway Company has decided to open the Loftus and Whitby Railway for passenger and goods traffic on Monday, December 3rd.

It is reported that the Weardale Iron and Coal Company is about to put down new plant at the Tudhoe Ironworks for the manufacture of steel on a large scale.

A company has been formed at Sunderland for starting a new shipbuilding yard at South Hylton. It is said that a capital site has been obtained nearly opposite the yard of Messrs. Obourne, Graham, and Co., and that a start will be made early in the new year.

Messrs. G. K. Smith and Co., iron shipbuilders and repairers, of North Shields, filed their petition at the Newcastle Bankruptcy Court on Friday last. The liabilities are £10,250, and assets about £1000.

Another mass meeting of ironworkers was held at Stockton on Monday last, when an address on "Organisation" was delivered by Mr. Lloyd Jones. The following resolution was unanimously carried:—"That organisation is an absolute necessity for working men in a defence of the interests of labour, as without such organisation nothing effectual can be done to secure proper wages to the worker, and to enforce such other conditions as will bring independence and comfort to the working population of the kingdom."

The failure is announced of the Vulcan Ironworks Company, Limited, which succeeded to Messrs. Fowler and M. Colon, formerly engineers, at Hull. Mr. Peat, of the firm of R. Mackay and Co., has been appointed receiver. It is not yet known what are the liabilities. The company in making an announcement to the above effect says that its principal losses have been incurred in the shipbuilding branch of its business.

The North-Eastern Railway Company has given notice that it intends to ask for parliamentary powers to purchase all the private lines of railway hitherto belonging to the Middlesbrough owners, or in other words, to the Pease family. These railways form a network connecting all the works and wharves on the south bank of the Tees, from near Newport to Cargo Fleet. When some years since it was proposed to invite the Midland Railway Company to extend its line to Middlesbrough it was part of the scheme to form a connection between the new line and the network of the lines in question. This was the only feasible way of giving a new access to most of the existing works. The North-Eastern Railway will, by its proposed action, put a stop to the Midland and all other schemes which might in future compete with it, and will place the district more completely than ever in its power. An early meeting will take place of the Marshowners to consider their interests, and petition Parliament against the new Bill, unless satisfactory conditions can in the meantime be obtained.

The death of Sir C. W. Siemens has produced universal regret in Cleveland, where he was well known and highly esteemed.

The collapse of the mining village of Boosbeck, in Cleveland, owing to subsidence of the surface produced by mining operations, is giving rise to an extensive crop of litigation. The surface owners are in all cases plaintiffs, and Mr. C. Jackson, land and mineral owner, and Stevenson, Jaques, and Co., lessees of the mine, are defendants.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

The warrant market, which improved considerably towards the close of last week, has been scarcely so strong this week as regards the quotations, but a large quantity of warrants changed hands. The low prices which existed at the beginning of last week induced a series of covering operations on the part of bears, and there has been at the same time more inquiry than usual from members of the outside public desirous of speculating in pig iron. Three blast furnaces have been re-lighted at Gartsherrie and one at Govan Ironworks, and there are now 101 in operation, producing on an average about 200 tons each a week, as compared with 114 at the corresponding date last year. The stock of pigs in Messrs. Connal and Co.'s Glasgow stores continues to decline, the reduction for the past week being upwards of 1000 tons. The general impression also is that makers' stocks are being slightly reduced, but this process has not as yet been found so effective as to free makers' iron from the depressing influence of the warrant market.

Business was done in the warrent market on Friday at 44s. cash. On Monday forenoon the market was dull, with transactions at 44s. 3d. to 44s. 1½d. cash, and 44s. 5d. to 44s. 4d. one month, the quotations in the afternoon being 44s. 1½d. to 44s. cash, and 44s. 3½d. to 44s. 2d. one month. A good business was done on Tuesday from 44s. 4d. to 44s. 4½d. and 44s. 3d. cash, and 44s. 6d. to 44s. 5d. one month. Business was done on Wednesday at 44s. 5d. to 44s. 2d. cash, and 44s. 7d. to 44s. 3½d. one month. To-day—Thursday—transactions occurred at 44s. 2d. to 44s. 5d. cash, and 44s. 7d. one month.

The quotations of makers' iron are again somewhat easier as follows:—Gartsherrie, f.o.b. at Glasgow, per ton, No. 1, 53s. 3d.; No. 3, 50s. 6d.; Coltness, 56s. and 51s. 3d.; Langloan, 56s. and 51s. 3d.; Summerlee, 55s. and 49s. 6d.; Chapelhall, 54s. and 51s.; Calder, 56s. and 47s. 6d.; Carnbroe, 53s. 6d. and 48s.; Clyde, 48s. 3d. and 46s. 3d.; Monkland, 45s. 9d. and 43s. 6d.; Quarter, 45s. 6d. and 43s. 6d.; Govan, at Broomielaw, 45s. 7d. and 43s. 9d.; Shotts, at Leith, 56s. and 53s.; Carron, at Grangemouth, 49s. (specially selected, 56s. 6d.) and 47s. 6d.; Kinneil, at Bo'ness, 48s. and 47s.; Glengarnock, at Ardrossan, 53s. 3d. and 46s. 3d.; Eglinton, 46s. 9d. and 44s.; Dalmellington, 48s. and 46s. 6d.

The total import of Cleveland pig iron into Scotland to date is 235,243 tons, showing an increase of 27,781 tons as compared with the arrivals in the corresponding period of 1882.

A somewhat gloomy view is now being taken of the condition of the malleable iron trade. Several firms in the central districts of Lanarkshire are now reported to be engaged upon their last orders, with little or no prospect of securing others that will at all equal them in importance. The want of fresh contracts in the shipbuilding department is severely felt at the malleable works, and unless an improvement occurs in the demand for other articles, there can be little doubt that a period of slackness will ere long have to be encountered. Makers complain much of extreme competition, and it is pointed out that the prices are from this cause gradually declining, the decrease in the prices of angles, plates, &c., in the past ten months being something like 10s. to 15s. per ton. The mild steel trade will be likely to suffer to a considerable extent from the quietness in shipbuilding, although the development of the steel works proceeds with scarcely any interruption.

The thick fogs that prevailed during the greater part of last week had a tendency to check the business in coals, by throwing the railway traffic into confusion, but a large amount of business has nevertheless been done. Among the quantities despatched were 1500 tons to Gothenberg, 1200 to Lisbon, 1070 to Demerara, 1650 to Odessa, 500 to Rouen, and 5912 coastwise. The inland trade is active, and as yet the recent advances in prices are fully maintained.

The sixth annual report of the committee entrusted with the large fund subscribed to relieve the dependents of men who lost their lives in the memorable explosions at High Blantyre Collieries was presented to the public meeting of subscribers in Glasgow a few weeks ago. It stated that there are still 245 persons dependent on the fund, that there has been spent since the first £21,461, and that the committee have still in hand £35,243.

The miners in the Lanarkshire district are now quietly working at the late increase in their wages of 6d. a day; but the movement seems to be spreading both on the East and West Coasts. In Ayrshire it has been resolved to form a union, and in East Lothian the miners have commenced an agitation for increased wages, and the question appears to be as far from settlement in Fife as ever.

The boilermakers of Greenock propose to reduce the wages of their men by 5 per cent.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

The mineral world of Wales was electrified this week by the announcement that the Marquis of Bute had bought the Glamorgan Canal. This is the oldest undertaking of the early coal days, dating from 1790, and was an enterprise undertaken by all the old ironmasters—Crawshay, Guest, Paitt, Cockshutt, and Farman, with a few of the landed proprietors, the banker Wilkins, and the old Vicar Meybery. It has done good service, and if served by small steamers, and the banks secured from the "wash," as on the Berkeley Canal, might yet figure well; but I imagine that the outlet of the canal at the West Mud, Cardiff, will figure in its new era more conspicuously than the canal itself, and that docking the West Mud to the mouth of the Ely will prove an effectual preventive to all Barry Dock schemes. So far, however, as I hear, the promoters of the Barry are bent upon their suicidal course. They will take their coal traffic twelve miles away from Cardiff, come what will.

The committees of the Houses of Lords and Commons will have the Darwinian principle of selection to carry out most carefully next session, and to restrain any reckless schemes which may be propounded in this age of lust for coal. No less than eight schemes are now being prepared that will impinge on the Taff! Some of these are excellent, skilfully designed, and will be supported by as much common sense as capital. Others appear visionary, and dictated by a greater desire to have a share of profit than to aid in public convenience or the development of our mineral resources. It is here that committees of both Houses will do good work—the pace may be too fast for the country's welfare.

I have never known such a fever heat as in the coal trade at present, and the pressure is something enormous. Here is a sample of work at one of the Rhondda collieries—the Clydach Vale:—This is sunk 400 yards down; it is worked upon an average fifty-one hours per week, and every working hour 200 tons of magnificent coal are sent to bank. The area of this pit is not a very large one; but even if of good size, such an output would soon tell. I give ten years again for many of the Rhondda pits, and after that, lower coals and much more expensive working.

The colliers are delighted with their sliding-scale results, and have now warmly supported the farthing movement in aid of the Cardiff College. In this way, and kindred ways, these excellent institutions—the sliding scale, the Association, and the Permanent Fund—are acting on social life, and without sermonising one may say that moral and social benefit will be the result. I should like to see a general Colliers' Building Fund started. It was suggested, I think, by Mr. Nixon—every collier to become possesser of his own house, thus securing the maintenance of pleasant relations between employer and employed, and leaving the widow the homestead after him.

The thirst for coal property is excessive. I hear of no less than five takings during the last week in Monmouthshire alone on the branch of the projected line—the Risca and Cardiff—a capital projection. Here we have an instance of railway speculation, prompting well in mineral enterprise, not following as is generally done. The anthracite colliers have had an advance of 5 per cent. They now work by sliding scale. Both house and steam colliers are agitating for an increased number of sub-inspectors.

I have no good news to record in the matter of iron and steel. Trade is still dull; iron ore is a drug, and low prices fail to tempt.

At the Rhymney Works I regret to hear of a breakage entailing some cost, but fortunately it will only keep the works idle a few days.

Cyfarthfa is being pushed on with rare spirit. There is an enormous outlay going on, quite in the spirit of the old Crawshay character, which would be first or nothing.

Very sincere regret is felt at the loss of Dr. Siemens, who died this week, just on the eve of the banquet to be given in his honour. He did good work in Wales, and realised the anticipations expressed in these columns when he began at the Landore Works in 1868. These works now manufacture 1000 tons of steel per week, and take high rank in the country generally.

Tin-plate is drooping again, all but best steel plates, which are in demand. Wire works are fairly busy again.

Pitwood prices are high, and maintained well. Coal prices firm, ranging from 11s. 3d. to 11s. 9d. best, f.o.b.

Iron prices low, and but little doing out of old contracts, which are running to an end. Better figures are hoped for with the new year.

Last week on the Birkenhead side of the river the boring machine in the Mersey tunnel excavated thirty-two yards, thus exceeding all previous efforts by four or five yards. The centre of the bed of the river has been passed some days, and the progress forward on both sides has been such as to reduce the distance to be bored between the extremities of the two tunnels to something under 290 yards.

THE PATENT JOURNAL.

Condensed from the Journal of the Commissioners of Patents.

*** *It has come to our notice that some applicants of the Patent-office Sales Department, for Patent Specifications have caused much unnecessary trouble and annoyance, both to themselves and to the Patent-office officials, by giving the number of the page of* THE ENGINEER *at which the Specification they require is referred to, instead of giving the proper number of the Specification. The mistake has been made by looking at* THE ENGINEER *Index, and giving the numbers there found, which only refer to the pages, in place of turning to those pages and finding the numbers of the Specification.*

Applications for Letters Patent.

***** When patents have been "communicated," the name and address of the communicating party are printed in italics.**

13*th November*, 1883.

5347. HATS, &c., J. H. Johnson.—(*C. H. Wilcox, U.S.*)
5348. BRIDGES, W. R. Kinipple, London.
5349. PIPES for COMMUNICATING FLUID PRESSURE to BRAKES, C. D. Abel. (*G. Westinghouse, jun., U.S.*)
5350. NUT LOCK, A. M Clark.—(*H. Schwarzwalder, U.S.*)
5351. LOWERING, &c, SHIPS' BOATS, C. J. Fox, Birkenhead.
5352. PNEUMATIC POWER HAMMERS, W. D. Player, Birmingham.
5353. GENERATORS for PRODUCING GASEOUS FUEL, J. Lones, C Vernon, E. Holden, and R. Bennett, Smethwick.
5354 UMBRELLAS, C. H. Butlin, Camborne.
5355 TREATMENT of SULPHUROUS, &c., ORES, B. J. B. Mills.—(*P. Manhès, Lyons.*)
5356. MANUMOTIVE VELOCIPEDES, W. P. Thompson.—(*S. Krnka, Michle, Austria*)
5357. HYDROCARBON FURNACES, A. J. Boult.—(*O. D. Orvis, Chicago, U.S.*)
5358. WOOL OILING MACHINES, J. L. Mathews, West Troy, U.S.
5359. EXTRACTING COBALT, &c., from their ORES, J. B Readman, Glasgow.
5360. STEEL INGOTS, C A. Day.—(*G. W. Billings, U.S*)
5361. MANUFACTURE of AMMONIA, &c., W. R. Lake.—(*T. B. Fogarty, Brooklyn, U S.*)
5362. LOOMS for WEAVING, W. R. Lake.—(*W. Brown and T. Lang, West Point, U S.*)
5363. TREATING CALCAREOUS PHOSPHORITES, W. R. Lake—(*J. Cox, Mulheim-on-the Rhine*)
5364. CUTTING, &c., TROUSERS, A Maclure, jun., London.
5365. AUTOMATIC EXPANSION GEAR, F. J. Burrell, Thetford.
5366. SELF-REGULATING MECHANISM, H. B. Payne, Nottingham.

14*th November*, 1883.

5367. STEEL, W. Beardmore and J. MacC. Cherrie, Glasgow.
5368. ROPES, G. E. Vaughan.—(*S. Trott and F. A. Hamilton, Halifax, U S*)
5369. AUTOMATIC FOG SIGNALLING, O. W. White and W. Sinclair, London.
5370. BORING TAPER HOLES, R Letherby, Barnstaple
5371. PRIMARY, &c, BATTERIES, J. Noad and R. Matthews, London.
5372. CAR COUPLINGS, H. J. Haddan.—(*J. W. Snyder, Pennsylvania, U.S.*)
5373. CONTROLLING ENGRAVING TOOLS, H. J. Haddan.—(*Bain Electric Company, Chicago, U.S*)
5374. PUMPS, G Murray and R. Turnley, Elvaston.
5375. PROTECTING SUBMERGED STRUCTURES, F. M. Lyte, Putney.
5376. PARING the EDGES of the SOLES of BOOTS and SHOES, F. Cutlan, Cardiff.
5377. LAMP GLOBES, F. and H. Biertumpfel, London.
5378. WIRE FENCES, W. R. Lake.—(*J. B Oliver, U.S*)
5379. DEODORISING FOUL AIR, J. F. Johnstone, Belvedere.
5380. BESSEMER CONVERTERS, W. M. Murdock, Gilwern.
5381. HYDRAULIC LIFTS, J. H. Johnson.—(*H. M. L. Crouan, Paris*)

15*th November*, 1883.

5382. COMPOUND MARINE ENGINES, W. B. Thompson Dundee, N.B.
5383. TEMPERING BOBBINS, H. S. Boase, Dundee, N.B.
5384. STEERING BOATS, T. B. Heathorn, London.
5385. EXHAUST VENTILATORS, W. Walker, Birkenhead.
5386. COMBS, W. H. Spence.—(*L. M. Chorier, Paris.*)
5387. PREPARING RAGS R Buckle, Shipley.
5388. BLINDS, H. A. Goodall, London.
5389. STEERING GEAR for SHIPS, W. H. Harfield, London, and G. T. Burden, Newcastle-upon-Tyne.
5390 SEWING MACHINES, T. J. Denne, Selhurst.
5391. HINGED DOORS, &c., J. Warhurst, London.
5392. MAKING CIGARETTES, R. W. Page, London.
5393. METALLIC TUBULAR COILS, T. B. Sharp, Smethwick.
5394. SEWING MACHINES, J. Imray.—(*S. Y. Love, U S.*)
5395. PUMPS, J. Imray.—(*G. Hanarte, Mons, Belgium*)
5396. HEELS for BOOTS, &c., W. H. Stevens, Leicester.
5397. DRILLS, J. Harrington, Coventry.
5398. DRYING APPARATUS, C. F. C. Morris, T. H. Baker, and W. Francis, London.
5399. STEAM ENGINES, A. M. Clark.—(*A. Eberhart, Philadelphia, U.S*)
5400. TELEPHONE APPARATUS, M. Kotyra, Cardiff.
5401. MACHINES for CUTTING NAILS, G. Williamson, Holbeck, Leeds.
5402. SEPARATING DUST from AIR, R. Lund and T. F. Hind, Preston.
5403. PROPELLING SHIPS, W. Lockwood, Sheffield.

16*th November*, 1883

5404. COMMUNICATING MOTION to SHAFTS, W. Ross, London.
5405 STEERING GEAR, J. Hastie, Greenock.
5406. GAS MOTOR ENGINES, G. G. Picking and W. Hopkins, London.
5407. OBTAINING COPPER, A. P. Price, London.
5408. MAGNETO-ELECTRIC, &c., MACHINES, G. Hookham, Birmingham.
5409. WIRE NETTING, H. J. Haddan.—(*E. Kretschmann, Leipzig, Saxony.*)
5410. UMBRELLAS, H. J. Haddan.—(*Knauth and Co., and R. Geisler, Leipzig, and W. Jaedicke, Berlin*)
5411. PETROLEUM HEATING APPARATUS, R. Schulz, Dresden.
5412. MOUNTS for GLASSES, &c., J. Dawson and T. F. D. Heap, London.
5413. RETAINING STUD for NECKTIES, &c., J. Dalziel, Glasgow.
5414. BEDS, J G. Davison, Sunderland.
5415 LAWN MOWERS, G. W. Carr.—(*Messrs Carr and Hobson, Limited, New York, U.S.*)
5416. PRODUCTION of ZINC, A. P. Price, London.
5417. PRIMARY VOLTAIC BATTERIES, D. G. Fitz-Gerald and T. J. Jones, London.
5418. UNTEASELING WOOLLEN FIBRES, W. A. Barlow.—(*T. Overend, Paris.*)
5419. MAGNETIC, &c., APPARATUS, S. Mason and C. R. Huxley, London.

17*th November*, 1883.

5120. TOOL HOLDERS for LATHES, M. C. Despard.—(*G. S. Jones, Cawnpore, India.*)
5421. CLOSET PAN, E. Hurley, Birmingham.
5122. DYNAMO-ELECTRIC MACHINES, Sir C. T. Bright, London.
5423. DREDGING MACHINERY, W. E. Gedge.—(*H. B. Angell, San Francisco, U.S.*)
5424. AUTOMATIC SALE, &c., of CIGARETTES, W. P. Keeson, London.
5125. AUTOMATIC FEEDING of BOILERS, A. Mayhew, London.
5126. CLOSING DOORS, &c, E. Leinert, Dresden.
5427. DISCHARGING VESSELS CONTAINING LIQUIDS, H. L Orr, Belfast.
5428 SULPHURETTED HYDROGEN, D. Urquhart, London.
5429. LIGHTING RAILWAY TRAINS by ELECTRICITY, E. Edwards.—(*D. Tommasi, Brussels.*)
5430. USING STEAM and HOT AIR COMBINED, W. Turnbull, New Hampton.
5431. STEAM ENGINES, W. P. Thompson.—(*F. D. Cumnver, Detroit, U.S*)
5432. FIRE-SCREENS, &c, A. Hildesheimer.—(*E. Nister, Nuremberg, Bavaria.*)
5433. VELOCIPEDES, E. C. F. Otto, London.
5434 SANITARY APPLIANCE, W. A. Barlow.—(*E. Sandow, Hamburg*)
5435. TRANSMITTING MOTION to MACHINERY. P. A. Dobis, Paris.
5436. TREATING WASTE MATERIALS, G. Epstein, London.
5437. FILTER PRESS PLATES, J. Pedder, Appleton-in-Widnes.
5438. VENTILATING APPARATUS, T. E. Bladon and W. Matthews, Birmingham.
5439. BICYCLES, &c., J. Bradshaw and J. Bradshaw, jun., Wigan.
5440. ROLLERS for MILLS, W. R. Lake.—(*F. Prokop, Pardubitz, Bohemia*)

19*th November*, 1883.

5441. STOPPERING BOTTLES, G. C. and A. G. Thompson, Sheffield.
5142 PIANOFORTE ATTACHMENT, H. J. Haddan.—(*E. Höfinghoff, Barmen, Germany.*)
5443. PRESSURE GAUGES, H. J. Haddan.—(*L. Carton, El Kseur, Algeria.*)
5444. EXAMINING the GERMINATIVE PROPERTIES of GRAIN, H. J. Haddan.—(*O. Coldewe and L. Schönjahn, Brunswick, Germany.*)
5445. INTERNALLY STOPPERED BOTTLES, D. Rylands, Stairfoot, near Barnsley.
5446. FACILITATING the COUPLING of DRAW-BARS, G. W. von Nawrocki.—(*P. Madsen, Berlin*)
5447. TELEPHONES, C. A. Jackson, Laurence, U.S.
5448. TELEPHONIC APPARATUS, H. H. Lake.—(*J. Berliner, Hanover.*)
5149. ASCERTAINING LEVELS, A. J. Boult.—(*C. C. Goetze, Cöthen, Germany.*)
5450. ORGANIC BASES, J. H. Johnson.—(*A. Kern, Basle.*)
5451. ALARMS, A. M. Clark.—(*C. F. Luquer, U.S.*)
5452. SMELTING ORES, &c, S. R. Smyth, London.

Inventions Protected for Six Months on Deposit of Complete Specifications.

5350. NUT LOCK, A M. Clark, Chancery-lane, London.—A communication from H. Schwarzwalder, New York, U S—13*th November*, 1883.
5358. WOOL OILING MACHINES, J. L. Mathews, West Troy, U.S.—13*th November*, 1883.
5362. LOOMS for WEAVING, W. R. Lake, Southampton-buildings, London.—A communication from W. Brown and T. Lang, West Point, U.S.—13*th November*, 1883.

Patents on which the Stamp Duty of £50 has been paid.

4751. TREATMENT of MAIZE, E. R. Southby, London.—18*th November*, 1880.
4670. SEWING MACHINERY, W. H. Dorman, Stafford.—12*th November*, 1880.
4682. GRINDING WIRE ENDS, G. Etty, Manchester.—13*th November*, 1880.
4693. EXTRACTING OILY MATTER from COTTON WASTE, C. T. Bastand, London.—13*th November*, 1880.
4756. WIRE SPRING MATTRESSES, J. B. Rowcliffe, Glossop—18*th November*, 1880.
4846. COLOURING MATTERS, O. N. Witt, Mülhausen, Germany.—22*nd November*, 1880.
4869. SULPHATES of SODA, &c., J. Hargreaves and T. Robinson, Widnes.—24*th November*, 1880.
5232. TUBE FASTENINGS, E. H. Bennett, Bayonne, U.S.—14*th December*, 1880.
4630. MEASURING MILK, &c, J. Wilson, London.—13*th November*, 1880.
4709. CAST IRON SLAG BOXES, M. and J. Cornthwaite, Parton.—16*th November*, 1880.
4767. TRICYCLES, &c, H. Weatherill, Manchester.—19*th November*, 1880.
5007. MARINERS' COMPASSES, J. Readman, Norton.—1*st December*, 1880.
4697. RUBBING APPARATUS, W. H. Beck, London.—15*th November*, 1880.
4721. SYRUPING, &c., AERATED LIQUORS, W. A. Ross and F. Lockhart, Belfast.—16*th November*, 1880.
4928. GLOVES, H. Urwick, London.—26*th November*, 1880.
4972. FIRE-GRATES, A. C. Engert, Bromley-by-Bow.—29*th November*, 1880.
5152. ELECTRIC DRILLS, S. Pitt, Sutton.—9*th December*, 1880.
4706. CLOTH, S. Thacker, Nottingham.—15*th November*, 1880.
4718. CONDENSING or COOLING, J. H. Johnson, London.—16*th November*, 1880.
4842. LOOMS for WEAVING CARPETS, W. Adam, Kidderminster.—22*nd November*, 1880.
5107. STEAM PUMPS, G Tangye Birmingham, and T. Jefferies, jun., and J. R. Williams, Handsworth.—7*th December*, 1880.
5287. SULPHATE of ALUMINA, B. E. R. Newlands, London.—17*th December*, 1880.
4722. BRICKS, F. Wirth, Frankfort-on-the-Maine.—16*th November*, 1880.
4725. PIANOFORTES, A. Capra, J. B. Rissone, and S. Detoma, London.—16*th November*, 1880.
4752. CUTTING, &c., STONE, J. Holgate, Burnley.—18*th November*, 1880.
4819. GAS ENGINES, H. L Müller and W. Adkins, Birmingham.—20*th November*, 1880.
4757. TRAM-CAR ENGINES, J. Hall, Manchester.—18*th November*, 1880.
4759. SUPPLYING FURNACES with FUEL, J. Proctor, Burnley.—18*th November*, 1880.
4770. STEAM SAFETY VALVES, P. M. Justice, London.—19*th November*, 1880.
4771. COUPLING ROLLING STOCK, W. P. Alexander, London.—19*th November*, 1880.
4772. POLISHING METALS, W. J. Clapp, Nantyglo.—19*th November*, 1880.

Patents on which the Stamp Duty of £100 has been paid.

4456. SEWING MACHINES, A. Anderson, Glasgow.—17*th November*, 1876.
4513. SAFETY APPARATUS for the TRIGGERS of SMALL-ARMS, W. Anson, Birmingham.—21*st November*, 1876.
4409. BLAST FURNACES, W. S. Williamson, Congleton.—14*th November*, 1876.
4424. RECEPTACLES for HOUSE SEWAGE, S. S. Hellyer, London.—15*th November*, 1876.
4199 CAST STEEL, J. Ledger, London.—21*st November*, 1876.
4163. CRUSHING, &c., MACHINE, N. G. Kimberly, London.—18*th November*, 1876.
4170. PRINTING INK, R. Pinkney and F. D. Ward, London.—18*th November*, 1876.
4519. CONNECTING SERVICE PIPES with DRAINS, W. Greenhill, Hampton Court.—21*st November*, 1876.

Notices of Intention to Proceed with Applications.

(*Last day for filing opposition*, 7*th December*, 1883.)

3408. PORTABLE OVENS, J. H. Johnson, London.—A communication from L. Dathis.—10*th July*, 1883.
3409. KNEADING DOUGH, J. H. Johnson, London.—A communication from L. Dathis.—10*th July*, 1883.
3422. FIXING COLOURS on FABRICS, A. W. Kirk, Halifax.—11*th July*, 1883.
3425. MAKING CIGARETTES, F. Hipgrave, London.—12*th July*, 1883.
3426. COMBING WOOL, &c., J. H. Whitehead, Leeds.—A com. from A. Prouvost.—12*th July*, 1883.
3436. VENT PEGS, W. E. T. Dawson, London.—12*th July*, 1883.
3443. MOVABLE GUIDE WHEEL, A. J. Boult, London.—A communication from J. M. Terras.—12*th July*, 1883.
3444. ELECTRIC LIGHTING APPARATUS, J. L. Clerc, London.—13*th July*, 1883.
3447. VACUUM BOXES, H. Marsden and H. Schofield, Sheffield.—13*th July*, 1883.
3448. PICKERS, J. Holding, Lower Broughton.—13*th July*, 1883.
3449. COUPLING, &c, RAILWAY CARRIAGES, &c., J. Darling, Glasgow.—13*th July*, 1883.
3451. ELECTRIC BATTERIES, P. de Villiers and E. F. Rey, London.—13*th July*, 1883.
3452. SECONDARY BATTERIES, F. M. Lyte, London.—13*th July*, 1883.
3461. FASTENINGS for GLOVES, &c., F. R. Baker, Birmingham.—13*th July*, 1883
3472. BOOTS and SHOES, H W. H. and E W. Lulham, Brighton.—13*th July*, 1883.
3475. RECORDING, &c., a SUPPLY of ELECTRICITY, J. Hopkinson, London—13*th July*, 1883.
3479. CONSTRUCTING SUBAQUEOUS STRUCTURES, W. J. Bentley, Leeds—14*th July*, 1883.
3483. SCREENING COAL, R. D. Thomson, Motherwell—14*th July*, 1883.
3496. REGISTERING the RECEIPT of FARES in OMNIBUSES, &c., H. H. Lake, London.—A communication from G. Marzari.—16*th July*, 1883.
3502 ROTARY WEB PRINTING MACHINES, G A. Wilson, Liverpool.—17*th July*, 1883.
3503. ROTARY WEB PRINTING MACHINES, G. A. Wilson, Liverpool.—17*th July*, 1883.
3510. CONSTRUCTING WEIGHING MACHINES, E. Thomas, Aberdare.—17*th July*, 1883.
3521. WATER-WHEELS, A. J. Barlow, London.—A communication from F. Pallansch.—17*th July*, 1883.
3541. CANS for MILK, &c., W. R. Lake, London.—A communication from E. Burnett and A. P. Browne.—18*th July*, 1883
3563. BARRELS for HOLDING LIQUIDS, C. L. Eyre, London.—A com. from G Spofford.—19*th July*, 1883.
3603. MAKING TURNBUCKLES, &c., A. W. L. Reddie, London.—A com. from E. Merrill.—23*rd July*, 1883.
3609. PIANOFORTE ACTIONS, C. Collard, London.—23*rd July*, 1883.
3614. ARTIFICIAL MARBLE, J. Heinemann, Hanover.—A com. from Dr. H. Rothe.—23*rd July*, 1883.
3631. STEAM CULTIVATION, A. Greig, Leeds.—24*th July*, 1883.
3652. TREATING COMPLEX ORES, W. P. Thompson, Liverpool.—A communication from G. T. Lewis.—25*th July*, 1883.
3743. LOOMS for WEAVING, W. Houghton and E. Knowles, Gomersal, and H. Bradbury, Leeds.—31*st July*. 1883.
3744. FURNACES for CARBONISING WOOLLEN RAGS, W. Brierley, Halifax.—A communication from E. Rosskam.—31*st July*, 1883.
3772. CUTTING METALS, W. W. Hulse, Manchester.—1*st August*, 1883.
3785. SETTING, &c, TYPE, W. R. Lake, London.—A com. from P. P. y Albizu.—2*nd August*, 1883.
4043. EXPLOSIVE COMPOUNDS, J. C. de Castro, London.—21*st August*, 1883.
4179. LAMPS for LIGHTING RAILWAY CARRIAGES, J. F. Shallis and T. C. J. Thomas, London.—29*th August*, 1883.
4221. SCENTED CIGARS, &c., J. McGovern, Liverpool.—1*st September*, 1883.
4234. STAMPING CORRUGATED IRON PLATES, R. Baillie, London.—3*rd September*, 1883.
4294. BARRELS of FIRE-ARMS, P. A. Bayle, Paris.—6*th September*, 1883.
4296. STEAM BOILERS, P. A. Bayle, Paris.—6*th September*, 1883.
4691. PIANOFORTE ACTIONS, C. Collard, London.—2*nd October*, 1883.
4787. ELECTRICAL SYNCHRONOUS TELEGRAPHIC SYSTEMS, S. Pitt, Sutton.—A communication from P. B. Delany.—9*th October*, 1883.
4788. TELEGRAPHY, S. Pitt, Sutton.—A communication from P. B. Delany.—9*th October*, 1883.
4812. CATCH for UMBRELLAS, W. P. Thompson, Liverpool.—A communication from V. D. Stockbridge.—9*th October*, 1883.
4829. SEPARATING METALS from their ALLOYS, J. J. Shedlock, Barnet.—10*th October*, 1883.
4830. EVER-POINTED PENCIL CASES, J. Appleby, Birmingham.—10*th October*, 1883.
4843. MAKING GAS, E Brook, Wigan.—11*th October*, 1883.
4879. TREATING GOLD ORES, H. R. Cassel, London.—13*th October*, 1883.
4909. SKATES, A. G. Brooks, London.—A communication from A. Dodge and G. R. Marble.—16*th October*, 1883.
4950. GAUGE GLASSES of STEAM BOILERS, A. M. Clark, London.—A communication from A. Guilbert-Martin.—17*th October*, 1883.
5001. TELEGRAPH INSULATORS, H. J. Allison, London.—A com. from C. C. Hinsdale.—20*th October*, 1883.

(***Last day for filing opposition***, **11*th December*, 1883.**)

2500. AMBULANCE CARRIAGES, &c., R. A. Westhorpe, London.—19*th May*, 1883.
3476. PRODUCING DESIGNS on PAPER, &c., R. Brown, R. W. Barnes, & J. Bell, Liverpool.—14*th July*, 1883.
3487. SOLDERING JOINTS of WIRE, J. T. Neighbour, London.—16*th July*, 1883.
3511. CLOSING, &c., BOTTLES, J. A. Bowles, London.—17*th July*, 1883.
3513. WASHING, &c., MACHINES, T. Woolfall and T. T. Mercer, Blackburn.—17*th July*, 1883.
3517. MAKING FODDER, H. J. Haddan, London.—A com. from H. Hencke and Co.—17*th July*, 1883.
3522. FIXING ANILINE COLOURS on FIBROUS MATERIALS, L. Heppenstall, jun., Milnsbridge.—17*th July*, 1883.
3532. SOUNDING BELLS, C. J. Harrison, Limehouse.—18*th July*, 1883.
3544. REPEATING FIRE-ARMS, W. R. Lake, London.—A communication from the Larsen Rifle Company.—18*th July*, 1883.
3545. FREEZING APPARATUS, J. H Johnson, London.—A com. from E Fixary.—18*th July*, 1883.
3546. MOULDS for REFINING SUGAR, J. Duncan and B. E. R. Newlands, London.—19*th July*, 1883.
3563. FACILITATING BALL PRACTICE with FIRE-ARMS, J. H. Johnson, London.—A communication from E. Gaupillat.—20*th July*, 1883.
3588. CONNECTING ROPES TOGETHER, J. D. Sprague, Upper Norwood.—21*st July*, 1883.
3591. SCOURING, &c., FIBROUS MATERIALS, J. and F. W. Petrie, Rochdale.—21*st July*, 1883.
3601. PURIFYING AIR and GASES, F. Windhausen, Berlin—23*rd July*, 1883.
3630. ORNAMENTAL FABRICS, W. Clark, London.—A communication from E. Barou.—24*th July*, 1883.
3644. VALVES or BUCKETS, J. K. Tullis, Glasgow.—25*th July*, 1883.
3664. GRINDING MILLS, C. Duckering, Lincoln.—26*th July*, 1883.
3678. REFINING OILS, J. Imray, London.—A communication from I. A. F. Bang and C. A. Sanguinetti.—27*th July*, 1883.
3782. TRANSMITTERS for TELEPHONES, T. M. Morriss, London.—2*nd August*, 1883.
3868. SCREW PROPELLERS, L. Barstow, Hazelbush.—9*th August*, 1883.
4003. TELEPHONIC APPARATUS, G. H. Bassano, A. E. Slater, and F. T. Hollins, Derby.—17*th August*, 1883.
4057. COMPOUND METAL or ALLOY, H. H. Lake, London.—A com. from J. B. Jones.—21*st August*, 1883.
4104. HANGING ELECTRICAL LAMPS, T. T. Smith, London.—24*th August*, 1883.
4121. BRUSHES, J. Thompson, London—25*th August*, 1883.
4704. WASHING MACHINES, J. Child, Headingley.—3*rd October*, 1883.
4818. TREATING COPPER MATTES, F. Claudet, London.—10*th October*, 1883.
4826. GRINDING EDGES of TOOLS, A. F. G. Brown, Glasgow.—10*th October*, 1883.
4865. COUPLING SHAFTING, A. Muir, Manchester—12*th. October*, 1883.
4886. CONVERTING FURNACES, W. R. Lake, London.—A com. from P. Manhés.—13*th October*, 1883.
4938. SHAFT COUPLINGS, T. L. Ellis and C. Leonard, Coatbridge, N.B.—17*th October*, 1883.
4943. COUPLING for SHAFTING, P. Brotherhood, London.—17*th October*, 1883.
4944. HEATING STOVE, A. C. Kennard, Falkirk.—17*th October*, 1883.
4961. ELECTRICAL HEATING, J. S. Sellon, London.—17*th October*, 1883.
4971. CUTTING FIBROUS MATERIALS, W. R. Lake, London.—A com. from I. A. Canfield—18*th October*, 1883.
5054. TRACTION ROPE TRAMWAYS, J. Y. Johnson, London.—A com. from A. Bonzano.—24*th October*, 1883.
5268. MOULDING MACHINERY, J. Walker, Cleveland, U.S.—6*th November*, 1883.
5350. NUT LOCK, A. M. Clark, London.—A communication from H. Schwarzwalder.—13*th November*, 1883.
5362. LOOMS for WEAVING, W. R. Lake, London.—A communication from W. Brown and T. Lang.—13*th November*, 1883.

Patents Sealed.

(*List of Letters Patent which passed the Great Seal on the* 16*th November*, 1883.)

2319. SPINDLES of SPINNING FRAMES, D. Skeoch, Stewarton, N.B.—8*th May*, 1883.
2182. ELECTRO-MOTIVE ENGINE, A. Browne, London.—17*th May*, 1883.
2505. CONSTRUCTING HORSESHOES, T. Allen, Bradford.—19*th May*, 1883.
2506. EXTRACTING IRON, &c., from SOLUTIONS, G. W. von Nawrocki, Berlin—19*th May*, 1883.
2511. OBTAINING MOTIVE POWER, A. Vacherot, Sutton.—19*th May*, 1883.
2516. CARRIAGE DOOR LOCKS, J. Holden, Swindon.—19*th May*, 1883.
2528. HOLDERS for INCANDESCENT ELECTRIC LAMPS, A. Swan, Gateshead.—21*st May*, 1883.
2540. NEGRO-POTS, &c., J. Millington, Wolverhampton.—22*nd May*, 1883.
2558. WEIGHING MACHINES, W. P. Thompson, Liverpool.—22*nd May*, 1883.
2559. FEEDING-BOTTLES for BABIES, A. Horne and J. Mancor, Liverpool.—22*nd May*, 1883.
2563. EXTRACTING PARAFFINE from MINERAL OILS, J. Siddeley, Liverpool.—23*rd May*, 1883.
2576. CONSTRUCTING FLOORINGS, &c., J. Garlick, Birmingham.—23*rd May*, 1883.
2599. STOPPERING BOTTLES, W. W. Macvay and R. Sykes, Castleford—24*th May*, 1883
2623. AIR GAS, G. Macaulay-Cruikshank, Glasgow.—26*th May*, 1883.
2633. PROPELLERS for NAVIGABLE VESSELS, N. D. Spartali, Liverpool.—26*th May*, 1883
2682. PULVERISING SUBSTANCES, H. C. Bull, Brooklyn, U.S.—30*th May*, 1883.
2740. BOOTS and SHOES, W. P. Thompson, Liverpool.—1*st June*, 1883.
2741. ELECTRO-MAGNETIC ENGINES, R. W. M. Fraser, London.—1*st June*, 1883.
2792. ROCK-DRILLING APPARATUS, W. P. Thompson, Liverpool.—5*th June*, 1883
3062. PRODUCING INTENSE WHITE HEAT, C. D. Abel, London.—20*th June*, 1883.
3820. TREATING LIQUORS PRODUCED in the AMMONIA-SODA PROCESS, L. Mond, Northwich.—4*th August*, 1883.
3821. GAS GENERATING FURNACES, L. Mond, Northwich.—4*th August*, 1883.
4053. REGULATING FERMENTATION in WORT, &c, W. P. Thompson, London.—21*st August*, 1883.
4127. METAL LATHS, G. M. Edwards, London.—27*th August*, 1883.
4275. LIGHT-FEED LUBRICATORS, W. A. G. Schönheyder, London.—5*th September*, 1883.

(*List of Letters Patent which passed the Great Seal on the* 20*th November*, 1883.)

2315. ENAMELLING CAST IRON, G. J. Rhodes, Wolverhampton.—7*th May*, 1883.
2537. PREVENTING DRAUGHT HORSES FALLING, W. G. Kite, Romford.—22*nd May*, 1883.
2547 SECURING CHESTS of DRAWERS, R. Mander, Birmingham.—22*nd May*, 1883.
2549 TANNIC BLACK, W. G Gard and T. H. Cobley, Dunstable.—22*nd May*, 1883.
2555. HOLDING HATS, A. Pyke, London.—22*nd May*, 1883.
2563. OPENING DOORS by means of ELECTRICITY, G. F. Redfern, London.—22*nd May*, 1883.
2565. FEEDING APPARATUS for CARDING ENGINES, E. Edwards, London.—22*nd May*, 1883.
2570. ELECTRIC ARC LAMPS, P. Jolin and J. Parsons, Bristol.—23*rd May*, 1883.
2574. CONVERTING RECIPROCATING into ROTARY MOTION, H. Burt, Southampton.—23*rd May*, 1883.
2575. ELECTRICALLY INDICATING the MOVEMENTS of TRAINS, E. C. Warburton and R. R. Harper, London.—23*rd May*, 1883.
2577. METALLISING NON-METALLIC SUBSTANCES, C. G. Hammersley, London.—23*rd May*, 1883.
2583. MERCHANT BAR ROLLING MILLS, G. G. M. Hardingham, London.—23*rd May*, 1883.
2597. EMBROIDERING MACHINES, W. E. Gedge, London.—24*th May*, 1883.
2600. TRAMWAYS, A. H. Rowan, London.—24*th May*, 1883.
2619. WINDING, &c., THREAD, J. Boyd, Shettleston.—26*th May*, 1883.
2625. PORTABLE FORGES, W. Allday, jun., Birmingham.—26*th May*, 1883.
2643. STEAM BOILER FURNACES, J. Elliot, jun., and T. A. Cunningham, Dalbeattie.—28*th May*, 1883.
2655 FACILITATING the SINKING of SHAFTS, &c., C. D. Abel, London.—29*th May*, 1883.
2757. MOULDING METALS in DRY SAND, S. E. Seanor and J. Hill, Leeds, and J. Butler, Bradford.—4*th June*, 1883.
2808. PENS, W. Brierley, Halifax.—6*th June*, 1883.
2823. SPINNING SPINDLES, &c., A. M. Clark, London.—6*th June*, 1883.
2831. PNEUMATIC BREECH-LOADING GUNS, T. N. Palmer, London.—7*th June*, 1883.
2855. ELECTRODES used as EARTH PLATES, D. G. Fitz-Gerald, London.—7*th June*, 1883.
2907. MOULDING CARBONACEOUS MATERIALS into BRICKS, J. H. Johnson, London.—12*th June*, 1883.
2993. GALVANIC ELEMENTS, F. Wirth, Frankfort-on-the-Main.—15*th June*, 1883.
3145. SADDLE-CLOTHS, H. H. Lake, London.—25*th June*, 1883.
3337. HORSESHOES, T. H. Heard, Sheffield.—5*th July*, 1883.
3439. LOOMS for WEAVING, T. Hanson, Bradford.—12*th July*, 1883.
3929. ISOMETER or DYNAMIC SECTOR, H. J. Allison, London.—14*th August*, 1883.
3953. BOOTS and SHOES, A. Bowman, Birmingham.—15*th August*, 1883.
3960. CHLORATE of POTASH, E. K. Muspratt, Liverpool, and G. Eschellmann, Widnes.—15*th August*, 1883.
4191. PUMPING APPARATUS, J. A. Wade and J. Cherry, Hornsea.—30*th August*, 1883.
4225. INTERMITTENT COCKS, B. H. Chameroy, France.—1*st September*, 1883.
4276. ELECTRICAL SWITCHES, H. H. Lake, London.—5*th September*, 1883.
4297. HOLDERS for TELEPHONIC INSTRUMENTS, H. H. Lake, London.—6*th September*, 1883.
4567. BOILERS, &c., H. J. Haddan, London.—25*th September*, 1883.
4633. ANIMAL and MAN TRAPS, W. Burgess, Worcester.—28*th September*, 1883.
4669. TELEPHONIC APPARATUS, E. George, F. A. Pocock, J. S. Muir, and J. S. Muir, jun., London.—2*nd October*, 1883.

List of Specifications published during the week ending November 17th, 1883.

4938*, 6d.; 1034, 2d.; 1102, 10d.; 1467, 8d.; 1544, 2d.; 1570, 8d.; 1577, 4d.; 1581, 2d.; 1582, 4d.; 1583, 8d.; 1590, 2d.; 1601, 6d.; 1605, 2d; 1607, 2d.; 1611, 6d.; 1613, 2d.; 1617, 10d.; 1620, 10d.; 1622, 4d.; 1624, 2d.; 1626, 4d.; 1627, 2d.; 1629, 4d.; 1630, 2d.; 1632, 6d.; 1633, 2d.; 1635, 2d.; 1636, 8d; 1637, 2d.; 1638, 6d; 1639, 8d.; 1641, 2d.; 1642, 2d.; 1643, 2d.; 1644, 6d.; 1645, 4d.; 1646, 4d.; 1647, 6d.; 1648, 6d.; 1649, 2d.; 1650, 6d.; 1651, 6d.; 1652, 2d.; 1653, 2d.; 1654, 2d.; 1655, 4d.; 1656, 2d.; 1657, 4d.; 1658, 2d.; 1660, 2d.;