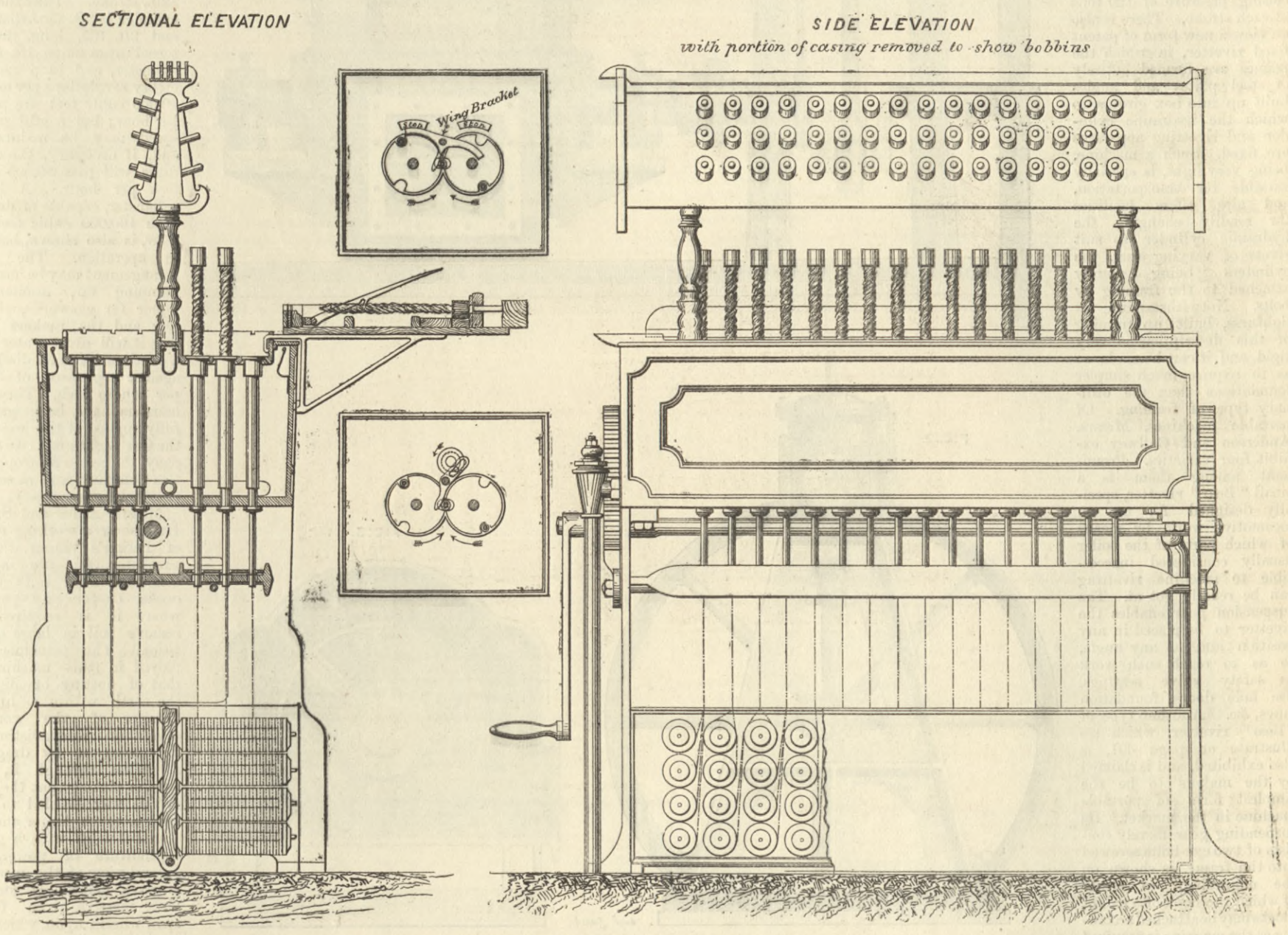
MISCELLANEOUS EXHIBITS AT THE INTERNATIONAL INVENTIONS EXHIBITION.

No. III.

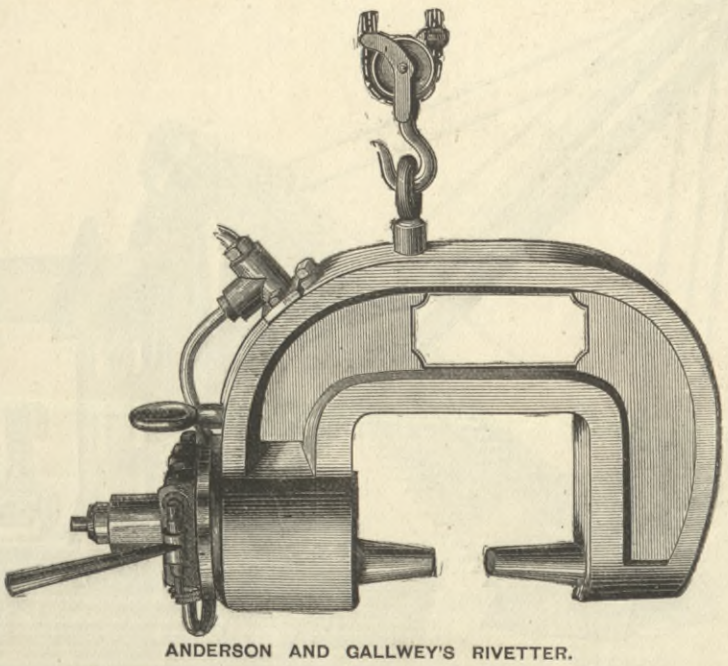
PRICE'S Patent Candle Company exhibits in operation in the West Annexe a plaiting machine, with its patent switching arrangement for transferring the bobbins from one spindle to the other. Plaiting machines are usually made up of four heads, each head consisting of a pair of upright spindles, carrying discs, and rotating at the same speed in opposite directions; the bobbin spindles, which carry the bobbins with the cotton, being held in notches in the peripheries of the discs. Each bobbin spindle, as it passes between the axes of the discs, is transferred from the discs upon one axis to those upon the other; the bobbins being thus made to describe a path resembling the figure 8. This transfer is controlled by a switch, which crosses from side to side in the intervals between the passages of the bobbins, so as to pass the bobbin to right and left alternately. In the ordinary plaiting machine the motion of the switch is determined by the impact of the bobbin spindles themselves—as shown in the detail sketches above—each bobbin spindle as it passes from disc to disc striking against a wing bracket, which stands out from the axis of the switch and carries it back against a stop, thus moving the switch through a sufficient angle to cause the next bobbin to cross over in the other direction. This method of switching the bobbin spindles is open to the objection that it is very noisy, and there is also considerable wear and tear; so much so, that large bobbins cannot be run at high speeds. In the plaiting machine shown the switches are actuated by a positive motion derived from the disc spindles, the wing brackets and stops being dispensed with, a crank pin working in a slotted arm serving to move the switch. This arrangement is illustrated above. The crank is fixed on the end of a spindle which is geared into the disc spindles in the ratio of 2 to 3, and moves the switch from side to side at the proper intervals for transferring the bobbin spindles to the different disc spindles, no other contact taking place between the bobbin spindles, and the switch or parts connected with it, than that by which the bobbins are guided in their course. In this way the noise and wear and tear are reduced to a minimum, and the machine can be run at much higher speeds than it otherwise could. The machine is shown in operation plaiting candle wick, for which purpose Price's Candle Company employs a considerable number of machines at its Battersea Works; but the switching arrangement is capable of application to plaiting machines for all purposes.

Another interesting exhibit is the manufacture of snuffless dips. Dip candles, as most people are aware, are made by winding the wick upon a rectangular iron frame and dipping the frame with the wick upon it into a trough or vessel containing the melted tallow or other material, the candles by a series of dippings being gradually formed upon the wicks themselves. The manufacture of snuffless dips, as shown by Price's Candle Company, differs from that method in so far that instead of forming the candles upon the wicks, the candles are produced by continued dippings upon a series of skewers, which are afterwards withdrawn and the wicks inserted. It is claimed for this method that, as there is no waste of wick nor remelting of candle material, it is more economical than the old system, and further, that it produces much better shaped candles.

Three candle-moulding machines are to be seen in operation. One of these is for producing Price's drawing-room candles with improved self-fitting ends, and differs slightly in some details from an ordinary candle-moulding machine. A "self-fitting" candle being tapered towards both ends, cannot, of course, be moulded in a single mould. In the machine shown the moulds are enlarged at the top to receive the "caps" which form the conical ends, and when the candles are forced out of the moulds they carry the "caps" with them. The candles are placed, one row at a time, on a "drawing board," the "caps" being received and held by a series of recesses. By moving a lever the operative advances a bar with a series of rams against the ends of the candles, pushing the whole batch out of the "caps" simultaneously. The wicks are then severed by a knife sliding in a groove in front of the "drawing board." Before "filling up" again, the wicks have to be threaded through the "caps," and these inserted into the tops of the moulds, the wicks being held centrally over the moulds by a slotted L iron bar, which passes along the top of each row of moulds. This method of working is scarcely so neat or so expeditious as that with the "clamps," but the advantages which it possesses are, that by obtaining a proper circulation of the cooling water, the self-fitting ends produced have a much finer finish, and may be formed with a series of V-shaped flutes, which are easily abraded, so as to fit any sized candlestick. Another of the machines, and that which most probably attracts the greatest amount of attention, is for making Price's spiral candles, and is illustrated below. This machine does not differ essentially from that already referred to, with the exception of the internal circulation, which has been improved by the application of a central outlet, as the production of spiral candles in such a machine is only possible with a very efficient cooling arrangement. The advantage of thus moulding spiral candles over the older method of cutting them in a lathe is too obvious to require comment. The other machine shown is for the manufacture of perforated candles, and is similar in design and general arrangement of its parts to those shown by Price's Company in the Health Exhibition last year. This machine works with the clamps just like an ordinary candle moulding machine, and is very compact, occupying as it does less than half the space, and at the same time producing 25 per cent. more candles at one operation than the French machine. This feature of compactness is a characteristic which distinguishes all the machines shown by Price's Company, and it has been secured without cramping the machines or interfering with their working in any way. The arrangement throughout is exceedingly neat and handy, everything being so placed as to be within easy reach of the workman. They are also of easy access for cleaning—a matter of very great importance—as by simply raising a loose cover the workman can introduce a brush and clean the outside of all the moulds in the tank without the least trouble. The work is very strong and substantial, the materials being specially selected, cast and wrought iron being in some instances replaced by steel.



PATENT SPIRAL CANDLE-MAKING MACHINE.



ANDERSON AND GALLWEY'S RIVETTER.

Morgan's ingenious, and, for its day, efficient candle-making apparatus, was worked by Price's Candle Company on a large scale, but was supplanted by the still more effective plant designed for them in 1856 by Mr. E. A. Cowper, at a time when other candle-makers were, for the most part, making candles with the old hand frames. The advanced position which it held then it still continues to maintain, and the display which it makes at the Inventions Exhibition shows that it is still well to the front.

Messrs. Anderson and Gallwey, Cremorne Works, Chelsea, exhibit a comprehensive collection of their fixed and portable hydraulic rivetting machines, embodying their most recent improvements. One of the machines is an "Eagle" fixed rivetter, with patent automatic return stroke, in which, by means of a constant pressure ram, the rivetting die is brought back immediately the foot lever is released. The stroke of the die is adjustable, and can be instantly altered to any required length by altering the

position of a tappet. This does away with the old plan of changing dies for every fresh length of rivet and for varying thicknesses of plates, so saving both time and money. Another feature in this machine is the improved treadle starting gear, which may be used from either side of the frame, the attendant's hands being left entirely free to control the work between the dies. These rivetters are made in all sizes, and have been supplied to many of the leading firms in this country and abroad. Among the latter we may mention the Compagnie Général Transatlantique, which has recently erected one of the most powerful machines yet made, capable of putting on a closing pressure of 120 tons at each stroke. There is also on view a new form of patent fixed rivetter, in which the frames are formed entirely of steel plates and angles built up into box girders, to which the hydraulic cylinder and rivetting apparatus are fixed. Such a machine, being very light, is specially suitable for transportation, and also offers facilities for readily changing the hydraulic cylinder to suit rivets of varying sizes, the cylinders being merely attached to the framing by bolts. Notwithstanding its lightness, built up framing of this description is very rigid, and it can be made so as to require much simpler foundations than the ordinary type of framing. Of portable machines, Messrs. Anderson and Gallwey exhibit four varieties. Prominent among them is a small "Bear" rivetter, specially designed for use on locomotive work, by means of which parts of the boiler usually considered inaccessible to machine rivetting can be readily got at. The suspension gear enables the rivetter to be placed in any position and at any angle, so as to reach such work as safety valve seatings, fire hole doors, foundation rings, &c. Another type of "Bear" rivetter, which we illustrate on page 491, is also exhibited, and is claimed by the makers to be the simplest form of portable machine in the market. Its suspending gear merely consists of two eye-bolts screwed into the frame, as shown on the engraving, to either of which the hook of a pair of blocks may be attached according as the machine is required to work in a vertical or horizontal position. These two positions are considered to be sufficient for the requirements of ordinary girder work, for which these machines are intended to be used, and no doubt their great simplicity renders them peculiarly suitable for it. The "Lion" or hinged type of portable rivetter is represented by one machine. In this class the cylinder and ram are placed at one end of a pair of steel arms, hinged at the centre, and having the dies at the other end. The advantage of such an arrangement is that the ends of the arms carrying the dies are not encumbered by the hydraulic working gear, as in the case of direct-acting machines, and can therefore reach into corners and other parts where room is limited. An important matter in all portable rivetters is to so construct the valves that they are opened and closed with little effort, in order that there may be no tendency to drag the dies away from the rivet head, after having once been brought into the proper position. Messrs. Anderson and Gallwey have paid special attention to this point, and by careful balancing have succeeded in producing a valve which can be worked with a very slight application of pressure upon the lever. Besides rivetting machines, there are also exhibited high-pressure vertical pumps, specially designed to work hydraulic machine tools. These are strong and well constructed, the workmanship being of a high quality. The pumps are intended to be worked by belting from the main shafting of the shop, and for this purpose are provided with fast and loose pulleys, but, of course, they may be driven by a steam engine combined on the same frame, if thought desirable. There is also a number of specimens of work done by the machinery we have described, and an assortment of cupped leathers, which, both as regards material and workmanship, seem of the highest excellence.

Messrs. Thomas Horn and Sons, Gray-street, Waterloo-road, exhibit Greenaway and Kitt's patent four-slide exhauster and pump. The principal feature in this apparatus, which we illustrate by three views below, is the provision of four slides worked from a shaft placed excentrically in the cylinder, by means of which a very regular action is obtained, the pulsations usually produced in the working of this class of apparatus being reduced below a perceptible amount, so that a high speed can be maintained without noise. The machine at the Exhibition is shown in operation, driven by a small inverted-cylinder oscillating steam engine working direct upon the shaft, the piston being 8in. diameter and 12in. stroke. The exhauster cylinder is 2ft. 6in. diameter and 2ft. 3in. long, the internal drum being 1ft. 10½in. diameter, and at a speed of eighty revolutions per minute 50,000 cubic feet are passed per hour; but a still greater speed may be maintained, and, if necessary, the apparatus will pass 80,000 cubic feet per hour. A larger exhauster, capable of dealing with 160,000 cubic feet per hour, is also shown, but not in operation. The same arrangement may be used for pumping tar, ammoniacal liquor for gasworks, slurry, &c.; and the makers state that it will draw water from a depth of 28ft. and discharge against a pressure of 32 lb. per square inch. These exhausters have been successfully applied at the works of the Gas Light and Coke Company, the South Metropolitan Gas Company, and at several provincial gasworks.

Messrs. Amos and Smith, Hull, show a working model of Parker's patent digging excavator, for use in the construction of railways or docks, or for any purpose where it is required to remove soil in large quantities. The principle employed in this machine is that of cutting or digging the earth within a limited distance of the working edge, in contradistinction to tearing it by dragging a bucket through it, the makers stating that they are in this way enabled to perform a much larger amount of useful work with a given expenditure of power. A general view of the machine is given below. It consists of a massive iron frame upon wheels, upon which are fixed the boiler and engine, and a jib and pillar of much the same construction as those of an ordinary crane, with the exception that the jib is a double one, the two portions being kept sufficiently far apart to admit of the frame of the digging apparatus passing between them. This frame is of wrought iron, and is pivotted to the top of the pillar at one end, the other being suspended by chains from the jib, so that it may be raised and lowered according to the depth of the surface of ground it is desired to remove. The digger is shown in the sketch on the next page. It consists of a series of steel tines A, each 2½in. wide, placed side by side in pairs in strong clip sockets B, which have movement given to them by the combined action of the cranked shaft C, which is driven by means of gearing from the top of the pillar, and the link D which is hung from a spindle attached to the framing. The shaft has three cranks at angles of 120 deg., each crank operating a pair of tines, so that while one pair is in the position shown in the sketch, *i.e.*, commencing to cut the earth, another is just completing its stroke, while the third is being brought forward ready to follow the first pair. The earth removed at each operation is indicated at E. It is pushed back on to the plate F by the tines, and from there it falls into an elevator which raises it to the top of the pillar and discharges it by means of shoots into trucks. The digger head is raised and lowered

FIG. 1

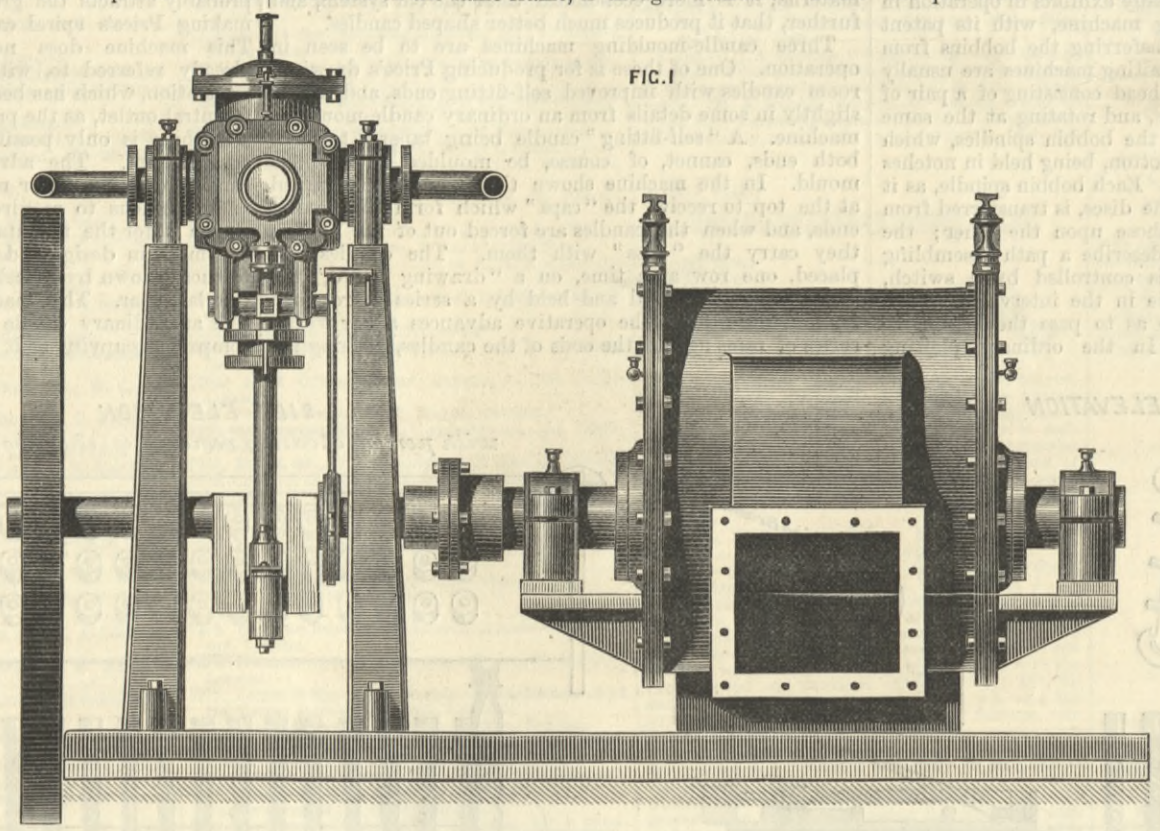


FIG. 2

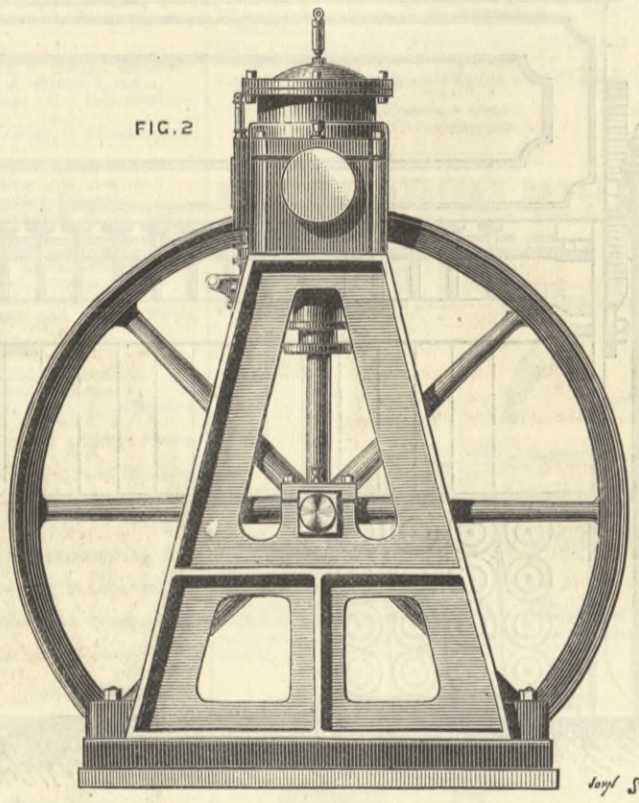
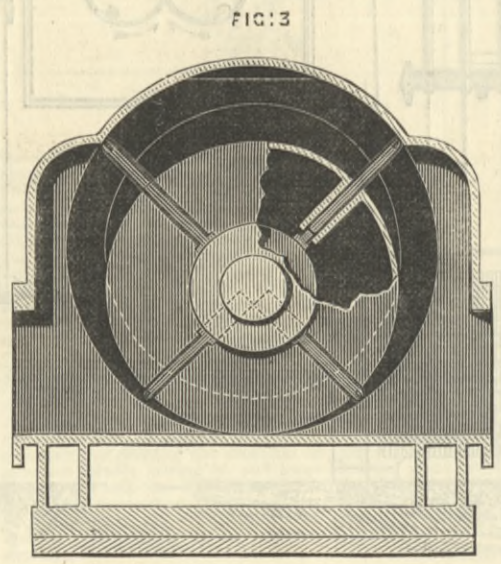
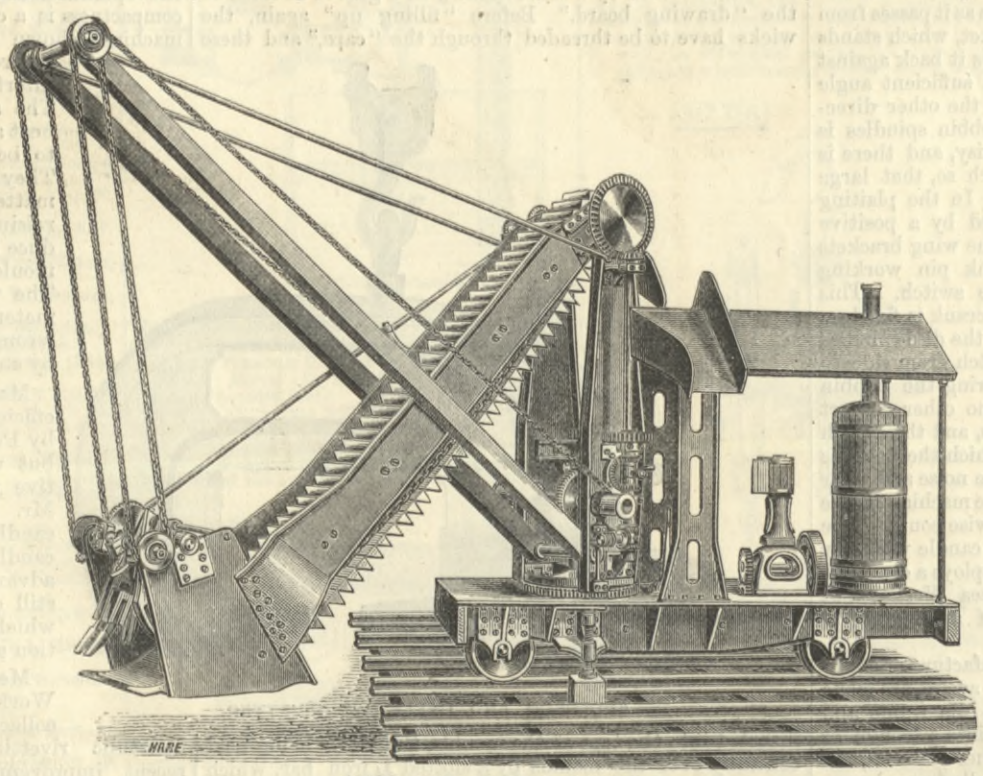


FIG. 3

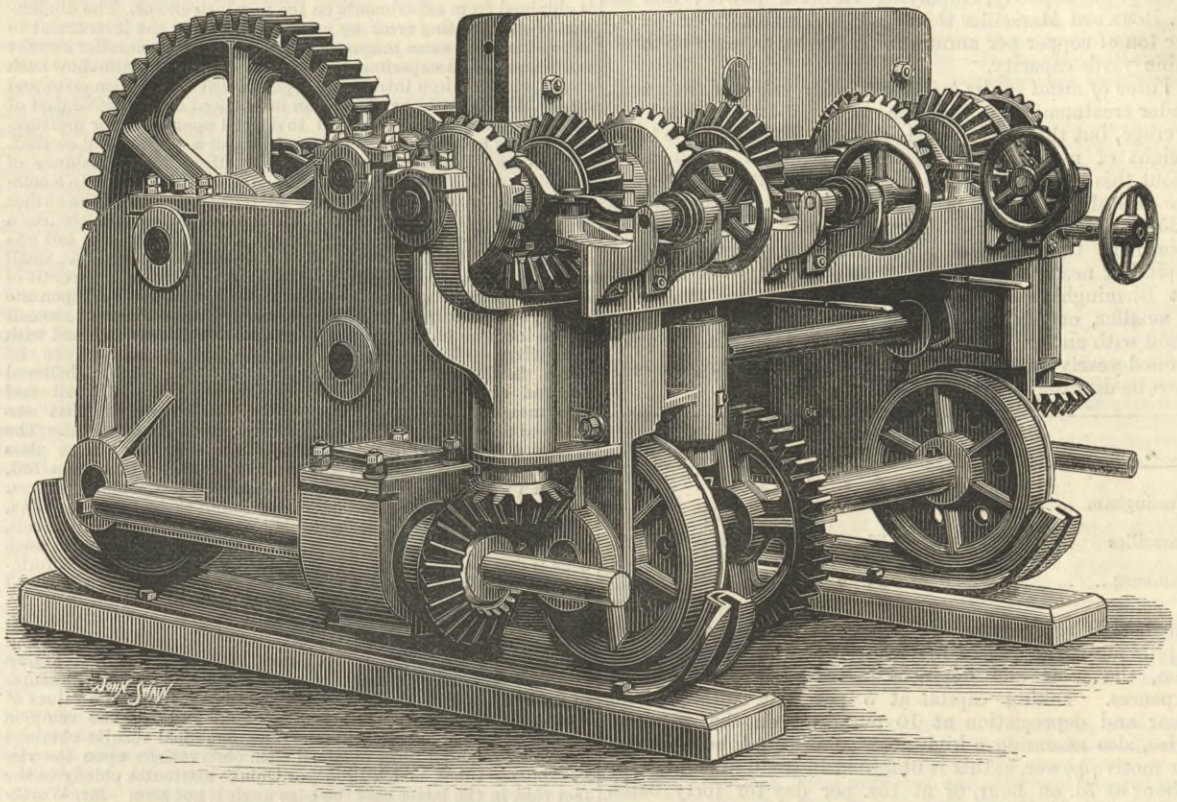


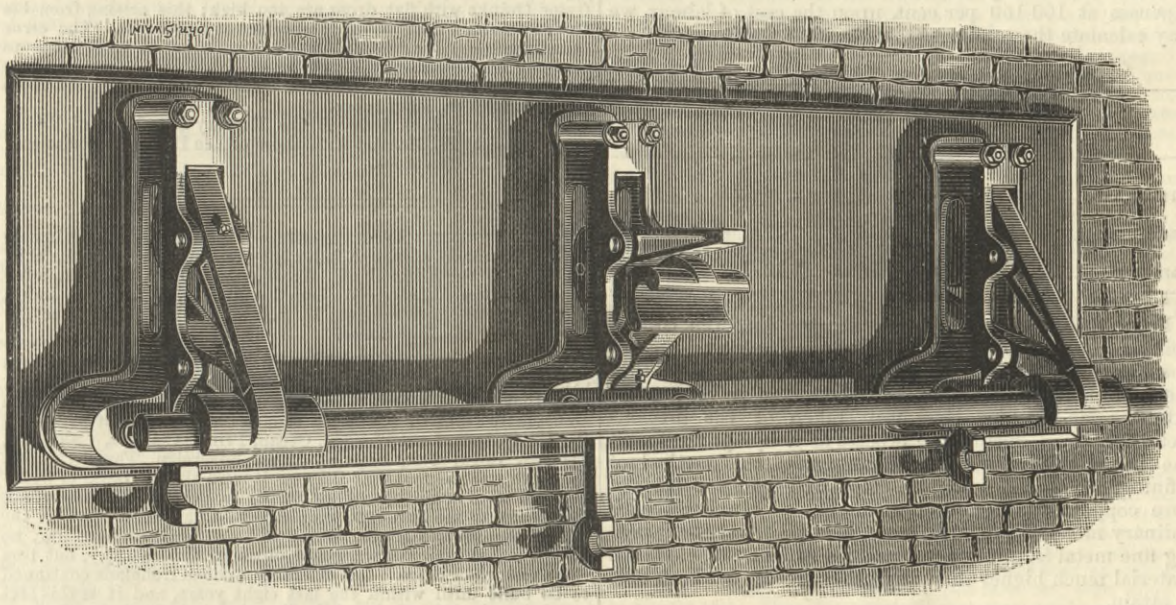
GREENAWAY AND KITT'S GAS EXHAUSTER.



AMOS AND SMITH'S DIGGER.

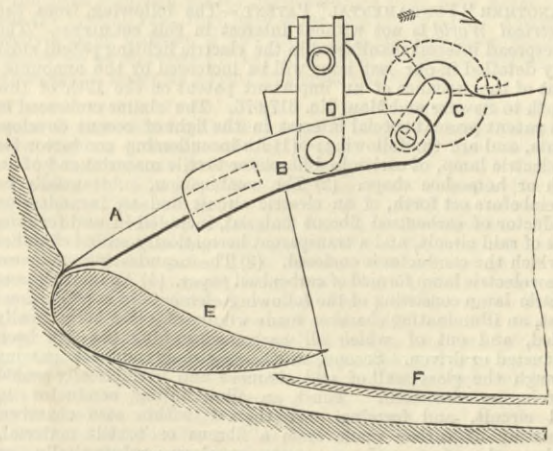
APPLEBY BROTHERS 20-TON OVERHEAD CRANE CRAB.





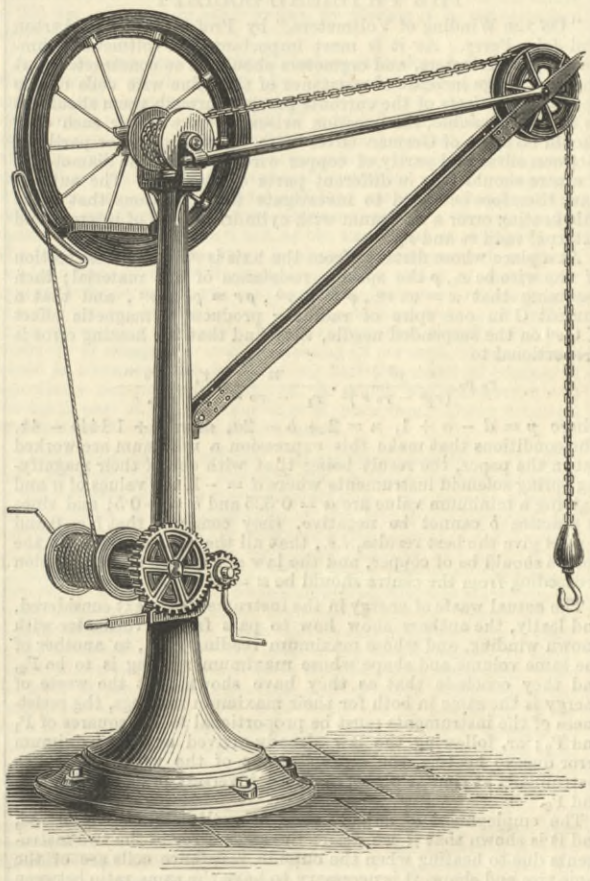
APPLEBY BROTHERS TUMBLER BEARINGS

by chains worked by a crab on the frame. When using a double line of trucks, the spoil is delivered at either side of the machine at will, irrespective of the position of the excavating head, and when working in a gulley the machine can be arranged so as to discharge over the end. By examining the sketch it will be seen that the action is a mechanical imitation of spade digging, the tines being pushed forward into the earth, the same as a spade is pushed by the foot, and then being swept back with increasing rapidity as the position of the centre of suspension alters. We understand that the inventor has devoted several years to the subject of excavating, during which time he has made numerous experiments on a large scale



AMOS AND SMITH'S DIGGER.

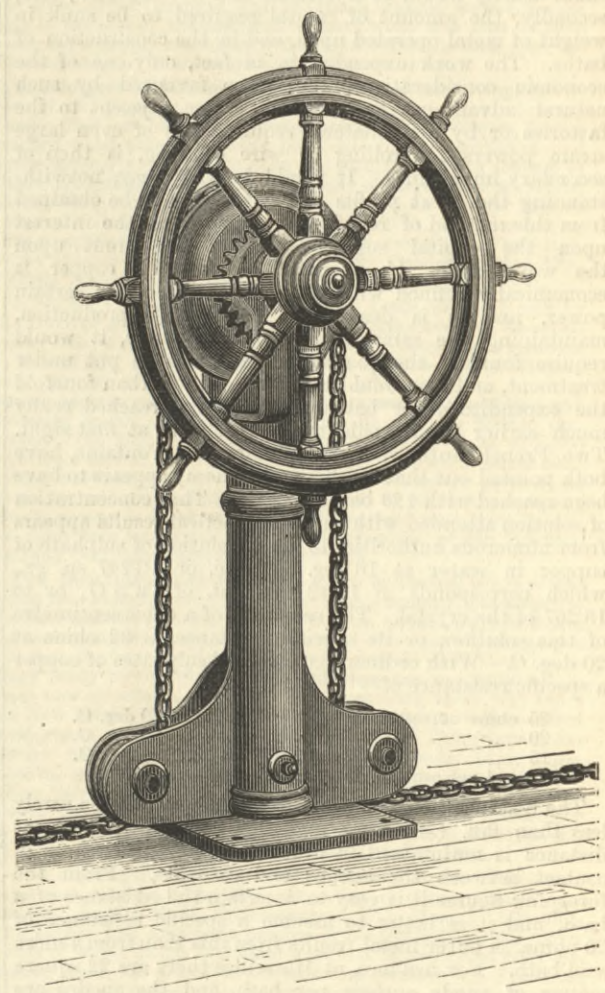
on this and the kindred subject of digging for agricultural purposes, these experiments having satisfied him of the superior results to be obtained by this system over those in which a bucket is dragged through the soil. One very important result anticipated is a great saving in repairs and maintenance. For in the new system the digging tools are simple and massive, and have only their proper work assigned to them, viz., that of loosening and moving the earth on to the carriers, which, being relieved of the heavy work of digging, can be run at a comparatively high speed and be made correspondingly lighter. In the machine, the model of which is now at the Exhibition, the gauge of the wheels is that of the ordinary railway. The necessity for laying a special track is therefore avoided, while convenience is secured by the machine being made available for use at any part of the works on the contractor's lines, or it may be passed to other works over the ordinary lines of railway.



APPLEBY BROTHERS WHIP CRANE.

Messrs. Appleby Brothers, Greenwich, exhibit an overhead travelling crab for 20-ton rope crane, which we illustrate above. All motions for lifting, travelling, and traversing, are transmitted from a shaft which runs across the crane beams, this being considered by the makers a better arrangement, both as regards safety and durability of rope, than passing the rope backwards and forwards in the usual manner. The attendant travels with the crab, and being directly over his work, has a much better command of it than if he were stationed at one end, as is often the case. The clutches for working all the motions are of the double-cone friction type. Tumbler bearings, which we also illustrate, are used for supporting the transverse shaft previously mentioned, and may, of course, be applied to any shafting the bearings of which must be alternately removed and replaced. There are three moving parts—viz., the falling bracket bearing, the strut which holds it in position, and the spindle which lifts and depresses this strut. This last-named operation is performed by an inclined plane, which is fixed in front of the travelling carriage, so that it engages the hook which is shown on the top of the spindle. The bearing gives a perfectly firm support for the shaft, and has, we understand, been used for several years with very satisfactory results. The whip crane which we illustrate is a cheap and neat arrangement for obtaining the speed required in loading and unloading light packages, while at the same time a means is provided for raising loads up to two tons. Weights of 5 cwt. and under are lifted quickly by pulling on the hand rope, which acts without gearing direct on the large wheel at top of the pillar; above that, and up to one ton, the handle is shipped on the barrel shaft; whilst for loads between one and two tons the pinion shaft is used. The crane is carried on a strong wrought iron post keyed into a cast iron base, whose bearing on the floor is so large that but little holding down is required. A cast iron sleeve fits over the post, and carries all the lifting gear, the lower end having a friction roller, which permits the crane to be very easily swung round. This is a neat and inexpensive crane, which may be very advantageously used in many circumstances.

Below we illustrate a neat and compact hand-steering gear, patented by Mr. T. Archer, and exhibited by the manufacturers, the Dunston Engine Works Company, Gateshead-on-Tyne. It consists of a cupped chain drum with internal toothed wheel, which runs loosely upon a horizontal shaft and gears with a pinion mounted on an excentric formed on the spindle to which the hand-wheel is fixed. On turning the spindle movement is communicated to the drum according to the difference between the number of teeth in the wheel and pinion, the latter being prevented from turning round by a stalk which projects down into the standard and is loosely guided by it. The position



ARCHER'S EPICYCLOIDAL STEERING GEAR.

of the rudder is indicated by a pointer actuated by a worm and wheel. The gear is self-holding, consequently less manual labour is required than with the ordinary hand-steering appliances, the rudder remaining in whatever position it may be put without exertion on the part of the steersman. It is, moreover, quicker in action, and being very simple and compact, can be produced at the same price as the ordinary apparatus. We understand that this patent gear has been largely used by Sir W. G. Armstrong, Mitchell and Co., the River Tyne Commissioners, and many leading firms in the North, and has invariably given satisfaction. The same firm also shows Archer's patent compressor or nipper for holding steel hawsers, which consists of a frame in which are two loosely hinged grooved jaws. By means of a lever, worked by a handle, the jaws can be opened and closed, so as to admit the hawser or grip it, the pressure when the rope is in place increasing with the downward movement of the jaws, which, when they once come together, form a kind of toggle joint. In this way the hawser can be held with certainty, or, if need be, it can be gradually slacked out without damage, or it may be released at once, while there is no possibility of it becoming wedged hard and fast, as is the case with some compressors.

A simple and inexpensive little machine for cutting keyways in pulleys and wheels is shown by Messrs. Harpers, Aberdeen. It consists of a circular table with a hole in the centre, through which a vertical rectangular cutter, serrated on one side like a milling tool, is caused to reciprocate by means of a crank and gearing below. The pulley or wheel is clamped to the table by a lever bar and pressed against the cutter, the width of which varies according to the size of keyway to be cut. Compared with an ordinary slotting machine, the keyseater has many advantages. There is no frame above the level of the table to limit the diameter of wheel; the work is done much more rapidly than with an ordinary slotter; and any desired taper can be given to the keyway without the trouble of adjusting the wheel. We understand that as many as sixty-six small pulleys have been cut in one hour by one of these machines.

COMMERCIAL ELECTROLYSIS.

No. IV.

By Paget Higgs, LL.D., D.Sc.

In the refining of metals the mechanical power producing the electric current—for, in present practice, the electric current is always produced by dynamo and magneto-electric machines—is absorbed chiefly in overcoming the resistance of the baths, which resistance depends upon the distance apart of the two electrodes, upon the concentration of the solution of the bath, and upon its temperature. In plating the power expended in transporting the metal from the anode to the cathode is insignificant, but in refining the mere weight of metal deposited requires clearly considerable work to be expended. As stated, this amount of work may be made, nearly without limit, almost as small as we please. To calculate the amount, there are required as data the quantity of current in ampères, and the resistance of the baths in ohms; the best resistance of the bath is a matter of economic moment. Now it is always possible to diminish the resistance of a bath by increasing the surface of the anodes and cathodes. Also the quantity of current may be diminished for a given production of metal by putting several baths in chain, and by so increasing their surface as to make the total resistance equal to that of the first bath. It is possible, theoretically, thus to refine a ton of copper per hour with the expenditure of only a horse-power of work. But there are two limits—first, the nature of the deposit, which with a current of so small density would be crystalline and not reguline; and, secondly, the amount of capital required to be sunk in weight of metal operated upon, and in the construction of baths. The work expended is, in fact, only one of the economic considerations, and when favoured by such natural advantages as a fall of water adjacent to the factories or by the collateral requirements of even large steam powers for rolling or wire drawing, is then of secondary importance. It would be very easy, notwithstanding the great profits and advantages to be obtained from this method of refining copper, to cause the interest upon the capital sunk to exceed the profit upon the work done. If a given quantity of copper is economically refined with the expenditure of a certain power, and it is desired to double this production, maintaining the same expenditure of power, it would require fourfold the quantity of metal to be put under treatment, and this would entail much more than fourfold the expenditure for baths. The limit is reached really much earlier than would appear probable at first sight. Two French authorities, Hospitalier and Fontaine, have both pointed out that the limit of economy appears to have been reached with 128 baths in chain. That concentration of solution attended with the best practical results appears from numerous authorities to be a solution of sulphate of copper in water at 16 deg. Beaumé, or 1·1247 sp. gr., which corresponds to 12·42 per cent. of $Cu\,S\,O_4$ or to 18·267 of the crystal. The resistance of a cubic centimetre of this solution, or its specific resistance, is 32 ohms at 20 deg. C. With ordinary commercial sulphates of copper a specific resistance of—

25 ohms corresponds to 1·0744 sp. gr. at 20 deg. C.
20 ,, ,, ,, 1·1425 ,, ,, 20 deg. C.
15 ,, ,, ,, 1·1425 ,, ,, 25 deg. C.
1 per cent. of sulphuric acid being added.

The distance between the electrodes in refining is rarely less than 2in. (=5 c.m.), and this comparatively great distance is maintained in order to avoid all chances of contact between the anodes and cathodes. From the foregoing figures it is easy to ascertain the resistance of a bath, and it is better to assume a specific resistance of 20 ohms, as purer metal results from this than from a more acid bath. For instance, at Marseilles there are 22 square metres of anode surface per bath, and the anodes are 5 centimetres distant from the cathodes. It is convenient to work in metric measures when dealing with specific resistances, but we may for practical purposes take the resistance of a cubic inch of sulphate of copper solution as 8 ohms. There are forty baths; the resistance of a square metre is $\frac{1}{10000}$ of that of 1 square centimetre, or $\frac{20}{10000} = 0020$; therefore the resistance of the whole chain of baths is 0·0184 ohm. At Birmingham the resistance is 0·2 ohm for the chain of forty-eight baths, and at Hamburg it is for 120 baths 0·1 ohm. From the deposits at these works it is easy to calculate the quantity of current in each circuit or chain of baths. This at Birmingham is 230 ampères; at Marseilles, 220 ampères; and at Hamburg, 265 ampères. From these currents we deduce that about 1¼-horse power is used in the baths at Marseilles, about 9¾-horse power at Hamburg, and about 15-horse power at Birmingham. The waste works may be represented at about 1 per cent. of the total work for that done on the metallic resistances, and at 5 to 10 per cent. for that due to polarisation. We have now only to deal with the actual commercial cost.

Cost of installation.—The cost of installation at Elliott's Metal Company, Birmingham, may be assumed for forty-eight baths, each of about one cubic yard capacity, and the work employing a motive-power of 20-horse power, as at £1724, or £16 10s. per ton of copper refined per year. At Hamburg this is £3940, or falling to £12 8s. per ton of copper refined per annum, with 120 baths, each of two cubic yards capacity, employing 12-horse power; and at M. Roux's at Marseilles this is £1680, or rising to £18 10s. per ton of copper per annum for forty baths, each of three cubic yards capacity.

Value of metal under treatment.—The value of the metal under treatment may be taken as at £64 10s. per ton on average, but this is very variable. At Hamburg the total weight of metal under treatment is about 122 tons, at about this price, and as the output is about 325 tons yearly, the capital sunk in the metal in the baths represents about £25 per ton. In Marseilles there is sunk in copper under treatment the value of about 54 tons, representing a capital of nearly £3000 for an annual output of 75 tons. At Birmingham the quantity of metal under treatment is smaller, only about 10 tons, representing a capital of £650 with an annual output of 100 tons. Per ton of copper refined yearly in these three large works the capital may thus be distributed:—

	Installation.	Metal under treatment.	Cost of works.	Total expense.
	£ s.	£ s.	£	£ s.
Birmingham	16 10	6 0	6	28 10
Marseilles	18 10	36 8	8	63 0
Hamburg...	12 8	24 4	15	51 12

The cost of refining the copper must include interest on capital sunk, the cost of motive power, that of manipulation, the wear and depreciation of plant, and general expenses. Taking capital at 5 per cent. interest, and wear and depreciation at 10 per cent. on the purchase price, also assuming a high average price per horse-power for motive power, as this is obtained in small amount, with labour at 7d. an hour, or at 15s. per day for forty baths and £1 10s. a day for 120 baths, and with general expenses at 100-150 per cent. upon the cost of labour, we may calculate the total cost to be made up as follows:—

Expenditure per Ton of Copper Refined.

	Interest on capital.	Motive power.	Depreciation.	Labour.	General expenses	Total.
	£ s.	£ s. d.	£ s. d.	£ s.	£ s.	£ s.
Birmingham...	1 8	7 4 0	1 4 0	2 6	2 6	14 8
Marseilles ...	3 3	4 10 0	0 14 0	2 17	4 6	15 10
Hamburg ...	2 11	1 11 6	0 9 6	1 12	1 12	7 16

From these figures it is easy to see that the cost of refining copper by the electrical way is largely dependent upon the circumstances of the installation, but also that these circumstances are under control to a very great extent. No account has been taken of the precious metals obtained during the process as a bye-product, and one that stands as a great advantage of this method of refining. The cost has been calculated upon the basis of pure copper obtained, and although, as compared with ordinary metallurgical treatment, it is high, yet the resulting fine metal is much purer and its value as an electrical material much higher than any other process has been able to attain.

In my next and last article I will endeavour to point out briefly the further present applications of commercial electrolysis.

THE PHYSICAL SOCIETY.

"On the Winding of Voltmeters," by Professors W. E. Ayrton and John Perry. As it is most important that voltmeters, ohmmeters, powermeters, and ergmeters should be so constructed that the percentage increase of resistance of their fine wire coils due to the heating effects of the currents passing through them should be as small as possible, the question arises as to whether such coils should be made of German silver wire, or of copper, or partly of German silver and partly of copper wire, and how the diameter of the wire should vary in different parts of the coil. The authors have therefore been led to investigate the conditions that make this heating error a minimum with cylindrical coils of internal and external radii r_0 and r_1.

At a place whose distance from the axis is r let the cross section of the wire be x_1, ρ the specific resistance of the material; then assuming that $x = x_0 r^a$, $\rho = \rho_0 r^b$, $\rho r = \rho_0 r_0 r^c$, and that a current C in one spire of radius r produces a magnetic effect $K C r^d$ on the suspended needle, they find that the heating error is proportional to

$$r_0 \rho_0 \frac{p^2}{(r_1^p - r_0^p)^2} \cdot \frac{n}{r_1^n - r_0^n} \cdot \frac{r_1^m - r_0^m}{m},$$

where $p = d - a + 1$, $n = 2 + b - 2a$, $m = 2 + 1{\cdot}144b - 4a$. The conditions that make this expression a minimum are worked out in the paper, the result being that with one of their magnifying spring solenoid instruments where $d = -1$, the values of a and b giving a minimum value are $a = 0{\cdot}325$ and $b = -0{\cdot}5$; and since in practice b cannot be negative, they conclude that $b = 0$ and $a = {\cdot}4$ give the best results, *i.e.*, that all the wire employed in the bobbin should be of copper, and the law of increase of cross section proceeding from the centre should be $x = x_0 r^{0{\cdot}4}$.

The actual waste of energy in the instruments is next considered, and lastly, the authors show how to pass from a voltmeter with known winding, and whose maximum reading is P_1, to another of the same volume and shape whose maximum reading is to be P_2, and they conclude that as they have shown that the waste of energy is the same in both for their maximum readings, the resistances of the instruments must be proportional to the squares of P_1 and P_2; or, following the law already arrived at for a minimum error due to heating, the cross sections of the wires of the two instruments at similar places must be inversely proportional to P_1 and P_2.

The employment of outside coils for voltmeters is considered, and it is shown that if we desire the same error in the two instruments due to heating when the outside resistance coils are of the same size and shape, it is necessary to have the same ratio between the resistance of resistance coil and that of the magnetising coil in the two cases. To have a less or a greater error in the second case it is only necessary to have the equation

$$e\,(\text{the error}) = \frac{2 + F V}{1 + F V},$$

where F is a constant and V the volume of the German silver resistance coil. From this V may be determined, and the ratio $\frac{R_1}{R}$ of the resistances of the resistance coil and the magnetising coil is given by $\frac{R_1}{R} = \frac{F}{D} V$, where D is a constant which, like F, is obtained from experiments on the first instrument. The diminution of the heating error by using much iron in the instrument so as to obtain the same magnetic action with a much smaller current is discussed, and experiments were shown to illustrate how such employment of iron introduced a permanent magnetism error and caused the indications of such an instrument on the lower part of the scale to be uncertain and to depend upon whether measurements were being made with an increasing or a diminishing current.

"On the Manner in which Light affects the Resistance of Selenium and Sulphur Cells," by Mr. Shelford Bidwell. In a communication made to the Society at its last meeting, the author had described a sulphur cell which behaved in all respects like a selenium cell when exposed to light. The action of this cell was supposed to be electrolytic, the sulphur containing a small quantity of sulphide of silver. If this were the case, the result of a current traversing the cell would be to deposit sulphur upon the anode, and as sulphur has an enormous resistance, that of the cell would increase unless the sulphur thus deposited combined with the silver. It is this combination that is believed to be much facilitated by light, a supposition the author believed he had confirmed by direct experiment. Mr. Bidwell had also measured the resistance of a piece of selenium that was believed never to have been heated in contact with a metal. The specimen was crystallised by heating for some time in a glass mould, two opposite sides cleaned, and two pieces of tin foil, between which the resistance was measured, pressed against them. In this way the specific resistance was found to be 2500 megohms, which is enormously higher than that of the selenium in the cell, a fact tending to confirm the theory that the conduction in such cells is due to the electrolysis of the selenides of the metals forming the terminals produced in the locking, and similar to that of the sulphur cell described above.

"On the Error Involved in Professor Quinke's Method of Calculating Surface Tensions from the Dimensions of Flat Drops and Bubbles," by Mr. A. M. Worthington. In a series of well-known papers, Professor Quinke has recorded a large number of measures of flat drops and bubbles, from which he has deduced the values of tensions for the free surface of a liquid and for the common surface of two liquids in contact. The numerical results obtained in this way exceed those obtained from observations upon the rise in capillary tubes, which Professor Quinke attributes chiefly to the fact that in the latter case the edge angle is not zero. Mr. Worthington, however, shows that the surface tensions obtained by Professor Quinke with flat drops are too high; this arising from his having assumed that the drops were flat at the vertex. The error thus introduced is very considerable, amounting in most cases to as much as 10 per cent. of the whole value, and upon its being duly corrected, the values obtained do not appreciably exceed those obtained with capillary tubes.

"On a Comparison between the Mercury Standards of Resistance Issued by M. Mascart with those of the British Association," by Mr. R. T. Glazebrook.

Naval Engineer Appointments.—The following appointments have been made at the Admiralty:—Charles A. Biddick, chief engineer, to the Albacore; F. Worth, engineer, to the Asia, additional, for the Malabar; William Broad, engineer, to the Indus, additional, for the Wrangler; H. P. Vining, assistant engineer, to the Asia, for the Imperieuse.

Effect of Encasing Wood with Iron.—It was always expected since first wooden ships were clothed with armour-plates, that they would speedily decay, and this anticipation has been abundantly realised. The only excuse for the armour-plating of the Lord Clyde, Lord Warden, Ocean, Prince Consort, Caledonia, Zealous, Royal Oak, Repulse, Royal Sovereign, Favourite, and Research was the fact that the vessels were already built or building, and were of no use at all unless so protected. When once those ships of the line were completed that happened to be on the stocks when ironclads were proved to be an absolute necessity, no other wooden ironclads were laid down in this country, but iron ships took their place. But in France wooden ironclads continued to be built until within the last eight years, and it is this fact which has doubtless induced the French Admiralty to lay down so many iron and steel ironclads since that time. It is the closely fitted wooden backing on the outside and flanking on the inside which entirely prevents air from getting at the unseasoned oak timber of the frames, and this causes the juices of the timber to ferment, and so induces the growth of the peculiar fungus known as dry rot. An examination of our wooden ironclad fleet a few years ago resulted in their being almost entirely condemned, and now we find the Admiralty are turning them into money by selling them to the ship breakers. The Royal Sovereign—the ship in which Captain Coles' turrets were first tested—also the Zealous and Favourite, have just been sold for this purpose, and others will doubtless speedily follow. While vessels of less than twenty-five years old are thus being broken up on account of rottenness, it is interesting to notice the number of two and three-decked wooden ships—some of them nearly a hundred years, and none less than thirty or forty years old—which still survive in ordinary at Portsmouth, Devonport, and Sheerness. These were built of seasoned timber before the age of hurry set in.

Another "Fundamental" Patent.—The following, from the *Electrical World* is not without interest in this country:—"The widespread interest manifested in the electric lighting patent suits fully detailed in our last issue will be increased by the announcement of the issuance of an important patent on the 12th of this month to Sawyer and Man, No. 317,676. The claims embraced in this patent present special interest in the light of recent developments, and are the following:—(1) An incandescing conductor for an electric lamp, of carbonised fibrous or textile material and of an arch or horseshoe shape. (2) The combination, substantially as hereinbefore set forth, of an electric circuit and an incandescing conductor of carbonised fibrous material, included in and forming part of said circuit, and a transparent hermetically-sealed chamber in which the conductor is enclosed. (3) The incandescing conductor for an electric lamp formed of carbonised paper. (4) An incandescing electric lamp consisting of the following elements in combination: First, an illuminating chamber made wholly of glass hermetically sealed, and out of which all carbon-consuming gas has been exhausted or driven. Second, an electric circuit conductor passing through the glass wall of said chamber and hermetically sealed therein, as described. Third, an illuminating conductor in said circuit, and forming part thereof within said chamber, consisting of carbon made from a fibrous or textile material, having the form of an arch or loop substantially as described. In order to understand the cause of its issuance at this late day, it must be explained that Mr. Edison filed his original patent on high resistance carbons on Nov. 4, 1879. His patent was issued on the 27th of January, 1880. But in the meantime Sawyer and Man had filed their application on January 9th, 1880, and when it came to be acted upon an interference with the Edison patent was naturally declared. Messrs. Sawyer and Man claimed priority of invention, and the case was carried from the Examiner-in-chief to the Commissioner of Patents, and finally to the Secretary of the Interior. A large amount of testimony was taken on both sides, and the case argued by Messrs. Roscoe Conkling, H. H. Dyer, and C. L. Tomlinson for Edison, and by Messrs. Amos Broadnax and H. K. Garden for Sawyer and Man. This Patent-office litigation was decided in favour of the latter, and hence the allowance of the patent after more than five years. We understand that the Consolidated Electric Light Company, the owners of the Sawyer-Man patents, intend to assert their rights, so that more troublous times seem to await the incandescent light."

RAILWAY MATTERS.

A PASSENGER train on the St. Paul Railway, nine miles north of Sioux City, Iowa, was on Friday last struck by a cyclone and almost entirely wrecked, six persons being injured.

THE first sod of the railway from Stanthorpe, Queensland, to the border has been turned. It is regarded as the first step towards connecting Queensland with the Intercolonial Railway.

WHAT might have been a very serious railway accident on the Alta Italia Railway was happily averted by the Westinghouse brake. On the 16th inst., as the train from Turin to Paris was running at high speed down an incline of 1 in 33 at the Mont Cenis Tunnel, one of the horn plates of the sleeping car broke; the driver feeling the hitch immediately applied the Westinghouse brake, and the train was pulled up at once. It was found that the sleeping car and a saloon carriage were off the line. No one was injured, but considerable delay was caused in forwarding the passengers.

THE Vienna tram-cars carried about 36,000,000 passengers in 1884, as against 30,000,000 in the previous year. Yet three new cars only were put on the lines during the year, the numbers being 603 in 1884, 600 in 1883; and this, the *Railway News* says, is held to justify the loud complaints which have been heard as to the overcrowding of tram-cars in Vienna. These vehicles are, it is said, shamefully overcrowded, and it is no uncommon sight to see one horse painfully dragging a car with forty persons in it. The traffic of the Vienna omnibuses, which are elongated coaches carrying but fifteen passengers each, amounted to 6,500,000 fares.

THE effect of the weather on tram-car business is shown by the following:—In 1884 the miles run by the South London cars on Whit Monday were 5271, this year only 4863, the extra cars that would have run all day being ordered back to the yard on accouut of the wet weather. The passengers carried last year were 54,571; in 1885 only 31,197. The receipts last year were £404, against £270 this. Owing to improved weather on the Tuesday and succeeding days, the company more than made up its loss, the cars being well filled. The receipts on the week were £1556, against £1491 in 1884, about 15,000 more passengers being carried than in the corresponding week of last year.

THE yearly average of railway accidents in the United States for the four years ending last April was 1408 accidents, 410 killed, and 1695 hurt. The monthly average for last year was 105 accidents, 30 killed, and 141 hurt. The month of April was below the average in all respects; the year was also below the average, although approaching it closely in the number injured. The averages per day were, for the month, 2·70 accidents, 0·47 killed, and 2·50 hurt; for the year, 3·45 accidents, 1·00 killed, and 4·63 injured. The average casualties per accident in the month of April were 0·173 killed and 0·926 hurt; for the year they were 0·290 killed and 1·342 injured.

THE *Times* Calcutta correspondent, telegraphing on Sunday, said:—"The cholera epidemic on the Bolan Railway is now dying out, if it has not quite disappeared. The work is being resumed, and it is expected that the line will be open to Mach by the 15th of August. This work will sustain a serious loss owing to Colonel Lindsay, chief engineer, being compelled to go home invalided. It is understood that his place will be taken by Major Gracey. The work of the Pishin Railway has been seriously delayed by floods and cholera, and the portion between Nari and Hurnai is temporarily suspended; but the alternative line up the Bolan Pass is progressing. Cholera having disappeared in that quarter, it is expected that it will be only a few months before the railway is open to Quetta."

IN a paragraph headed "Failure of the Cable Road in Philadelphia," the *Scientific American* says:—"The road is constructed through twelve miles of the principal streets of the city, and has cost the projectors 600,000 dols., but it is estimated that 1,250,000 dols. more will be required to correct mistakes. When the iron conduits through which the cable passes were laid, iron rods were run through the stringers and bolted to the top of the conduits just below the slot where the grip passes down to the cable under the street. Every change of temperature has been found to affect the width of the slot and hinder the passage of the grip." The public will no doubt soon hear announcements relating to the cable tramways in this country which will contain the word failure. The failure in this case will, however, not be of a mechanical origin, but will probably be due to the difficulty of showing where the money has gone, or in what way it has been used.

A CORRESPONDENT writing to the *Times*, calls attention to the scheme for deepening the Grand Junction Canal between Birmingham and London. At a meeting of the Council of the Wolverhampton Chamber of Commerce on the 5th inst. it was announced, as stated in our columns, that the South Staffordshire Railway and Canal Freighters' Association had taken up this scheme, involving an expenditure of one million sterling, for deepening the Grand Junction Canal between Birmingham and London to allow of the passage of steamers of 120 tons burden. The Association decided to order a survey and estimate, at a cost of £500. The correspondent referred to says:—"This movement will, I trust, receive the hearty support of London traders generally, who have been unfairly handicapped by the various railway companies. For instance, the rate for sugar by railway from London to Birmingham, a distance of 113 miles, is 20s. per ton, whereas the rate from Greenock to Birmingham, a distance of 312 miles, is only 25s. per ton; and although the railway companies have been asked to lower the London rate, they have so far declined to do so. Consequently a large tonnage is now going by canal, and more would certainly go by this route if anything could be done to facilitate the passage of steamers serving this important district."

WRITING to the *Times*, a correspondent sends the following account of an accident which happened in the Mont Cenis Tunnel, with a view to a timely warning of those readers who wish to travel by that pleasant and well conducted line:—"We left Turin on Tuesday, the 16th, by the 2.15 p.m. express train for Paris, having taking three places in a *coupé salon*, quite the best and most luxurious railway carriage I have yet travelled in. We reached Bardonnechia in good time, and entered the famous tunnel at an unusually slow pace. This, however, was soon changed to a rate quite novel to myself, who have often done the journey before, and we rushed along through the thirteen miles long tunnel as if speed, and speed only, was the chief object in view. Our carriage wobbled about ominously for a time and then left the line. Our four lamps, two in each compartment, went out, and we bumped and jolted about in the dark, wondering what our fate might be, till we gradually came to a stop. After a few moments delay to recover ourselves, we proceeded to light a bit of candle we had with us and look about. Our four lamps no longer existed, and the glass globes, of extra thickness, strewed the floor in small fragments, the oil being impartially distributed over ourselves and the cushions of the seats. One of the two lavatories in the carriage also was wrecked. Looking out of the window, we saw large pieces of the springs of the carriage scattered about and the rails torn up, the carriage itself having come to a standstill only a few inches from the wall of the tunnel. After waiting for an hour and three-quarters in suffocating smoke and anxiety for the promised relief, we were packed into the van of our own train—which operation, by the way, might have been done at the first—and so taken to Modane station, which was close by. There we found that our train—or I should more correctly say an engine with perhaps a couple of empty carriages, our train still remaining in the tunnel—had been punctually forwarded on its way to Paris without waiting for us its passengers. So we had to remain in that most uncomfortable station till the arrival of the next train, due at midnight; we were only passengers, entitled to neither courtesy nor consideration on the part of the railway staff."

NOTES AND MEMORANDA.

THE following, from the report of the Astronomer Royal, are the principal results for magnetic elements for 1884:—Approximate mean westerly declination, 18 deg. 8 min.; mean horizontal force, 3·931 in English units, 1·812 in metric units; mean dip, 67 deg. 29 min. 8 sec. by 9in. needles, 67 deg. 29 min. 32 sec. by 6in. needles, and 67 deg. 30 min. 9 sec. by 3in. needles. In the year 1884 there were only five days of great magnetic disturbance, but there were also about twenty days of lesser disturbance.

THE mean daily motion of the air in 1884, as given in the report of the Astronomer Royal, was 286 miles, being three miles greater than the average of the last seventeen years. The greatest daily motion was 891 miles on January 23rd, and the least 78 miles on February 8th. The only recorded pressure exceeding 20 lb. on the square foot in 1884 was 22·7 lb. on January 23rd, after which the connecting chain of the pressure plate broke. It is probable that greater pressures occurred afterwards on the same day, and also in the gale of January 26th, at which date the chain had not been renewed.

THE monthly report of Mr. William Crookes, Dr. William Odling, and Dr. C. Meymott Tidy shows that the character of the water supplied to the metropolis during the past month has been in every respect excellent. The mean ratio of brown to blue tint of colour in the Thames-derived water was found to be as 11·4:20; while the mean proportion of organic carbon was ·128 part in 100,000 parts of the water, with a maximum in any one sample examined of ·148 part; this maximum of organic carbon corresponding to just over a quarter of a grain of organic matter per gallon.

A PAPER was recently read before the Paris Academy of Sciences on the electric conductibility of solid mercury and of pure metals at low temperatures, by MM. Cailletet and Bouty. From numerous experiments made with mercury, silver, tin, aluminium, magnesium, copper, iron, and platina, the authors conclude that the electric resistance of most pure metals decreases regularly when the temperature is lowered from 0 deg to −123 deg., and that the coefficient of variation is apparently much the same for all. It seems probable that the resistance would become extremely slight at temperatures lower than −200 deg., although this point has not yet been practically tested.

M. P. GABRIEL gives the following method of tempering steel, in the *Revue Chronometrique*:—Cyanide of potassium is dissolved and red heated in a metallic or earthen crucible; the pieces of steel are then immersed in the liquid until red, and afterward plunged in water. This process is said to give great satisfaction, and many advantages are claimed for it. The temper is said to be harder, and if a finished piece is under treatment the polish is not lost. It will show a greyish tint, but the original polish will reappear immediately, if a piece of polished wood with the finest rouge is passed over it. It is also said that if the steel has been well annealed, and not put out of shape by the file or the hammer, it will come from the crucible perfectly straight; arbors 4 or 5 centimetres long are not deformed, if tempered by this method. It is recommended as particularly advantageous for tempering escapement springs.

THE incandescent lamp life test which has been going on at the Franklin Institute, Philadelphia, has reached its 1064th hour. The *Scientific American* says the Edison, the Weston, the Stanley, and the Woodhouse and Rawson companies competed. The Sawyer-Man and Brush-Swan companies were invited, but declined to participate in the trial. Extraordinary precautions were taken to prevent access to the lamps except by members of the committee. The lamps were lighted on April 11th, and have burned ever since. At 11.35 this morning the Edison Company, who had entered 21 lamps, had lost 1; the United States Company, who entered 24, had lost 17; the Stanley Company had lost 19 out of 22, and Woodhouse and Rawson, an English firm, had lost 11, or their whole number entered. The Edison Company used the natural fibre bamboo carbon, while the Weston people used the artificial tamidene carbon.

SOME curious statements on tempering steel are made in a paper published in *Dinglers' Polytechnic Journal*, vol. 225, by Herr A. Jarolimek, "On the Influence of the Annealing Temperature upon the Strength and the Constitution of Steel." Hitherto it has been generally considered that to obtain a specified degree of softness it is necessary to heat the hard steel to a particular annealing colour—that is to say, to a definite temperature—and then allow it to rapidly cool. Thus, for example, that steel might anneal—be tempered—yellow, it had to be heated to 540 deg., and the supposition was formed and acted upon that it must be allowed only a momentary subjection to this temperature. Herr Jarolimek says the requisite temper which is obtained by momentarily raising the temperature to a particular degree, can also be acquired by subjecting the steel for a longer time to a much lower temperature. For example, the temper which the annealing colour—yellow—indicates can be obtained by exposing the hard steel for ten hours to 260 deg. of heat; in other words, by placing it in water rather above the boiling point.

A PAPER was read in April before the Royal Society "On Magnetisation of Iron," by Dr. Hopkinson. It contained an account of the results of experiments which have been made on a considerable number of samples of iron and steel of known composition, including samples of cast iron, malleable cast iron, wrought iron, ordinary steels, manganese, chromium, tungsten, and silicon steels. The electrical resistance and the magnetic properties are determined in absolute measure. Amongst the electrical resistances the most noteworthy fact is the very high resistance of cast iron—as much as ten times that of wrought iron. The fact that manganese steel is almost non-magnetic is verified, and its actual permeability measured. The action of manganese appears to be to reduce the maximum magnetisation of steel, and in a still greater ratio the residual magnetism, but not to affect the coercive force materially. It is shown that the observed permeability of manganese steel containing 12 per cent. of manganese would be accounted for by assuming that this material consists of a perfectly non-magnetic material, in which are scattered about one-tenth part of isolated particles of pure iron. Some practical applications of the results are discussed.

AT the meeting of the Royal Geographical Society on the 23rd inst., Sir Peter Lumsden read a paper on the countries and tribes he has recently visited west of Afghanistan. He gave an interesting description of the geography of the Murghab valley and the customs of its people, and quoted a singular account of the Numaksar, or salt lakes of Yar-oilan, visited and described by Captain Yate. He said: "The valley of the lake from which the Tekke Turkomans from Merve get their salt is some six miles square, and is surrounded on all sides by a steep, almost precipitous, descent impassible for baggage animals, so far as I am aware, except by the Merve road, in the north-east corner. The level of the lake I made to be about 1430ft. above sea level, which gives it a descent of some 400ft. from the level of the connecting ridge, and of some 950ft. below the general plateau above. The lake itself lies in the centre of the basin above described, and the supply of salt in it is apparently unlimited. The bed of the lake is one solid mass of hard salt, perfectly level, and covered by only 1in. or two of water. To ride over it was like riding over ice or cement; the bottom was covered with a slight sediment, but when that was scraped away the pure white salt shone out below. How deep this deposit may be it is impossible to say, for no one has yet got to the bottom of it. To the east of the dividing ridge is the second lake, from which the Saryks of Penj-deh take their salt. The valley in which this lake is situated is much the larger of the two. The valley proper is itself some fifteen miles in length by about ten miles in breadth. The salt in this lake is not smooth as in the other, and did not look so pure. It is dug out in flakes or strata, generally of some 4in, in thickness, is loaded into bags and carried off on camels for sale without further preparation."

MISCELLANEA.

Nature says it is contemplated to use the electric light in Algiers for night work during harvest time, in order to escape the heat, which is just too much for Europeans, and is an obstacle to their carrying on agricultural work.

THE first annual dinner of the University College Engineering Society was held last Tuesday evening at the Holborn Restaurant. The attendance was large. Among others present were Mr. Bryan Donkin, Mr. Rich, Mr. C. E. Stromeyer, and others. Professor Alex. B. W. Kennedy, president of the society, occupied the chair.

THE Russian papers say that, at the request of General Komaroff, Governor of the Transcaspian region, the Minister of War has recognised the urgency of immediately establishing a line of telegraph connecting Merv with Askabad. This line would pass by Annow, Babadoorma, Bougatchik, Artchigan, and Sarakhs. Its length will be 500 versts, and the expense about 100,000 roubles.

MESSRS. ROSE, DOWNS, AND THOMPSON, of Hull, have published an exceedingly well-finished new edition of their catalogue of oil mill machinery, oil refining plant, warehouse and other hydraulic machinery and appliances. It is well got up for office use, and is bound with a sheet of paper between each two pages for notes, &c. We notice that a first-class medal for oil mill machinery has been awarded this firm at New Orleans.

STRIKES and rumours of intended strikes are on the increase in Germany, and some of the revelations as to the "starvation" wages that prevail in certain branches of labour are somewhat startling. Thus the linen weavers of Erdmannsdorf, a village in Silesia, have ceased work in an attempt to secure an advance of about 20 per cent. on their wages, which average six and a-half marks per week for twelve hours' work per day, and seldom or never exceed nine marks, equivalent to as many shillings.

IT is said that the construction of a ship railway to connect the Bay of Fundy with the Gulf of St. Lawrence has been finally decided on. Ships of 1000 tons and under will thus be able to reach St. John from Montreal, Quebec, and other ports on the St. Lawrence, without having to encircle the dangerous Nova Scotian coast, a saving of 600 miles. The ship railway, which is to be seventeen miles long, will, it is expected, be supported by a subsidy of £60,000 per year for 20 years from the Canadian Government.

A FLOATING dome was some time since presented by M. Bischoffsheim to the Observatory at Nice. It is intended to cover a colossal telescope; it is 22 m. in diameter inside, and has a circumference of 60 m., or 2 m. more than the dome of the Pantheon. Instead of rendering it movable by placing it on rollers, according to the ordinary method, it is closed below by a reservoir for air, which rests on the water in a circular basin. This system of suspension is said to be so perfect that, in spite of its great weight, a single person can turn it completely round the horizon.

ACCORDING to the report of Dr. Frankland on water supplied to the metropolis during May, the Thames water sent out by the Chelsea, West Middlesex, Southwark, Grand Junction, and Lambeth Companies exhibited a further improvement as regards organic matter, the average proportion being even less than in any month of last year. All the waters were clear and bright on delivery. Of the water drawn from the Lea, that distributed by the New River Company was, as regards organic matter, second only to the best of the deep-well waters; while the East London Company's supply contained rather more organic matter than the Thames waters. Both samples were clear and bright.

THE longest bicycle ride ever made has just been completed by Mr. H. R. Goodwin, of the North Manchester Club. Leaving Land's End on June 1st, he journeyed to John o' Groats, having reached which point in 7½ days, he at once turned southward, and again arrived at Land's End on the 16th, the double journey of about 1750 miles, or from one extremity of England to the other, having occupied less than sixteen days. From Land's End he rode to London, which was reached on the 19th, the rider having thus completed a journey of 2050 miles in exactly nineteen days, or an average of 108 miles per day. Mr. Goodwin rode a 40in. "Facile" safety bicycle, and arrived in London well.

A SELECT Committee of the House of Lords, presided over by the Duke of Richmond, has passed the Southwark and Vauxhall Water Bill, which empowers that company to construct a reservoir at Forest Hill, in order to give a high-service pressure to Wimbledon. It also enables the company to affix stop-cocks to every service pipe in their district for the purpose of preventing and detecting waste, which stop-cock must be paid for by the consumer. The Bill also empowers the company to raise £250,000 additional capital, but the Committee have inserted a clause compelling the company to raise the sum by debenture stock to be issued by public tender at par. The clause by which the company sought powers to purchase the dust-sifting yard near their Battersea filter beds was struck out on the opposition of the Brighton Railway Company, the owners of the yard.

THE New British Iron Company, which by-the-bye is one of the oldest iron manufacturing companies in this country, has awoke to the fact that the printing machine may in various ways facilitate the communication from manufacturer to consumer of information and that the latter will not hunt up for himself when there are so many ready to supply it. Old reputations are not sufficient to make new consumers run after those possessing them, and hence the New British Iron Company has just published a well-executed catalogue of its manufactures in iron and steel. This company has always produced first-class irons, and its brands, Lion, Corngreaves, and Ruabon, are known to thousands who do not know to whom they belong. The company now makes steel by the open-hearth process in six different grades, and no doubt will acquire the same high reputation which it has held for iron manufacture. The New British Iron Company was established in 1825.

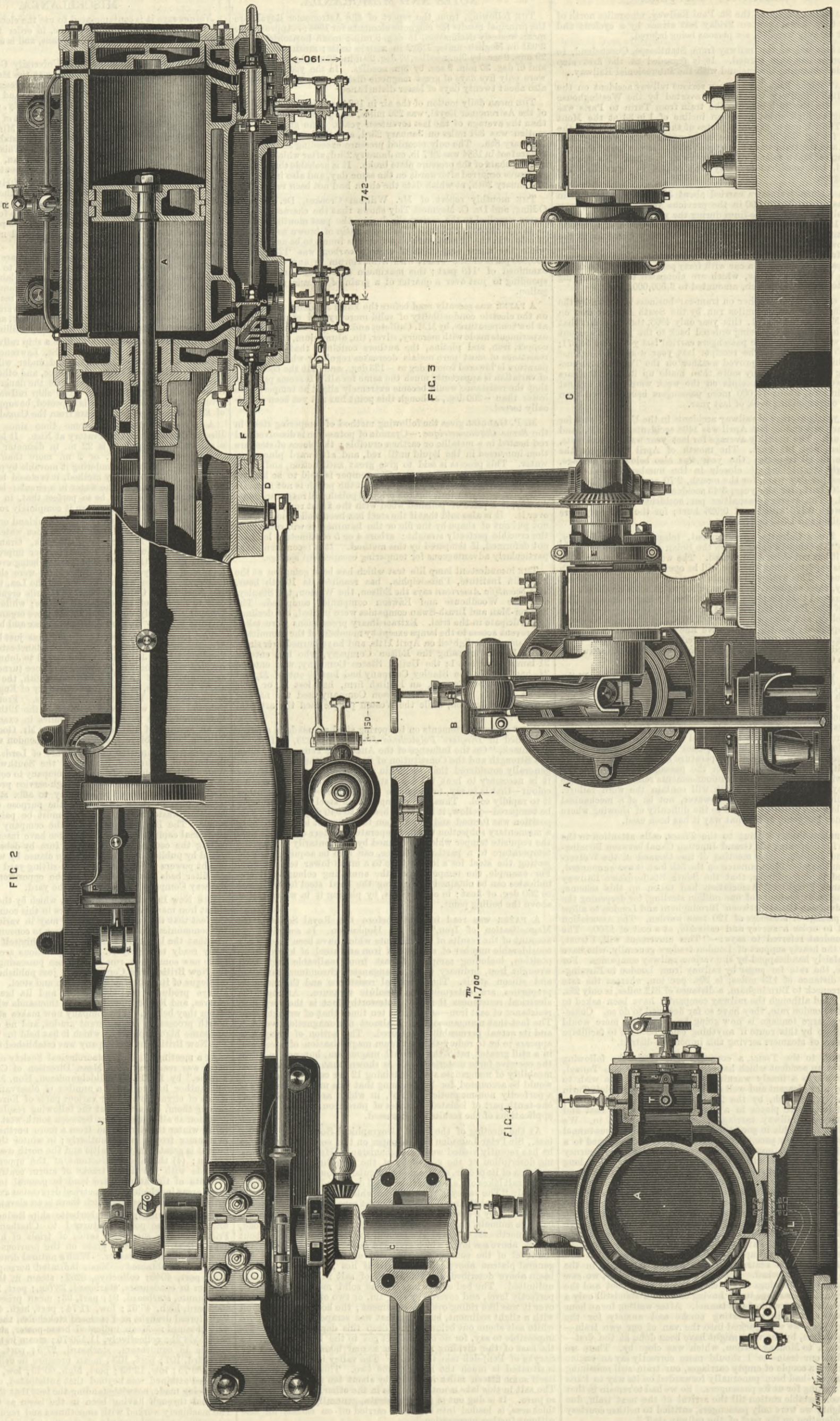
AT a meeting of the Meteorological Society on the 17th inst. a paper was read on "The Mean Direction of Cirrus Clouds over Europe," by Dr. H. H. Hildebrandsson, Hon. Mem. R. Met. Soc. The author has collected a number of observations on the movements of cirrus clouds over various parts of Europe, and after discussing them, has arrived at the following results:—(1) The mean direction at all stations lies between south-west and north-west; (2) in winter the cirri come from a more northerly direction, and in summer from a more southerly; in winter the northerly component is greater on the Baltic and the north coast of the Mediterranean; (4) the mean directions of the upper currents nearly coincide with the mean tracks of storm centres; (5) the upper currents of the atmosphere tend in general to flow away from those areas in which a barometrical depression exists at the earth's surface towards those in which there is an elevation of pressure.

THE steel armour-plated barbette ship Rodney, ten guns, 9600 tons, 7000-horse power, returned to Chatham Dockyard last Friday, after a successful series of trials of her engines. The official trial, which took place on the previous day, was of the most satisfactory character. With a natural draught the following results were obtained:—Mean indicated horse-power, starboard, 4222; port, 4040; collective, 8262; steam in the boilers, 89 lb.; vacuum in condensers, starboard, 28·5in.; port, 28in.; revolutions per minute, starboard, 94; port, 93; mean pressure in cylinders, starboard, high, 45·61; low, 11·74; port, high, 43·44; low, 11·50. With forced draught and enclosed stokeholes, the following results were obtained:—Mean indicated horse-power, starboard, 5598·55; port, 5558·21; collectively, 11,156·76; steam in the boilers, 90 lb.; vacuum in condensers, starboard, 27·5; port, 28; revolutions, starboard, 104; port, 103; mean pressure in cylinders, starboard, high, 59·75; low, 12·83; port, high, 60·10; low, 12·78. The rate of speed attained was beyond that anticipated, over 17 knots per hour being made, notwithstanding the fact that the vessel's bottom was foul through having been in the basin at Chatham so long. The machinery worked with smoothness and regularity, the boilers generating an ample supply of steam, and no hitch occurred.

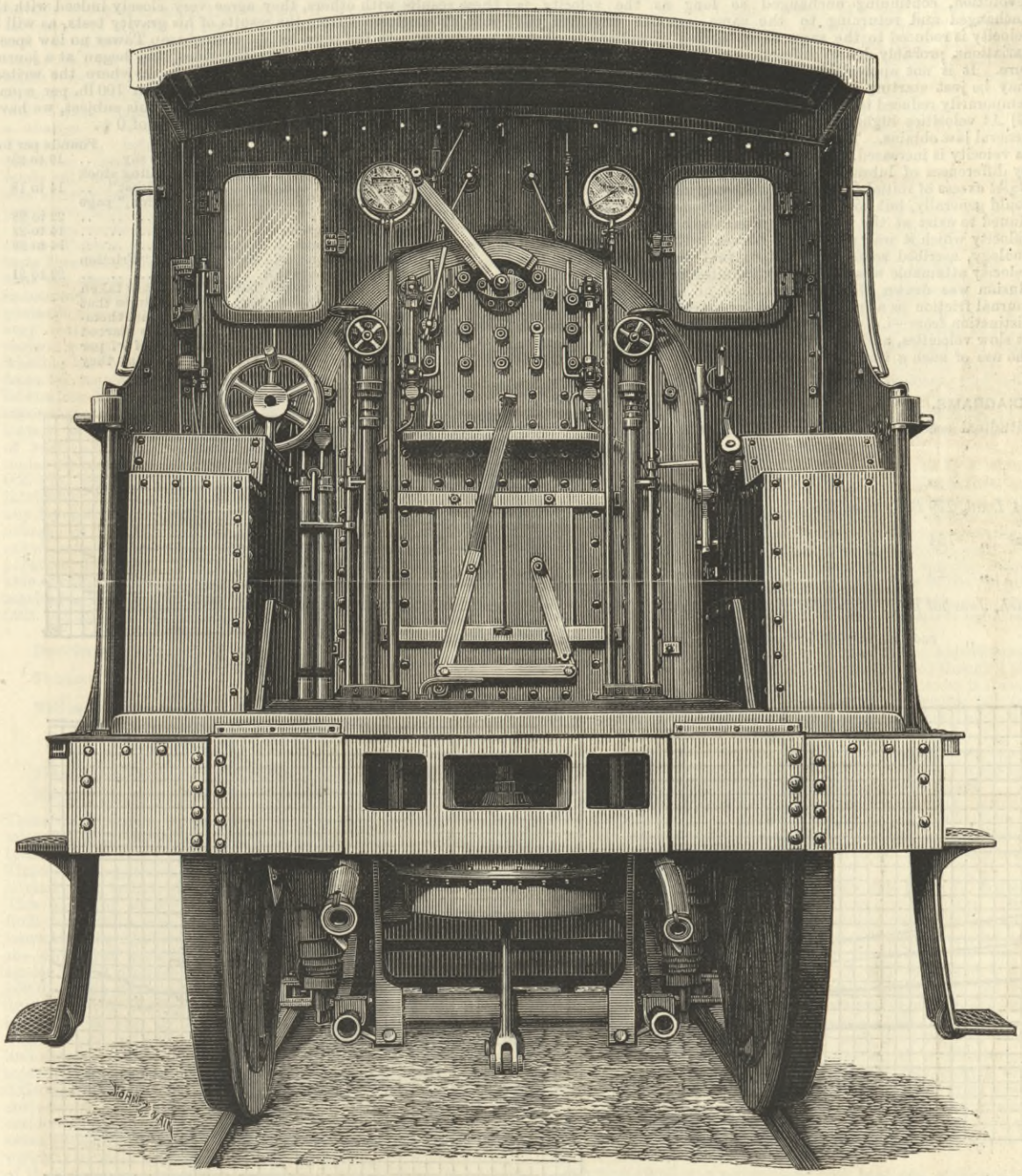
50-HORSE POWER HORIZONTAL CONDENSING ENGINE.

CONSTRUCTED BY THE SOCIÉTÉ LYONNAISE, PARIS.

(For description see page 497



FOOT PLATE OF G. S. AND W. R. ENGINE.



PASSENGER ENGINE, GREAT SOUTHERN AND WESTERN RAILWAY, IRELAND.

ON page 500 we illustrate one of several new engines with 6ft. 6in. drivers, constructed by Mr. J. A. F. Aspinall, locomotive superintendent of the Great Southern and Western Railway, for working the passenger traffic of the line. Above we give a view of the foot-plate. Mr. Aspinall, it will be remembered, succeeded Mr. Macdonall as locomotive superintendent at Inchicore, when the latter gentleman went to the North-eastern Railway. Mr. Aspinall does not lay claim to the design of this engine we illustrate as a whole, because he has carefully made every part interchangeable with other engines already on the line. The working parts also interchange with the goods engines, and although Mr. Aspinall has got a more powerful passenger engine than was before built at Inchicore, there are still only three classes of engines on the line. The arrangement for the vacuum brake is one introduced by Mr. Aspinall, which gets rid of useless piping. The ejector is placed in the smoke-box, and bolted on to the cylinders, round which air passages are cast. These passages are continued to the back end of the cylinders; from these run two pipes to the engine foot-plate. A flap valve is placed in the pipe near each cylinder in a position in which it can be readily got at, and one in which it is prevented from freezing up in the winter. At the footplate the pipes are cast in, thus getting rid of a number of joints liable to leakage, and making a neat-looking arrangement. The old method of running the pipes along under the outside footplating was bad, because if an outside rod broke all the piping was knocked away, and the brake rendered useless.

From the end view of the footplate it will be seen that two glass water gauges are fitted, a Shendley's speed indicator, and a duplex vacuum gauge, with other ordinary fittings.

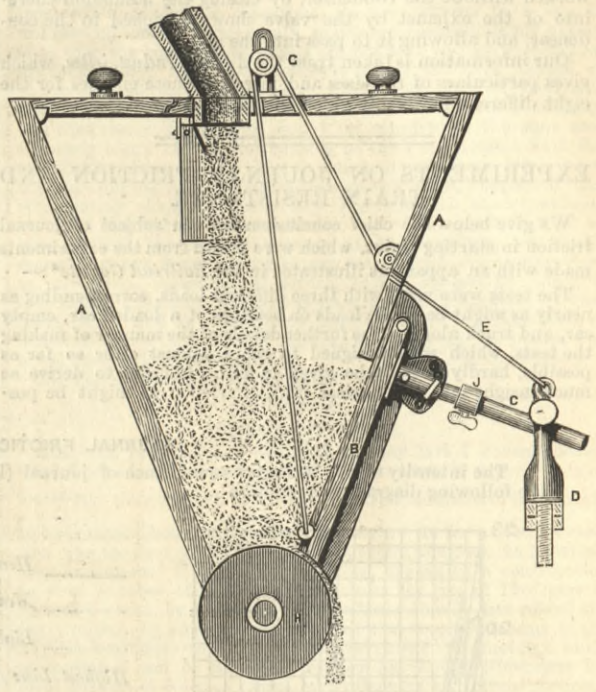
Cylinders—	
Diameter	18in.
Stroke	24in.
Distance apart between centres	2ft. 6½in.
Length of ports	13⅜in.
Width of steam port	1½in.
Width of exhaust port	3⅜in.
Width of bars	1in.
Lap of slide valve	⅞in.
Lead of slide valve, full gear	⅛in.
Travel of valve, full gear	3⅞in.
Motion—	
Throw of excentrics	2⅜in.
Diameter of piston-rods	3in.
Length of connecting-rod between centres	5ft. 7in.
Length of excentric-rod between centres	3ft. 10⅜in.
Wheels—	
Diameter of driving wheels	6ft. 6in.
Diameter of trailing wheels	6ft. 6in.
Diameter of bogie wheels	3ft.
Distance between centres of bogie wheels	5ft. 3in.
Distance between centres of bogie and driving wheels	9ft. 6⅜in.
Distance between centres of driving & trailing wheels	8ft. 3in.
Total wheel base	20ft. 4½in.
Width of tires	5½in.
Thickness of tires	3in.
Boiler—	
Length of barrel	9ft. 9½in.
Diameter of barrel inside at middle	4ft. 3in.
Thickness of plates of boiler shell	½in.
Boiler—	
Thickness of smoke-box tube plate	⅜in.
Length of fire-box casing outside	3ft. 5in.
Width of fire-box casing outside	4ft. 6in.
Depth below centre line of boiler	5ft. 2in.
Height above centre line of boiler	2ft. 3in.
Thickness of plates	½in.
Frames—	
Distance apart of frames	4ft. 7in.
Thickness of frames	1in.
Distance apart of bogie frames	4ft. 6½in.
Thickness of bogie frames	⅜in.
Fire-box—	
Length of fire-box at top, outside	4ft. 10$\frac{13}{16}$in.
Length of fire-box at bottom, outside	4ft. 11in.
Width of fire-box at top, outside	3ft. 11in.
Width of fire-box at bottom, outside	4ft.
Height of fire-box	5ft. 9$\frac{15}{16}$in.
Thickness of plates	$\frac{9}{16}$in.
Thickness of tube plate	⅜in. & $\frac{9}{16}$in.
Tubes—	
Number of tubes	204
Length of tubes between plates	10ft. 0$\frac{9}{16}$in.
Diameter of tubes outside	1⅝in.
Thickness of tubes	9 & 11 s.w.g.
Diameter of blast nozzle	4⅜in.
Inside diameter of chimney at top	14½in.
Inside diameter of chimney at bottom	15½in.
Bogie springs—	
Description	Volute
Depth of spring	10½in.
Diameter of spring	5in.
Thickness of plate	¼in.
Driving and trailing springs—	
Description	Volute
Depth of spring	10½in.
Diameter of spring	5⅜in.
Thickness of plate	¼in.
Heating surface—	
Tubes (outside) between plates	938 sq. ft.
Fire-box (outside), less ring at bottom, fire-hole and tube-holes	113ft.
Total heating surface	1051 sq. ft.
Fire-grate area	18¾ sq. ft.

Weight in working order—	tons	c.	qrs.
Bogie	13	12	0
Driving wheels	12	19	0
Trailing wheels	12	19	0
Total	39	10	0
Empty—			
Bogie	12	10	0
Driving wheels	11	15	0
Trailing wheels	11	15	0
Total	36	0	0

The gauge, 5ft. 3in., gives the designer of Irish locomotives splendid opportunities, and of these Mr. Aspinall has availed himself, and produced an engine handsome to look at, well made, and thoroughly suited to the work which it has to do.

WALSH'S SELF-REGULATING MILL AND PURIFIER FEED.

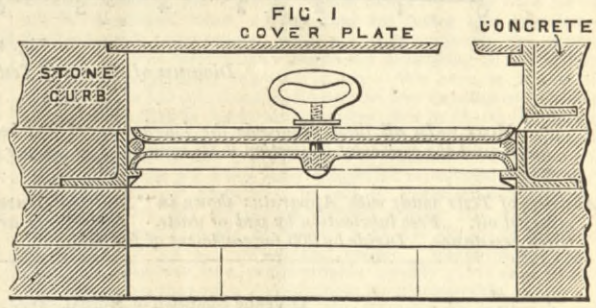
IN the East Annexe of the Inventions Exhibition Mr. J. E. Walsh, of Crossley-street, Halifax, exhibits the self-regulating feed for roller mills and purifiers illustrated by the annexed engraving, in which A is the hopper, B is a pivotted door, to which is attached a pivotted adjustable inclined stud or lever C; upon the lever is a sliding weight D; to the weight is attached a cord or chain E, passing over the pulley G at the top part of the hopper; the pulley G is adjustable, and regulates the

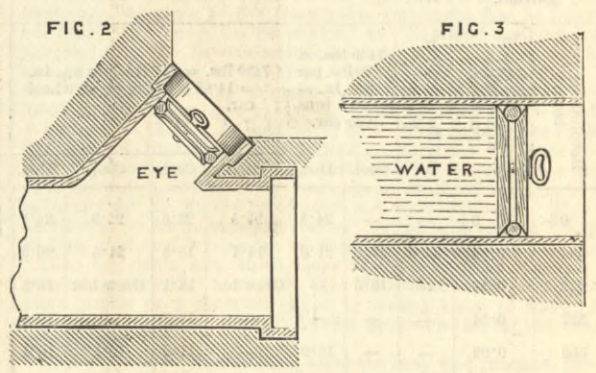


position of the sliding weight upon the lever C; the chain E passes down the inside of the hopper to the bottom of the pivotted door, to which is attached the sliding weight D upon the rod or lever C, keeps the door against the feed roller H, and so evenly distributes the contents of the hopper to the crushing rollers below the sliding weight, acting both upon the lever and upon the bottom of the door or valve by means of the chain; when a flush or flooding of the hopper takes place, the door, after offering the necessary resistance, opens, and as it opens the gradient of the lever is decreased, so that there is both less pull and leverage upon the door. As the feed supply increases or diminishes, the weight moves automatically upon the inclined lever, acting as a perfect governor to the feed. The collar J acts as a limit or check to the door or valve. The limit or check and the amount of weight or pull upon the door are easily and readily adjusted. The gradient of the sliding weight is also adjustable.

BOTTING'S AIR-TIGHT COVERS AND PLUGS.

THE accompanying engravings represent a form of air-tight cover for sanitary and other work, and in small size for permanently or temporarily stopping water, gas, ventilating or sewer pipes. Fig. 1 shows the larger size cover as an air-tight cover plate. It consists of two discs, between the flanges of which is an india-rubber ring, which is forced outward when squeezed by screwing the discs together by the bolt shown.





The action is precisely the same as with the world-known Thomson's pickle bottle stopper. Figs. 2 and 3 show a smaller form of the plug in different applications, such as stopping a clearing socket in a drain and stopping a water pipe. They are also used for stopping drain and ventilating pipes during a smoke or water test. Mr. F. Botting, Baker-street, W., is the maker.

FIFTY-HORSE HORIZONTAL ENGINE.

THE engine which we illustrate by the engravings on pages 480 and 496, is one of a type made by the Société Lyonnaise, Paris It has been fixed in the Hotel du Crédit, Lyonnais, Paris, for driving the dynamo-electric machines, which provide current for the Brush lamps, by which this establishment is lighted.

The distribution of the steam is effected by means of the excentric E and two Farcot valves T T^1 on the one spindle F guided by the slide D. On the back of the valves slide two cut off valves t t^1, the movement of which is determined by the governor through the medium of two half cams. On the axes of these cams are fixed two helicoidal pinions, movable by the two screws and the hand-wheel G. By this means the position of the cams is adjustable, and thereby the cut off, through a range of from one-fifteenth to one-half the stroke. The arrangement secures very short steam ports. The governor is of the Buss type, driven by gearing, and steadied by an air cushion in the cylinder H. The engine is fitted with an injection con-

denser, the double-acting air pump, of which is actuated by a bell-crank lever, and the rod worked from the crank. The bell-crank lever also operates the feed-pump. The cylinder and its ends are steam-jacketted. The condensed water-cocks in the cylinder are both moved by one lever L, and the pipes from them converge in a cock R. The engine, in case of need, can be worked without the condenser, by closing the admission thereinto of the exhaust by the valve shown attached to the condenser, and allowing it to pass into the air.

Our information is taken from the *Annales Industrielles*, which gives particulars of the sizes and prices of these engines for the eight different powers in which they are made.

EXPERIMENTS ON JOURNAL FRICTION AND TRAIN RESISTANCE.

WE give below the chief conclusions on the subject of journal friction in starting trains, which were drawn from the experiments made with an apparatus illustrated in the *Railroad Gazette** :—

The tests were made with three different loads, corresponding as nearly as might be to the loads on bearings of a loaded car, empty car, and truck alone. The further details of the manner of making the tests, which were designed to guard against error so far as possible, hardly need to be given in full. In order to derive as much insight into the general laws of friction as might be possible from these tests, they were compared with those previously made by the writer on railroad rolling stock by the gravity method already referred to with the very complete and thorough investigations of Prof. R. H. Thurston, as set forth in his treatise on the subject, and with a still more complete series of tests recently made in England by Mr. Beauchamp Tower, under the auspices of the Institution of Mechanical Engineers. In the apparatus for the latter tests a suspended dead load was used of the actual weight which it was desired to throw upon the bearing, instead of using springs, as in Professor Thurston's apparatus or leverage, as in the writer's. Mr. Tower's investigations, however, did not touch at all on one of the chief ends to which the writer's tests were directed, viz.:—

Initial friction in starting trains.—The observations under this head were exceptionally complete, and the conclusions reached were as follows:—(1) Friction at very low journal speed of 0 + is abnormally great, and more nearly constant than any other element of friction, under varying conditions of lubrication, load, and temperature. It varies from 18 to 24 lb. per ton (coefficient 0·09 to 0·12) for load of from 30 to 280 lb. per square inch. Within those limits it is not greatly modified by load or temperature. (2) This abnormal increase of friction is due solely to the velocity of revolution, continuing unchanged so long as the velocity is unchanged and returning to the same amount whenever the velocity is reduced to the same rate, barring exceptionally slight variations, probably due to differences of lubrication and temperature. It is not appreciably affected by the fact that the journal may be just starting into motion, or is just coming to rest, or is temporarily reduced to a velocity of 0 + during continuous motion. (3) At velocities higher than 0+, but still very low, the same general law obtains. The coefficient falls very slowly and regularly as velocity is increased, but is constantly more and more affected by differences of lubrication, load, and temperature. (4) A *very slight* excess of initial friction proper—varying from ¼ lb. to 2 lb.—could generally, but not always, be observed over that which continued to exist at the nearest approach to a strictly infinitesimal velocity which it was possible to obtain. This difference was by analogy, ascribed solely to the fact that the lowest continuous velocity attainable was not strictly infinitesimal, and the final conclusion was drawn that—(5) There is no such phenomenon in journal friction as a friction of rest or a friction of quiescence, in distinction from—*i.e.* differing in amount from—friction of motion at slow velocities, and due to the fact of quiescence. Consequently, the use of such a term, although convenient, is scientifically inaccurate, in that it ascribes the phenomenon to the wrong cause, and to a cause which is not necessary for its existence. The fact that friction of rest, as such, appears to exist, is due solely to the fact that no journal or other solid body can be instantly set into rapid motion by any force, however great. There must be a certain appreciable instant of time during which the velocity is infinitesimal and gradually increasing. This interesting fact, which is believed to have been here observed for the first time—no other apparatus being known to have been used suitable for determining it—was determined with great completeness by many tests. Very slow motion could be produced at any time by revolving the driving pulley of the lathe by hand when geared for a slow speed. With a little experience, the weight on the scale-beam could be placed in advance at a point which would be a trifle less than the initial friction proper, and—when properly placed—it would barely lift when motion first began, and then have to be moved back a notch or two only, to weigh the friction which continued to exist indefinitely. Similarly, when a test at comparatively high speed was about to be concluded, the scale-weight would be placed to measure the same pressure, or a little less, as existed in starting, and it was always found to indicate in stopping substantially the same friction as in starting. The same test was made by interrupting tests at speed, so as to give a continuous motion, but to suddenly reduce the speed to 0+. These tests were repeated again and again, with practically identical results. Comparing these results with others, they agree very closely indeed with the writer's conclusions from the results of his gravity tests, as will be seen below. In the tests by Mr. Beauchamp Tower no low speeds nor low pressures at all were tested, since they began at a journal speed corresponding to twelve miles an hour, where the writer's tests left off, and gave no pressure less than 100 lb. per square inch. Including all other known results on this subject, we have :—"Initial" journal friction—*i.e.*, at velocity of 0+.

	Pounds per ton.
Writer's conclusions from journal tests, above say.. ..	19 to 25
Writer's conclusions from gravity tests of rolling stock (see Trans. Am. Soc. C.E., Feb., 1879), "at least" ..	14 to 18
Prof. R. H. Thurston ("Friction and Lubrication," page 175), W. Va. oils	22 to 28
" sperm	14 to 28
" lard..	14 to 22
Prof. Kimball (*Am. Jour. Sci.*, March, 1878, or "Friction and Lubrication," page 186)	22 to 31

In addition, it may be noted that the writer has taken pains to observe with some care at various times that in ordinary service no railroad cars can start themselves from rest, nor can they, in general, be started without the use of much force, on a grade of 0·7 per cent. (= 14 lb. per ton, 36ft. per mile), but that they will generally, but not always, start of themselves on a grade of 1·1 to 1·2 per cent. (= 22 lb. to 24 lb. per ton, 58ft. to 63ft. per mile), indicating an "initial" friction of .. .. 20 to 24

These results agree wonderfully well with each other, the averages running 18 lb., 16 lb., 25 lb., 20 lb., 18 lb., 25½ lb., and 22 lb. per ton, the average of all being 18·0 lb. to 25·0 lb. per ton, or 20½ lb., as the general average of all. This corresponds to the accelerating force of gravity on a 1 per cent. grade, and that being also the lowest grade, upon which cars can be relied on to start off from a state of rest, the correctness of this coefficient may be considered as well determined.*

* On a 0·7 per cent. grade—14 lb. per ton—the writer found it impossible in several instances for six men pushing, two with pinch bars, to start two loaded box-cars into motion. In no single instance out of over sixty did cars start without some assistance. This indicates that a statement on page 14 of "Friction and Lubrication," "The resistance in starting . . . has for its measure ⅜ of 1 per cent., or 8½ lb. per ton," requires correction; being inconsistent, indeed, with experimental results given in the same volume.

* "Experiments with New Apparatus on Journal Friction at Low Velocities." By A. M. Wellington, C.E. Trans. Am. Soc. C.E., December, 1884.

JOURNAL FRICTION DIAGRAMS.

The intensity of the strain per square inch of journal (longitudinal section) is indicated graphically in this and the following diagrams, as follows:—

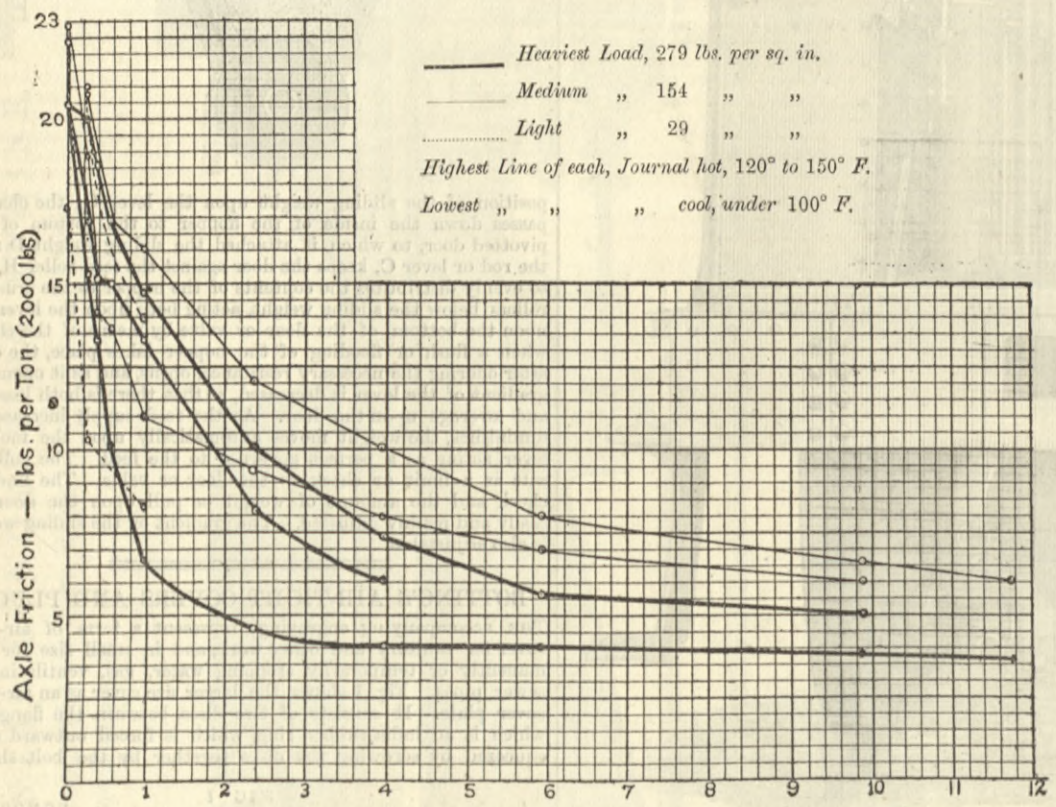


Fig. 1.

Diagram of Results of Tests as Tabulated below.

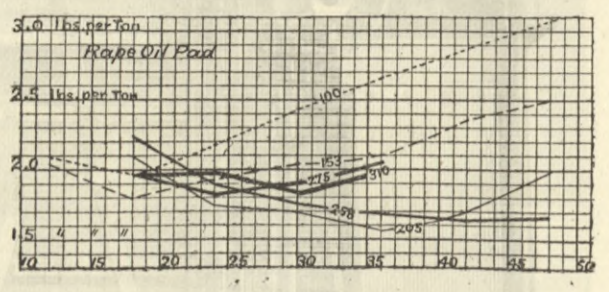
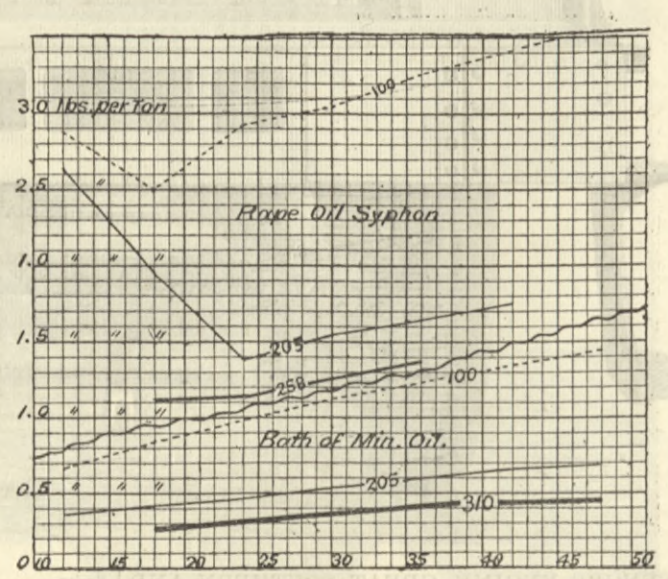


Fig. 2



Figs. 3 and 4.

Results of Mr. Beauchamp Tower's Tests, giving Effects of High Velocity, Variation of Pressure, and Differences of Lubrication upon Coefficient of Friction.

NOTE.—*In all these diagrams the journal speed has been reduced to its equivalent train velocity in miles per hour, and the coefficient of friction to its equivalent in lbs. per ton tractive resistance to the locomotive.*

Abstract of Tests made with Apparatus shown in "Railroad Gazette," May 22nd.—West Virginia mineral oil. Free lubrication by pad of waste. Resistances are expressed in pounds per ton of train resistance. Divide by 200 for coefficient of friction.

Speed of journal.		Load and condition of journal. ($3\frac{7}{8} \times 7$.)									Higley roller B'r'g.	
Revolutions per hour.	Equivalent speed of car miles per hour.	205 lbs = 8·5 per sq. in.	1439 lbs. = 29 lbs. per sq. in. = 2·88 tons per car.		7439 lbs. = 157 lbs. per sq. in. = 14·88 tons per eight-wheel car.				13,439 lbs. = 279 lbs. per sq. in. = 26·88 tons per eight-wheel car.			Load, 7439 lbs. +	Load, 13,439 lbs. +
			Cool.	Hot.	Cool.	Cool.	Cool.	Hot.	Cool.	Warm	Hot.		
0+	0+	—	—	24·5	21·5	23·6	22·9	24·1	{22·4 / 20·0}	20·9	20·9	6·7	4·9
144	0·24	24·5	17·3	21·0	14·1	18·8	21·5	20·8	15·3	16·9	20·1	6·2	4·8
212	0·37	—	10·3	—	Grew hot	14·1	Grew hot	18·8	13·3	15·2	18·6	5·9	4·8
327	0·54	—	—	—	—	13·7	—	17·0	10·1	15·0	16·9	5·6	4·7
600	0·98	—	—	13·9	—	11·0	16·1	16·1	6·7	13·3	14·6	5·6	4·6
1440	2·36	—	8·3	—	—	9·4	Cooled in	12·1	4·6	8·1	10·0	4·8	3·5
2400	3·93	—	—	—	—	8·0	water	10·5	4·1	6·1	7·4	4·0	3·1
3600	5·89	—	—	—	—	7·0	6·7	8·0	4·1	—	5·7	—	2·7
6000	9·82	—	—	—	—	6·0	—	6·7	3·8	—	5·0	3·0	2·2
7200	11·78	—	—	—	—	5·1	—	6·0	3·6	—	—	—	—

Velocity in miles per hour × 9 = (approximately) journal speed in feet per minute.

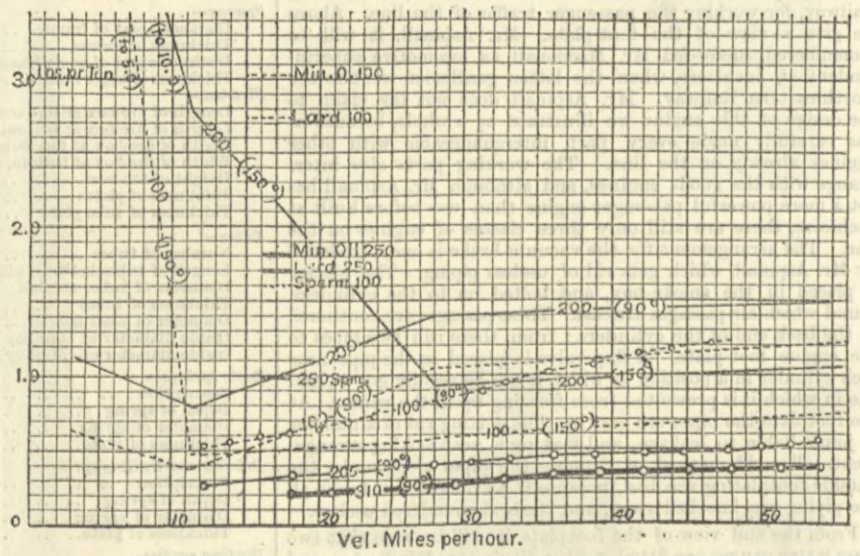


Fig. 5.

Comparative Results of Professor R. H. Thurston's Tests with Sperm Oil and Mr. Beauchamp Tower's Tests with Sperm Bath. The latter indicated thus: —o—o—o—o—

The most notable fact in this diagram is, that while Thurston's and Tower's tests agree almost precisely, with sperm oil, at 90 deg. temperature and 100 lb. per square inch, increasing the pressure to 200 lb. per square inch caused a marked *increase* of coefficient in Thurston's tests and an equally marked *decrease* in Tower's tests. Intensity of load per square inch indicated by thickness of lines.

But as respects the friction of journals when coming to rest, Professor Thurston's results differ markedly from the writer's. He finds this friction, "at the instant of coming to rest," to be nearly constant instead of varying considerably, with the pressure, and to be equivalent to only 5 lb. or 6 lb. per ton, in some cases only 2 lb. or 3 lb. per ton,* instead of 14 lb. to 28 lb. per ton, as at the instant of starting. It seems rational that there should be this difference, since the journal is more likely to be well lubricated in coming to rest; but the writer did not find it so, and the point was tested so many times in so many different ways, that he feels compelled to believe that the discrepancy arises from the theoretical deficiency in Professor Thurston's apparatus, before alluded to, for testing rapidly varying and almost instantaneous changes of coefficient. That such a change of resistance, if it be called upon to do work dynamically, before it can express itself statically upon the index, cannot but introduce a possible source of error, is made still plainer if we remember that a force of this kind which was strictly instantaneous, however great, could not move the pendulum, and hence express itself upon the index at all.

Normal coefficient of journal friction at ordinary operating velocities.—Certain general facts seem to be clear from all the various tests here considered. The first and most important of these is that the character and completeness of lubrication seems to be immensely more important than the kind of the oil, or even pressure and temperature, in affecting the coefficient. This is very clear from the diagrams—Figs. 1 to 5—showing the various results. Mr. Tower found that lubrication by a bath, whether barely touching the axle or almost surrounding it, was from six to ten times more effective in reducing friction than lubrication by a pad. By this method of lubrication Mr. Tower succeeded in reducing the coefficient in a large number of tests to as low a point as 0·001, equivalent to only 0·2 lb. per ton of tractive resistance, and the general average in the bath tests, under all varieties of load and speed, is given as only 0·00139, or 0·278 lb. per ton, against 1·96 to 1·95 lb. per ton with syphon-lubricator, or pad under journal. These results are very far below any heretofore reported, as will be seen from the following general average of results; not considering now the the comparatively minor variations produced by ordinary working differences in temperature, load, &c. The normal journal friction, under favourable conditions, deduced from various series of tests, may be summarised as follows for velocities greater than ten miles per hour, or 90ft. per minute, journal speed :—

	Pounds per ton.
Beauchamp Tower, bath of oil	0·278
,, ,, pad or syphon	1·9
Thurston, light loads	2·75
,, heavy loads	1·75
Wellington (gravity tests of cars in service), light loads	6·0
,, ,, ,, ,, heavy loads	3·9
,, direct tests (as shown in Fig. 2)	5·1 to 3·7
Thurston, inferior oils ("Friction and Lubrication," p. 173)	4·8 to 3·0
Morin, continuous lubrication	6·0 to 10·8

These discrepancies, especially as they are accompanied by many minor ones, are very instructive, as showing that the character of lubrication is the great cause or variation of coefficient. Thus, Thurston's experiments show almost everywhere a very marked advantage in sperm oil over all others for reducing the coefficient. This does not appear at all in Mr. Tower's tests. Thurston also finds that with sperm as a lubricant and temperature 90 deg. F., increasing the load from 100 to 200 lb. per square inch, increases the coefficient materially. On the other hand, Mr. Tower, who agrees almost precisely with Thurston with sperm at 90 deg. and 100 lb., finds that increasing the pressure to 200 lb. materially decreases the coefficient. The extent of these discrepancies is shown in Fig. 5. Other minor discrepancies of this kind might be pointed out. They are not, it is believed, to be taken as indicating a lack of either care or correctness in either experimenter, but simply as showing the overmastering effect of minute differences in the condition of the lubrication. This was also curiously shown in two ways in Tower's experiments :—(1) It was accidentally discovered that with bath lubrication the bearing is actually floated on a film of oil between the lubricated surfaces, which is so truly a fluid that it will rise through a hole in the top of the bearing in a continuous stream and exert a pressure against a gauge equal to more than twice the average pressure per square inch on the bearing. This is precisely what theory would require if the lubricant were a perfect fluid. (2) Tower's apparatus required that the journal should be revolved first one way and then the other. It was found that the friction was always greater when the direction of motion was first reversed. The increase varied considerably with the newness of the journal. "Its greatest observed amount was at starting, and was almost twice the nominal friction, and it gradually diminished until the normal friction was reached, after about ten minutes' continuous running. This increase of friction was accompanied by a strong tendency to heat, even under a moderate load. In the case of one brass which had worked for a considerable time it almost entirely disappeared." It is with apparent justice concluded that the phenomenon must be due to the interlocking, point to point, of the surface fibres after having been for some time stroked in one direction.†

In view of the variations of several hundred per cent., which are often produced in the lowest coefficients of friction by minute differences in lubrication, as shown by comparison of Thurston's and Tower's tests, and in view also of the further facts (1) that the lubrication of railroad journals is far more imperfect than an oil bath, and rarely equal even to pad lubrication, and that the oil is rarely free from dust and of uniformly good quality.

(2) That the condition of the surface of ordinary railroad journals and bearings is and necessarily must be inferior to such as are stated to have been employed in Thurston's and Tower's tests; it seems reasonable to conclude that the writer's direct tests Fig. 1) correctly represent journal friction under ordinary working conditions, and that it may be taken at 5·0 to 6·0 lb. per ton with empty cars, and 3·5 to 4·0 lb. per ton with loaded cars or heavy passsenger cars, at the velocity of minimum friction, which appears to be from 10 to 15 miles per hour.

These results closely correspond with the results obtained by the writer from gravity tests of cars in ordinary service; the latter results giving 0·5 to 1·0 per ton greater resistance, but including rolling friction between rail and wheel, as well as journal friction.

* "Friction and Lubrication," page 175. On page 209 it is stated that "it is nearly constant, and may be taken at 0·03," equivalent to 6 lb. per ton.

† The phenomenon thus observed has an interesting bearing, it may be noticed in passing, upon a theory deduced by Dr. Charles B. Dudley, chemist of the Pennsylvania Railroad, that the fibres of steel in the top of a rail head are in reality subjected to a bending stress, and it lends much support to his conclusions that such tests ought, consequently, to be an approximate measure of the probable durability.

LETTERS TO THE EDITOR.

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

THE LAWS OF MOTION.

SIR,—"Φ. Π." will, I trust, permit me to congratulate him on his good nature and his perseverance, both of which are admirable. In so far as he is an apostle of Sir William Thomson's doctrine that elasticity is a mode of motion I have no fault to find with him, and am in no concern whether the idea is or is not original on his part; but what has this doctrine to do with "the laws of motion?" I have not the slightest wish to deny that all energy may ultimately turn out to be in its essence motion—in fact, this seems extremely likely; but I deny that Newton's laws of motion require us to form an opinion on the matter one way or the other. In other words, I deny that an acceptance of this doctrine is in the least degree necessary for a comprehension of the "third law." If I may be permitted to say so, in all sincerity and politeness, "Φ. Π." does not understand the third law, though he believes he does, and he has invented an ingenious way of his own of evading or slurring over the difficulties in which such a misunderstanding would otherwise inevitably involve him. Let me further assure him that I read his letters carefully, and have not forgotten declining to write "motion" for "energy." Were every proof forthcoming that there was no energy but kinetic, I should still, just as strongly, decline this misuse of terms. (By the way "Φ. Π.'s" particular collocation of fly-wheels would not be elastic, but only viscous. He will find, however, what he is thinking after, viz., a gyroscopic model of a coach spring, depicted in Sir W. Thomson's address to Section A of the British Association at Montreal, as printed in the annual volume of the Association.)

I understood "Φ. Π." to say that "gravity had ceased to act on a freely falling stone," and I think he did say so. [Quotation from "Φ. Π.'s" letter of 29th May: "When a heavy body drops freely it ceases to have weight. In other words, gravity exerts no push on it . . . . no force of any kind acts on a body freely falling in vacuuo. The body under such conditions possesses mass, but not weight. Why should such truths (*sic*) as these be kept from the student?"] But 'tis no matter what he said if he didn't mean it. He now says he did not assert that gravity exerts no push on a freely falling stone, but only that it is impossible to "detect the least trace" of such a push. Even this statement I am constrained to differ from. The accelerating velocity of the stone is good evidence, and indeed *measure*, of the push exerted by gravity, and must, one would think, be accepted as such by "Φ. Π.," *unless*, as seems probable, *he disbelieves in Newton's first law of motion.* For if no force acts on a falling stone, why is its velocity not constant?

I know he means that you can't show its weight by hitching a spring balance to it; but neither can you by hitching a thermometer to it. You are not likely to be able to demonstrate a thing unless you go about it the right way. A spring balance hanging on a fixed hook does well enough to measure weights of stationary bodies hung to it, but one would find it difficult, not to say dangerous, to attempt to indicate the weight of a flying cannon-ball by any such device. The weight of a flying bullet is manifested and measured by the curvature of its path, *i.e.*, by its downward acceleration; the weight of a falling one is manifested and measured in essentially the same manner.

I had better not discuss "Φ. Π.'s" tug-of-war experiment, in which the "facts" seem turning out hostile to me; though I shall amuse "Φ. Π." by informing him that if I did discuss it I should have to take up the position "so much the worse for the fax." I should, in fact, suggest that the active and energetic character of an ordinary tug-of-war contest was perhaps modified in this case by the insecure nature of the foothold, and that his big son had too great an involuntary regard for his own spine, or for his small brother's nose, to exert himself with his customary vigour.

A psychological explanation of a physical experiment cannot be very satisfactory. I do not, however, quite know what "Φ. Π." wished his experiment to prove; but surely we do not differ on a theoretical point of such simplicity that it can be crucially settled by a comic observation like this.

I will grant him that action and reaction between bodies in contact are equal and opposite, as much as ever he likes. But it seems that he wishes to extend the statement to bodies not in contact. For "equal action and reaction" let me use the short word "stress," and state the case once more for the tug of war. There is a stress between A and rope, and a stress between A and ground. There is a stress between B and rope, and between B and ground. So far we agree; but "Φ. Π." seems to wish me to go further, and agree that these four stresses are always and necessarily equal. This I can't do. They all happen to be equal during periods of static straining or equilibrium, but directly motion begins they are not equal; in fact, motion begins *because* they are not equal. The A-rope stress is a trifle greater than the B-rope stress when motion begins, unless you prefer to neglect the inertia of the rope. The A-ground stress is distinctly bigger than any of the others, because it has to overcome the inertia of A and of rope and of B.

Let a man stand on a roller-plank or a boat and suddenly begin to run, does not the plank or boat move backwards? And if it does for one man, why not for two?

Finally, in my sentence referring to a falling stone "there is only one force acting on the stone," "Φ. Π." has chosen to italicise "only one force;" if he had italicised "acting on the stone" he would have understood what I said better. There are two forces acting, as there always are—the action or push of the gravitation medium, and the reaction or push back of the stone—*but only one of these equal forces is acting on the stone.* I said this before, but it is necessary to be very explicit.

If I have not succeeded in making this at last intelligible I must give it up.

OLIVER LODGE.

Liverpool, May 21st.

SIR,—I am very much obliged to "A Girton Girl" for her last letter. I believed I fully understood her meaning before; her letter has made that belief certainty. She holds that it is quite possible for an unbalanced force to exist. I do not. Here, then, is a fundamental difference between us, which renders it impossible to continue this discussion with any advantage. Before we could advance one step further we should have to go into a secondary controversy as to whether it is or is not possible to have an isolated force. I do not suppose that "A Girton Girl" is a whit more disposed to break new ground in this direction than I am.

One word in conclusion. "A Girton Girl" says that I have advanced no proof that force is not a cause of motion. I can only express my regret that I have been so unsuccessful in my endeavours. Possibly the following argument may modify her views. It is stated by all philosophers, and universally accepted as true, that matter is entirely incapable of resisting motion. If this be so, why should force be necessary to cause motion?

It is due perhaps to myself, or rather to the opinions which I hold, to say that I have never for a moment denied that stress, effort, push, pull, or force accompany the transfer of motion from one rigid or quasi rigid body to another; but this effort is caused by motion, and neither "A Girton Girl" nor any one else can cite a single instance in which effort has not got motion for an antecedent. When a boat moored to the shore pulls on her painter, that pull is caused by the motion of the stream; that pull is typical of Force in general, and the action of the stream is typical of the modes of motion which cause Force.

Here my discussion with "A Girton Girl" ends, if she will permit me to retire. I will always look back with special pleasure to one statement at least which she has made—namely, that my letters have given her something to think about.

Φ. Π.

London, June 24th.

SIR,—To one not a metaphysician, "Φ. Π. s" last contribution is most interesting. I could not see the difficulty about the stone, or the abutments and girders of Blackfriars Bridge, apart from fundamental unintelligibility. Nor can I see why for most purposes the word force may not conveniently denote certain transferences of occult to sensible motion; nor why, whatever sound philosophy may lie in such a phrase as "the sentient ego is conscious of a tabular impression on the retina" should not be understood to form part of the connotation of the verb to see when "A Girton Girl" says she sees a table—or was it a trunk? The notion, too, of applying spring balances to freely falling weights rather transcends my comprehension, unless we may consider the earth a freely falling weight. But the experiment with the plank was worth betting about, and the result opens quite a vista of possibilities to the practical mind.

For consider, we have a system consisting of two boys and a plank isolated by the projection of the rollers from the universe so far as motions in the direction of the length of the plank are concerned. A strain is set up between them, and presently the two boys who began at opposite ends of the plank are found together at one end, the plank retaining its position in space unaltered, so that in an isolated system we have observed an alteration in the position of the centre of mass, consequent upon stresses acting wholly within that system. Apart, therefore, from all questions of causation, we are witness to a case of unbalanced motion. This result, to be sure, contradicts my experience with the boat; but perhaps I did not take enough care to keep my feet steady. Further, it is likely that if the boys jumped off at one end the plank would recoil, which suggests that recoil only takes place when the parts of a system actually lose continuity, and that the recoil of a gun would be annulled if the shot were infinitely long! But before rushing to the Patent-office with this and similar ideas, I should like to hear more of those trials when the boys did not keep their feet steady, and what happens if they run sharply along the plank, and I should like the experiment repeated in a light punt; and finally, I would suggest that till we have settled the simplest aspects of the question, we should regard cart and horse, or tug-of-war teams with connecting rope, as our units, molecules of several atoms, subject no doubt to interesting internal stresses, but moving visibly together if they move at all, and as units by no means capable by themselves of illustrating the third law of motion, and showing us plainly two equal and contrary motions.

W. A. S. BENSON.

23, Young-street, W., June 23rd.

STRAIN DIAGRAMS.

SIR,—In your issue of the 29th of May last I communicated what I considered a novel proof of the fact that, in experiments on elasticity, the quantity $\frac{d\,P}{d\,t}$, or the rate of addition of load, ought to be constant both in magnitude and sign. As far as I am aware, this was the first attempt to submit a strain diagram to Newton's laws of motion. It is curious, therefore, to read in a contribution to your number of the 12th inst., from the pen of Professor A. Herschel—who, by the way, seems to fancy that he has solved the fan problem by stringing together all the sesquipedalians in the English language—that "now we know elasticity is merely a mode of motion;" and in the same number Dr. Lodge illustrates his lucid defence of Newton's laws by a reference to "strain motion." My object in adding this note is, first, to express my satisfaction to find that I am not singular in this view of an elastic curve, and, secondly, to point out the logical inference that, in order to study any autographically described strain diagram, we must rule the curve from equal increments on the ordinate axis of loads; in other words, we must make the dependent variable $d\,s$ take its dimentions from the independent variable $d\,P$, which is added at a constant rate.

I cannot fathom Professor Unwin's reasons for calling a strain diagram a "stress strain diagram." In a steam expansion curve we have ordinates giving pounds pressure; yet we do not say "a steam pounds pressure expansion curve," but more shortly, a "steam expansion curve," or a "steam pressure curve." So also I think we ought to limit our precision to the simpler expression of a "strain diagram," reserving the term "stress" in its usual acceptation as applied to reciprocal stress diagrams.

Referring to Professor Unwin's letter on this subject in your issue of the 5th inst., I would remark that strain diagrams of extension, whether they be plotted with load or extension ordinates, are all written from left to right; so that Professor Unwin's illustration from the letters of a sentence is not apposite, and is only partially true of a compression strain curve, the positive, not the negative, impression of which is from right to left.

Greenwich, June 24th.

R. H. G.

STEAM HAMMERS.

SIR,—Absence from Glasgow during the last ten days has prevented the letter of Mr. Graham Stevenson, in your issue of 5th inst., being seen by the writer till now. Mr. Stevenson seems to be dissatisfied with us for expressing "considerable interest" in the description of his "patent" steam hammer. We trust he will not be displeased when we say that his letter has afforded us "considerable" amusement, because it is so evidently the production of one who feels called upon to say something in his defence and who has nothing relevant to say. We have to thank Mr. Stevenson for his courteous testimony to the excellence of design and workmanship in our steam hammers; but in the same sentence he takes exception to our extreme watchfulness over our interests, which he likens to the "watchfulness of a gaoler." It is true that before this time we have been compelled on several occasions, in your columns and elsewhere, to call in question the action of various parties, Mr. Stevenson himself among the number; but does it not occur to Mr. Stevenson that his simile is somewhat unfortunate? To all law-abiding people "watchfulness" in a gaoler or detective is a commendable quality; it is only to those who transgress that such watchfulness is objectionable.

Passing over three-fourths of Mr. Stevenson's letter as quite irrelevant, we come to the remarkable statement that he regards our query, "Wherein lies his patent," as "ill-timed and not *bonâ fide*, and therefore have no answer to make to it." We can understand that the query is "ill-timed" for Mr. Stevenson, because he has "no direct answer to make to it;" but it is perfectly "*bonâ fide*," and, we take leave to say, not at all ill-timed for the public. What are the facts? In your paper of 15th ult. a hammer by Mr. Stevenson is illustrated and described as patented. On the 29th ult. we pointed out that in every particular the hammer is a copy of a hammer patented thirty years ago by William Rigby, and we naturally ask Mr. Stevenson to point out what he claims. This he declines to do for no sufficient reason; but he tells us that "Rigby had no profound knowledge of patents," and that some patents "have no rights save those alone which the public choose to generously accredit." Can it be that Mr. Stevenson is drawing still more largely on a generous public by asking them to accept his hammer as "patent" without having applied at all for the necessary rights?

It is pleasing to observe that, amid the busy and practical life of an engineer, Mr. Stevenson is able to devote some attention to the refining pursuits of poetry. He quotes the line, "There is a beauty born of grace," and makes the profound observation that the words composing it are all old words and often used in writing prose. We are glad to agree with Mr. Stevenson in something, and therefore concur in his remark, but beg to point out further that if any writer were now to introduce the above line, and pass it off as his own composition, that writer would be justly charged with plagiarism. In like manner, when a man desirous of passing for an inventor reproduces as his own the work of another, that man throws himself open to quite as heavy a charge.

GLEN AND ROSS.

Greenhead Engine Works, Glasgow, June 18th.

TREVITHICK MEMORIAL.

SIR,—There is no need for Colonel Davis to attribute to my letter the term "acrimonious" until he has answered it. In my letter I endeavoured to avoid personalities, as he will see on reperusal. I shall be ready to attend a committee when there is a chance, but this does not affect the public, as there is no personal question. What I ask of him is that the plan of a monument to Richard Trevithick in Westminster Abbey shall not be altered or abandoned at a small committee meeting, which ought in actual course to have been adjourned, and further, that our committee shall, according to practice, convene a meeting of the subscribers to the Trevithick memorial, to determine on the report of the committee when duly made. To no one point raised has Colonel Davis given an answer or an explanation.

HYDE CLARKE.

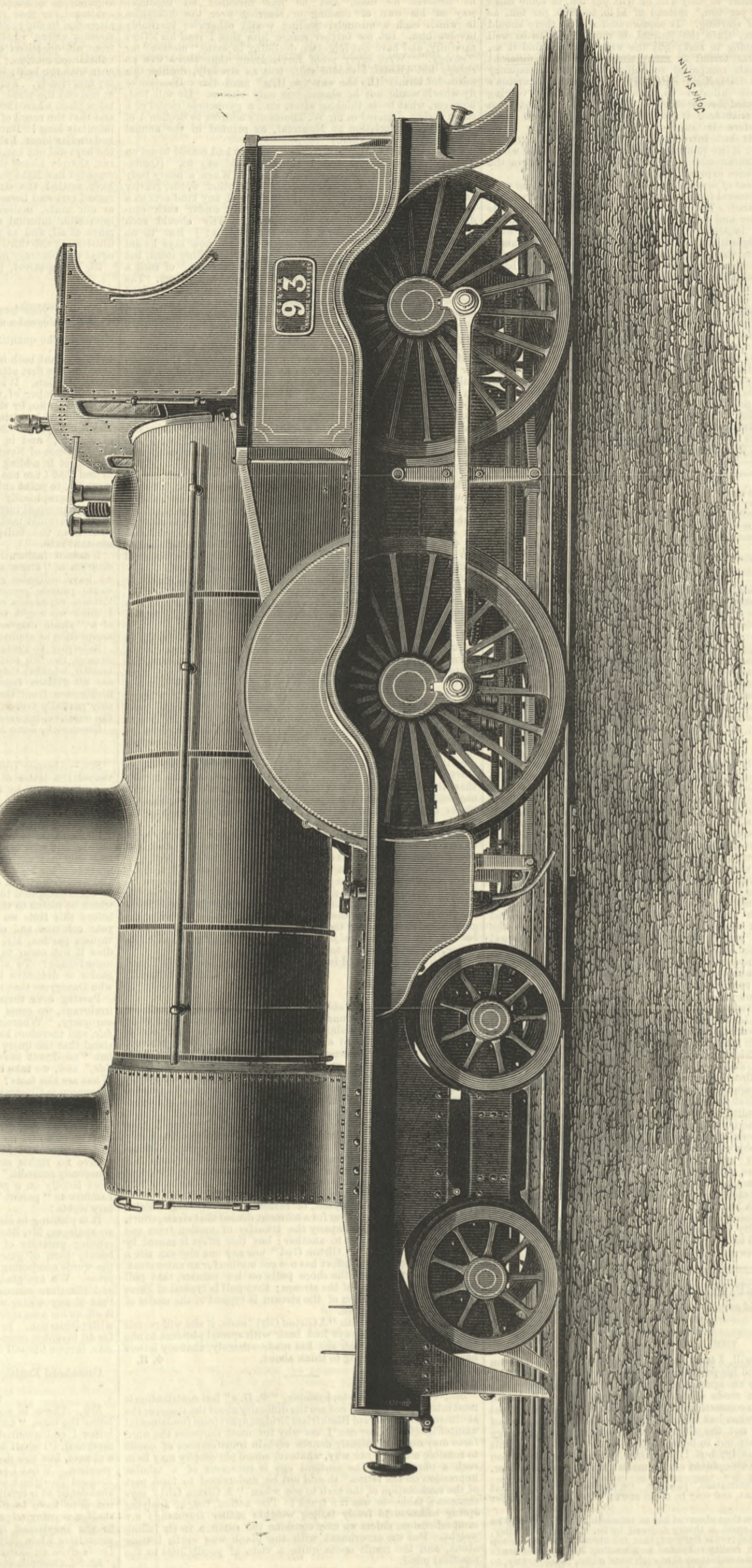
32, St. George's-square, S.W.,

June 20th.

FOUR-COUPLED PASSENGER ENGINE, GREAT SOUTHERN AND WESTERN RAILWAY OF IRELAND.

MR. J. A. F. ASPINALL, INCHICORE, DUBLIN, ENGINEER.

(For description see page 497.)



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H. H.—*We do not know of any other book than Wilson's "On Factory Chimneys," published by Lockwood and Co.*

G. H. (Nottingham).—*Your invention is not new in principle, though it may be in details. It could only be applied to small ships.*

D. S.—*Yes, so far as that portion of the patent is concerned, if you claimed the casting of the part in the stated material; but you might get a valid patent for improvements in the method of casting, which would constitute a new invention.*

W. S. B.—*The only notice of the Creusot engine trials in English is that which has appeared in our columns. We have no doubt that you can obtain copies of the "Annales Industrielles" containing the original by applying to the publisher,* 18, *Rue Lafayette, Paris.*

MACHINERY FOR MAKING FIVE GALLON "DRUMS."

(*To the Editor of The Engineer.*)

SIR,—Can any reader inform me of the name of the makers of appliances for making five gallon round iron drums? The drums are required for carrying seed oils.

J. R. B.

London, June 22nd.

AUTOMATIC FEED OF ROCK BORERS.

(*To the Editor of The Engineer.*)

SIR,—There is an error in my letter regarding the above in your impression of the 19th inst. Instead of "I have had three of his rock borers at work for about eighteen months in one of the hardest known rock tunnels without a single failure of his automatic feed," kindly read, I have had three of *my* rock borers at work for about eighteen months in one of the hardest known rock tunnel without a single failure of *my* automatic feed.

GEO. LOW.

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THE ENGINEER.

JUNE 26, 1885.

THE A B C PROCESS AT AYLESBURY.

THE A B C process, as carried out at Aylesbury, is the subject of a report by Dr. C. Meymott Tidy and Professor James Dewar, who have for the purpose carried out a series of experiments at the Aylesbury works. The experiments seem to have been of an exhaustive character; that is to say, they were not made upon a few samples of sewage, effluents, and of sludge of one day, but were made with a large number of samples collected on several days. It is very well known that the strength and composition of sewage change rapidly and frequently, and conclusions based upon a few isolated observations are therefore useless. Moreover, as the passage of sewage through the tanks occupies some hours, samples of raw sewage and of effluent taken at the same time bear no real relationship. For these reasons Dr. Tidy and Professor Dewar conducted three series of experiments, one in January and two in March last; each series continued throughout twenty-four hours, so as to embrace the varying conditions of the sewage and effluent. Samples of both these were taken every half-hour, and equal portions of four consecutive half-hour samples were mixed together for chemical examination. Guided by the rainfall principally, the reporters chose three different periods, which gave samples of sewage differing considerably in total quantity and strength.

For the purpose of the experiments it was necessary to obtain the amount of sludge from a given quantity of sewage, and the proportions severally of the A B C precipitating materials and of the sewage matter. A special arrangement was needed for this purpose, it being found impossible to determine these details with even an approach to accuracy in the large subsiding reservoirs. Four iron tanks, each holding about 200 gallons, were therefore divided, by chalk lines on the inside, into six equal divisions, one of these divisions being filled every hour by means of a small force pump placed in the narrow channel down which the treated sewage runs before entering No. 1 tank, with the sewage that had been already treated. The deposit in each of these four tanks, therefore, represented the mean amount of sludge produced during six consecutive hours. The sewage deposit in these tanks was allowed to settle, and the clear effluent syphoned off. The deposited sludge was then dried at 212 deg. Fah. and weighed. The quantity of carbon, clay, and alum used during the twenty-four hours was determined, and subtracted from the total—calculated—sludge.

The usual method of working the process was carried on without any innovation during the experiments. This may be described in the words of the report. "The sewage is delivered at the works into a small oblong space about 4ft. wide by 6ft. long, paved with bricks. Across this space, and about one yard from the sewer mouth, a wooden V-shaped trough is placed, into which the B C mixture is run—even distribution into the sewage being effected by means of numerous notches cut on the sides of the trough. By this means the sewage is completely and immediately deodorised, no escape of offensive odours from the sewage into the surrounding air taking place. The entire works are free from any objectionable smell whatsoever. After being mixed with the B C mixture the sewage passes through an iron grid for the purpose of catching paper, straw, and similar floating materials. It then passes along a brick-paved channel for about 12ft., the channel afterwards narrowing to 2ft. in width. Here the alum solution flows in from a wooden trough in the same manner as described in the case of the B C mixture. The alum is added some short time after the B C mixture. The addition of the precipitating ingredients separately is found to afford better results than when they are run in together. The treated sewage flows along the 2ft. channel for about 40 yards, in order to facilitate mixture before it is allowed to run into the first subsiding tank. There are three subsiding tanks, each holding 42,000 gallons, through which the treated sewage successively flows before finally passing through a fourth and last tank, which is about double the size of the other three. On leaving the tanks the effluent, now practically free from suspended matter and devoid of smell, passes for several hundred yards along an open brick channel, before finally discharging itself into the brook. The materials used for the precipitation of the sewage matters are clay, carbon, blood, and alum, and they are manipulated as follows:—Weighed quantities of the clay and carbon are ground together in a mill with a certain small proportion of blood and some water. When thoroughly incorporated, the mixture is run into a reservoir placed beneath the mill, where a considerable proportion of the heavier clay particles subside, whilst the lighter particles of clay and carbon are added to the sewage as above described. The sulphate of alumina is dissolved in a separate tank, and is run directly from this into the sewage. The solution of alum used was found to contain on an average from 1 to 2 per cent. of sulphate."

As a result of the three series of observations and chemical analysis, the reporters say they consider it established "that the A B C process is capable of producing a uniform effluent, notwithstanding the very varied nature and concentration of the raw material to be dealt with. The quality of the effluent, however, more especially as relates to the quantity and kind of dissolved organic matter, unquestionably depends upon the strength of the original sewage." They add, however, that there seems to be no reason to doubt that a minimum quantity of organic matter in the effluent might be permanently maintained if the weak nightly sewage could be stored and mixed with the stronger day sewage, or if the two effluents were stored and mixed. They say, also, that with due care an effluent can be easily obtained practically clear and with less than one grain of suspended matter per gallon, and that the precipitation seems to be more complete as the quantity of suspended matter in the raw sewage increases.

The reporters then describe the sludge-drying process and its conversion into "native guano," which, it is remarked, is nothing but the partially-dried precipitated sludge mixed with some "sulphate of magnesia"—ammonia?—and ground. From a table of analyses given in the report, it appears that the manure freshly ground contains 31·7 per cent. moisture, and after being ground five months it contains 28 per cent. of moisture, and one sample after eight months contained 17·2 per cent.; but taking it as containing 20 per cent. of moisture, the combined nitrogen reckoned as ammonia in the manure is 3 per cent. From four samples taken from different parts of a heap of the manure, the phosphoric acid was estimated, an average of 5 per cent., reckoned as tricalcic phosphate of lime, being found. On the subject of the manurial value of the native guano, Dr. Tidy and Professor Dewar express themselves in a manner which certainly does not commit them to much. They say:—"We are strongly of opinion that this must be judged rather by the practical results of the agriculturists than by presumed theoretical values based on analytical data, and on the price of ingredients not necessarily in the same physical or chemical condition. Recent research tends to show that very small changes brought about in soils may have very important indirect effects." The discrimination shown in the selection and combination of words in this paragraph certainly indicates genius which ought to be acknowledged.

So much, then, for the report on the work going on at Aylesbury. The first question that will be asked by every one is—Having this so-called "native guano," what is the cost of its production, taking into consideration its value as a manure from an agriculturist's point of view, and the cost not only of the ingredients employed, but of the machinery and plant used in dealing with sludge? The report says nothing of cost, and there is only one mention of the quantity of precipitating materials employed. It is as follows:—"The quantity of precipitating material used was only slightly more than one-third of the total weight of sludge produced, the absence of any appreciable amount of suspended matter in the effluent proving that efficiency was not impaired by the small quantity of material employed." This quantity may be considered small in the sense that by familiarity we may cease to be surprised at anything, but it certainly makes us ask why was this report published. It could not be to prove that a good effluent could be obtained by the A B C process, for that has long enough been known, and it could not be to show that the process could be looked upon as generally applicable on account of its cheapness or possible profitable character, for that it does not show. Aylesbury is a small place; it does not appear now, any more than in days gone by, that the A B C process could be commercially satisfactory in a large place. We may be mistaken, but the information at present forthcoming does not convince us of it.

PATENT-OFFICE DELAYS.

UNDER the new Patent Act a provisional protection secures the privileges of a patentee to an inventor for twelve months—that is to say, it nominally does this. As a fact, the duration of a provisional protection is but nine months, because just before the end of that time at the latest, a complete specification must be filed and a complete patent applied for. For all practical purposes, therefore, nine months represent the useful duration of provisional protection. This period, brief as it is, is seriously curtailed by the action of the Patent-office; and we think that it is quite time that inventors should make their voices heard, and take strong action in a matter which very closely concerns them. When a provisional protection is applied for, the petition and specification are accepted by the officials at the Great Seal Patent-office, and a receipt is given with a number and a date. Then commences a weary period of waiting extending over at least three weeks, during which period the inventor can take no action whatever, because he does not know whether his specification will be accepted or not. The theory is that during this period searches are being made to ascertain whether the invention is or is not novel. The fact is that the documents are simply put in a pigeon-hole to wait their turn, and that as a rule all the examination they receive is performed in five minutes. It is not difficult to see that if the authorities kept abreast of their work it would be quite possible in nine cases out of ten to let the applicant have a definite answer, yes or no, in a couple of days after the specification was lodged. In a few instances where doubts might arise, a longer time would be necessary, and no one could object, because that would be a reasonable cause for delay. But delays now take place for which there is really no excuse whatever, inasmuch as they have nothing whatever to do with the question of novelty. Here is a case in point. Some weeks since an inventor in the country sent up a provisional specification, for which he received in due course of post a receipt. Then he waited, and continued to wait. At the end of a month or thereabouts he wrote to ask for information, and he very promptly received a reply stating that his papers were informal because the title of the invention had not been put in the proper place on the page. Now we may, for form's sake, concede that it was a criminal piece of negligence on the part of the inventor to write the title in the wrong place, but to the ordinary business mind it appears that it was the duty of the clerk who received the documents in the first instance to see whether they were or were not informal, and if they were, to notify the fact then and there to the applicant. Instead of this, four weeks are lost to the applicant, because, of course, the amended specification will have the old date. Again, it is at least open to doubt that the inventor would have heard anything more about his papers for months if he had not agitated. Such cases are by no means isolated. We may cite another which is instructive. An inventor applied for protection for a simple invention. Protection was granted him in due course. Before the expiration of nine months he applied for another provisional for the same invention, thus adopting a very common practice by which protection can be had for eighteen months for £2. The new provisional was as nearly as possible word for word with the old. After the usual delay he received an intimation that this specification could not be accepted, as it covered two distinct inventions. It was useless to point out that protection had already been granted once. There was no help for it. One half the specification had to be cut out. This kind of thing goes on week after week.

We have, too, the strange anomaly that while the authorities will not take the trouble to write the title of a patent in the proper place on a sheet of foolscap—a matter which involves no principle of any kind—they do not hesitate to settle the claims of very important patents. It is, of course, tolerably widely known that the claims in a specification are vital, and that the alteration of a word may be of the utmost possible importance. The authorities in Southampton-buildings, however, having examined specifications, construe them after their own fashion, and tell the inventors that their claims are erroneous and must be modified, and state in what way the alteration is to be made; and more than once astonished patentees have found themselves blessed with patents for machines which they never dreamed they had invented until they were told so by the Patent-office authorities. Several specifications with these officially amended claims have been made the basis of patents, and should litigation arise about them hereafter, the Patent-office will find itself in a very peculiar predicament, to say the least.

We have here the old old story—too much red tape. There is no reason why competent business men should not carry on the work of the Patent-office just as a bank, for example, is carried on. The truth is, however, that the officials employed, with certain exceptions, are not business men, and they thwart by their officialism those who are. The Board of Trade is by no means the best place from which to supply the Patent-office. In fact, the traditions of Government offices are against commercial

efficiency. Changes must be effected sooner or later, and they will be effected very much later instead of sooner, unless those most concerned—namely, the inventors—take measures to make their complaints heard.

THE HARBOUR AT ADEN.

A SOMEWHAT unusual question has arisen out of the discussion which has recently taken place with reference to desired improvements in the harbour at Aden. It is, indeed, of so unusual, and yet of so important a character, as affecting the conditions to be taken into consideration with reference to action in the future as regards colonial harbours—especially those in the Eastern seas—that it seems very necessary that the matter should engage the attention both of those authorities who have to deal with improvements of this nature, and of those who preside over the question of national defence. Secured as Aden is from the effect of stormy weather, and safe as is the anchorage it affords at all times, it is yet defective, in that shallow water reaches far out from the shore. The tidal range which is experienced there, in common with all ports in the East is so limited that one would almost expect to find that it might be left entirely out of view in dealing with the needs of Aden harbour; but, slight as it is—we believe that even at springs it never exceeds 2ft. 6in. or 2ft. 9in.—the tide certainly plays an important part in the matter with which we propose to deal. As we have said, the shallowness—or what may, in these days of deep-draught vessels, be considered shallowness—extends to a considerable distance from the shore, entailing upon all shipping operations very great delay and expense. In order as far as may be to obviate these inconveniences, the large steamers which call at the port always enter, if possible, on the top of the tide, so as to secure an anchorage as closely approaching the wharves, or the foreshore which serves as their substitute, as may be safely done. It is no uncommon thing for the recession of the tide to leave the keels of such steamers partly imbedded in the soft mud which forms the bottom of the harbour, and when that is the case, although steamers sometimes force their way out in spite of this disagreeable condition, it is oftentimes impracticable to do so, and is always an operation attended with some risk. The majority of the vessels, therefore, the loading or discharge of which cannot be accurately timed, have to wait for their departure till the rising of the tide sets them free.

It is not to be wondered at, therefore, that the shipowners, merchants, and others who are interested in the shipping trade resorting to Aden, which may, indeed, be said to include all that passing through the Suez Canal, have united in a strong representation to the Secretary of State urging the desirability of undertaking extensive dredging to remove the defects named, and so to admit of a closer approach to the landing place. At first sight it would seem as if it would be impossible to raise any objection to so manifestly a desirable improvement, but we learn with much astonishment that it has been advanced by some of those who oppose the suggested deepening of the harbour, that to excavate it would entail the complete nullification of some of the new works of defence which have of late years been constructed. If this be really the case, we can only say that our military engineers to whom such works have been entrusted have shown a most remarkable and culpable want of prescience. We all know with what religious secrecy the key to the works of such fortresses as Aden and Gibraltar is guarded. We believe, indeed, that but two complete plans of them are allowed to be extant, the one being kept under the most careful guardianship by our Home War Department, the other being in the charge of the local governor and deposited under locks requiring duplicate keys, the second of which is in custody of the chief local military authority, to open them. It is scarcely necessary for us to say, therefore, that we are in no position to judge as to the amount of information possessed by those who have advanced this novel and extraordinary argument, nor of its weight or accuracy. But it may safely be assumed, we should say, that no one would have ventured publicly to advance such an argument unless he was in a position to feel certain that it could not be refuted on a basis of incorrectly-stated fact. Assuming, therefore, that the position is such as has been stated, we find that we must either forego the security resulting from works of defence—executed, no doubt, at large cost—or abandon the hope of seeing the harbour improved up to the requirements of modern times.

Military engineers charged with the designing of the position or extent of batteries must, it appears certain, obtain the sanction of their superiors at home before proceeding to carry their designs into effect. No doubt, therefore, can exist but that prior to such constructions being put in hand the plans were duly weighed and considered by the highest military engineering advice available; but if the decision thereupon has been arrived at without having in view the necessities of an early future, we cannot but think there has been a lamentable want of foresight on the part of the officers consulted. It is the old complaint again coming to the front that specialists are but too prone to deal with questions—even those of the highest imperial importance—from their professional point of view alone. This is particularly the fault, we fear, of military men. It is almost impossible to realise that, with the plan of the harbour as it exists before them, furnished as they must surely have been with the reports of those concerned with the port and harbour of Aden as to its present disabilities and its future necessities, they could have overlooked the fact that the day for improvement must come, and that they were bound therefore to locate their batteries or defensive works in such positions that their utility could not afterwards be nullified by such improvement. But if such a mistake, such a palpable oversight, has been committed, it is too late to cry over spilt milk, and abstain in consequence of it from work which is a necessity to a large proportion of the carrying trade of the whole world. Since the opening of the Suez Canal, Aden has ceased to occupy its former position of a mere fortress only. It is a large commercial rendezvous, one the importance of which must go on increasing in proportion to the extension of our eastern trade, and no such consideration as we have pointed out can be allowed to stay its proper development. We have cited this case because it appears to us to instance a disregard of future requirements, and a one-sidedness of view which may be most prejudicially exercised with reference to many other places in our colonial possessions which may need, like Aden, artificial extension. It certainly behoves those whose duties lie in the superintendence of such matters to see that these faults are not again permitted to be operative.

THE AMALGAMATED SOCIETY OF ENGINEERS.

THE delegate meeting of the Amalgamated Society of Engineers, which for the last five weeks has been sitting at Nottingham, and has not yet completed its labours, will be a very costly affair. The allowance granted to the delegates represents alone an expenditure of over £1000 per week, and the total expenditure out of the funds of the Society, which will be involved in connection with this conference, cannot fall far short of about £8000. It seems very questionable, however, whether the Society will reap any corresponding advantage out of the enormous outlay to which it has been put. There have been two special matters very seriously affecting the financial stability of the Society in the future which the delegates have had under their consideration. These have been the alarming increase during the past ten years in the expenditure on superannuation benefit, with the prospect of a proportionately similar expansion in the future; and the enormous expenditure for which during the last two or three years the Society has been called upon by its out-of-work members. These two questions the delegates have scarcely faced in a manner calculated to place the Society permanently in a financially healthy position, but rather in a temporising spirit of adopting half-measure expedients simply to overcome present difficulties. The fact that is plainly before the members is that the Society has been attempting to do more than its means will allow, and by one of the newspaper organs specially representing working class interests, it is estimated that if the Society, with its present accumulating expenditure, is to make any headway financially in the future, it will be necessary to increase the subscription of the members from 1s. to 1s. 6d. per week. The delegates, however, have not had the courage to meet the difficulties in which the Society is placed by boldly increasing the subscription of the members, but have preferred a tinkering amendment of the basis on which the superannuation and out-of-work benefits are to be paid. The period of membership previously necessary before a member could claim to retire on a superannuation allowance was eighteen years; this has been increased to twenty-five years, but with members admitted at twenty years of age the option is still left to a man comparatively early in life retiring permanently on the Society's funds. The out-of-work benefit has been dealt with in a fashion that is calculated to raise suspicion as to the manner in which members have hitherto been taking advantage of the funds for this purpose. The recent policy of the Society has indicated a disposition to subordinate the character and qualification of the members admitted to a desire to seek after the power of numbers, which may have contributed to the heavy burden of unemployed which of late has been thrown upon its books. It is sought to lighten this burden by limiting the out-of-work benefit to a period of two years, but unless this is an admission that hitherto members have shown more readiness to draw out-of-work pay from the Society than anxiety to secure work at their trade, it is difficult to see how such a provision can bring material relief to the Society's funds.

THE RATING OF MACHINERY.

SHEFFIELD is beginning to feel the pinch which the Leeds district felt last year in the assessment of machinery. At the Town Hall, this week, the stipendiary magistrate heard a case in which the Savile-street Engineering and Foundry Company, Limited, was summoned by the Corporation for the payment of two district rates made on April 9th and October 8th, 1884, of the amounts of £67 10s. and £60 15s. respectively. The solicitor for the defendant stated that the question at issue was the same as that raised by the counsel for the water company in a recent action. During the last twelve months a new assessment of property in the township of Brightside had been introduced, which had the effect of trebling the rates on his client's property. The dispute was as to what extent machinery was liable to be rated, and it was a question which involved a large number of works besides those of his client. Notice of objection to the valuation list had been given to the Assessment Committee, and he had pointed out to them that it was scarcely worth while to take a decision on one small case, and had suggested that it be allowed to stand over until the question was settled for the whole of the works. The Assessment Committee agreeing with that suggestion, the summonses had already been twice adjourned on that understanding. The Town Clerk contended that the present case did not stand on the same footing as that of the water company, because the defendants had omitted to give notice of appeal against the assessment to the quarter sessions. He asked the stipendiary to make an order for the payment of rates now long overdue. The defendants' solicitor pointed out that in the case of the poor rate an appeal could only be made after the Assessment Committee had refused relief, and that in the case of district rates the committee had never refused relief, and, therefore, it was impossible for the defendants to appeal. His clients were prepared to pay the rates on the former valuation if the case were adjourned for six months, or until the case now pending against the water company were decided. The stipendiary gave an order for payment, but granted a case at the request of the defendants. This is a question to which the Chamber of Commerce, rightly appreciating its great importance to Sheffield manufacturers, has determined to give special attention.

RAILWAY PREFERENCES.

THE town of Hull is raising a railway question of the greatest importance. The port of Hull is largely interested in the Scandinavian trade, and a considerable part of the goods exported to and imported from that port is sent inland. It has to compete with other ports, especially those of the Tyne, Wear, and Tees. Nearly forty years ago there were three railways competing, and shipping at three ports. These three agreed upon a general basis of railway rates, and in the end, in 1854, the three companies amalgamated, and formed the North-Eastern Railway. The basis of rates then agreed upon has substantially continued down to the present day, and it is that basis which Hull is now determined to upset. On the part of Hull it is urged that it is nearer most of the places which send or receive the goods for shipment or which have been imported, and that it ought to have the benefit of that proximity in cheaper rates than it has. On the part of the North-Eastern ports it is contended that there has been a basis agreed upon for years; that it is this which has allowed trade to grow into its present channels, and that it is inexpedient to disturb it, whilst it would be unfair to disturb it. The North-Eastern Railway Company takes this view, and it is one of the defendants in the action to be taken. Other railways concerned are also defendants—the Midland and the Lancashire and Yorkshire—and they have so far made no sign of their opinions. It is evident that the question is one of the utmost importance to the trading classes, for the principle at stake would affect many districts and trades; but on the whole the opinion of the commercial classes will in this instance be with the north-eastern ports. The rates to Hull are within the railway powers, and that being so, the reduction to the North is not one to be complained of, because its only result is to secure to the trader alternative routes to the seaboard at substantially similar rates, and to the exporter or importer a free choice of ports. It has been well said that it is a commercial sequel to the parable of the labourers, for Hull receives its traffic at rates lower than agreed upon, and in consequence it has little ground of complaint. But the issue of the question will be awaited with interest by all concerned in traffic to and from ports.

RAILWAY RATES AND FOREIGN COMPETITION.

THE question of Belgian and German competition in the wire trade still demands much attention. By the wise and generous co operation of the workpeople our Warrington and Birmingham manufacturers have, it is true, succeeded in lessening the difference in price which formerly gave the foreign product such an advantage in the market. They are still, however, confronted with the heavy charges for freightage made by the railway companies. This is a difficulty that they have not been able to overcome, and they are now renewing their protests against the continuance of the imposts. The chairman of the Nettlefolds' Company, speaking at the annual meeting of the company this week at Birmingham, laid it down that the matter of freights was the only serious advantage which the foreigners now possessed. In regard to wages, the advantage which they have now, in the view of this authority, become an apparent rather than a real advantage, since he believes that the increased wages paid here will be warranted, if not compensated for, by the increased output. There is a good deal in the complaint that in England the railway companies seem to discourage enterprise, while the German companies appear to encourage manufacturers. Some further relief must be afforded the wire industry by the carriers, if the trade is to be preserved. If this is not conceded, we shall undoubtedly hear of English firms transferring their business abroad. Nettlefolds are already hinting at such a possibility. The chairman, referring to the geographical position of the foreigners, remarked that he thought it would be necessary for that company to take such steps as would place them in a position to reap the same advantages as their foreign competitors enjoyed.

THE INFLEXIBLE EXPLOSION.

IT is as yet too early to venture upon any discussion of the cause which may have led to the two successive gas explosions recently occurring in the coal bunkers of H.M.S. Inflexible. We must await the details to be furnished after due examination before discussing them. It may, however, be remarked that the occurrence is singularly inopportune so shortly after the sitting of a special commission to inquire into the explosion which but a short time back caused the total loss of another of the vessels of our Royal Navy. But we can consider with propriety one of the causes named, to which some weight appears to be attached by the authorities at Portsmouth as likely, at least, to have conduced to the comparative frequency of such explosions. It has been stated that, as a rule, the coaling of our ships of war is conducted from wharf stores containing coal which has for some months been exposed to the action of the atmosphere, and has thereby been caused to part with much of its gas. The Inflexible, on the contrary, was supplied direct from the vessel which brought the coal southwards; it being argued therefrom that that coal remained charged with an amount of gas from which stored coal has been freed. We do not dispute such an argument; but we would point out that to use deteriorated coal, or to advocate its use, as a possible factor of safety, is as uneconomic, unscientific, and unsatisfactory a way of escaping from future cause of accident as can well be imagined. In parting with its gas a very valuable constituent of the heating power of the coal is sacrificed, and a dusty condition, inimical to proper combustion, is entailed. It will be very undesirable to try and escape from the dilemma by the extended adoption of such a system. It is in the proper construction and ventilation of the bunkers themselves that the true remedy must be sought.

THE DRAINAGE OF THE HORSE GUARDS' PARADE.

IF one might expect to find anywhere the most perfect attention paid to the condition of the drainage of London, it should be in the locality immediately surrounding our great naval, military, and civil offices, and yet it is scarcely too much to say that nowhere in this great city are fouler smells to be met with by passers by than have of late emanated from the gratings situated upon Horse Guards' Parade. Warned by repeated disagreeable experience we have, when recently crossing this open space, given these gratings as wide a berth as possible, and we would call attention to what is not only a public nuisance, but a source of very great possible danger to the many men whose avocations compel the occupancy for many hours of the day of the buildings surrounding it. We are unaware if this space is subject to the charge of the Metropolitan Board of Works or is under that of the Park or the military authorities. Certainly we have observed none of those precautions taken which are to be seen used in daily practice by the employés of the first-named body. In even the most distant streets in our outskirts there may be noted the constant flushing of sewers and the deposition of deodorising material not only below the gratings themselves, but on the matter remaining at their sides after every cleansing operation. It has never come under our own observation, though repeatedly crossing the Horse Guards' Parade, to see even the ordinary precaution of cleansing practised. It may be that this is not altogether unattended to; but at all events it is either too rarely or too inefficiently performed, and the sooner the charge of this area is put into hands experienced in such matters the better for the general weal as well as for that of the occupants of our great public offices.

A RAILWAY ACCIDENT IN RUSSIA.

COMMENTING on the accident which occurred on the 8th of this month to the mail train on the Nicolai Railway from St. Petersburg to Moscow, a foreign contemporary says the facts confirm

the supposition that it was the result of criminal intention. "It was established beyond doubt by the Judge of Twer and the police that the derailment of the mail train was brought about by criminals, who had unscrewed one of the rails of the Moscow line. This rail was found lying on its side at a distance of about 17in. from its normal position, whilst the bolts, nuts, keys, and spikes, &c., which had been taken out, were found by the side of the detached rail. The permanent way was considerably damaged for some distance. The sleepers were of excellent quality, and were laid in 1883. Not a single person was injured, and in the opinion of the inspector, who had been ordered by the Minister to investigate the accident, the fortunate results were principally due to the powerful action of the Westinghouse automatic brake with which the train was fitted, and also to the massive construction of the carriages, which were built on the American system."

TRIPLE EXPANSION ENGINES.

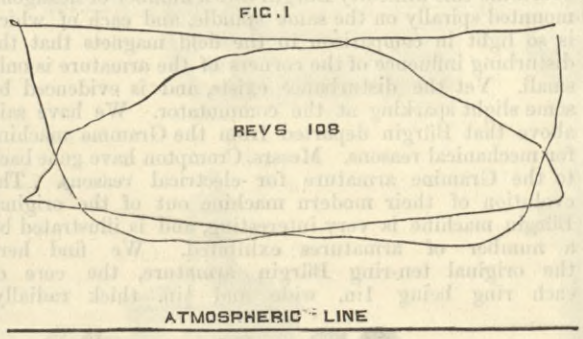
IT is very generally held now by engineers that the marine engine of the immediate future will have three, and very probably four, cylinders, in which steam of very high pressure will be expanded three or four times. Now, there is nothing in the thermo-dynamic theory of the steam engine to justify the belief that any peculiar virtue resides in the system of expanding steam over and over again in different cylinders. The consumption of fuel for a given power depends, other things being equal, on the number of expansions, and on nothing else. The economic results are very nearly the same whether we expand 50 lb. steam five times or 100 lb. steam five times. Indeed, there will be a small loss incurred by adopting the higher pressure. If, on the other hand, we expand steam of great pressure a great many times—as, for example, 150 lb. steam twenty times—then a serious loss is incurred by condensation taking place in the cylinder, a result which ensues because we are dealing, not with a gas, but with a very unstable elastic fluid. All this is an old story, however, and it will suffice to recall the circumstances to our readers' minds without going into details. A practical fact, however, appears to be that triple expansion engines are more economical than compound engines with two cylinders only, and it is, we think, not a little remarkable that no attempt worth the name has ever been made to explain why practice should in this matter give the lie to theory. It is quite useless to assert that practice is wrong in this matter. Engineers and shipowners know much better. The result of voyage after voyage demonstrates that the triple expansion engine uses less coal per horse per hour than the ordinary compound engine. Does this follow because steam is more expanded in the triple than in the double compound engine, or in spite of it? The information placed at the disposal of independent experts by the builders and users of triple expansion engines is very limited. It is by no means easy to obtain diagrams, or accurate data of any kind concerning minute details. With the object of throwing some light on the subject, we place before our readers the following facts concerning one of the first triple expansion engines ever made. The performance of this engine is exceptionally good; in fact, nothing but a few changes of a trifling character in the arrangement of certain details are required to render it very nearly a perfect steam engine, in a practical sense of the word. When indicating 200-H.P. the consumption of Welsh coal is about 300 lb. per hour.

The engine in question was designed for the steam yacht Isa, by Mr. Taylor, of Sunderland, and was built by Messrs. Douglas and Grant, of Kirkaldy. The Isa is a very handsome yacht of about 270 tons. She was built for Mr. Andrewes about seven years ago. She is now the property of Mr. E. C. Healey. No repairs of any importance were made or required during six years, although the boat did a good deal of hard work in the Mediterranean and elsewhere. Last winter, however, it was deemed advisable to thoroughly overhaul the engines, and this work was carried out by Mr. Mumford, of Colchester. The principal repairs consisted in renewing the brasses of the big ends of the connecting rods, and replacing the much-worn brasses of the link motions with new blocks with larger surface. As the yacht has just been commissioned, a run from Wivenhoe to Southampton was made a species of trial trip, rendered non-continuous by stormy weather, which made it necessary to lie at Deal one night and Newhaven the next night. Unfortunately, coal taken on board at Wivenhoe proved to be of so bad a quality that it was impossible to keep steam at much above 85 lb., or 40 lb. under the proper working pressure.

The Isa has three cylinders and two cranks. The pistons are 10in., 16in., and 28in. diameter, with a stroke of 2ft.; and with the full working pressure they make 109 to 112 revolutions per minute, depending on the trim of the boat and the state of her bottom. Steam is supplied by one boiler with two furnaces. The boiler is 8ft. 9in. diameter and 8ft. 6in. long. On the top of the boiler is a horizontal steam drum in the fiddley house. There is no superheater. The smallest cylinder stands on three legs on top of the intermediate cylinder, and both are very carefully jacketted. The low-pressure cylinder, driving the after crank, has no jacket. We give here three sets of reduced diagrams chosen from a considerable number taken with a Darke's indicator during the run. These diagrams were taken only to ascertain whether the slide valves were properly set or not, and it will be seen that the distribution of steam is very good indeed. More lead is, however, wanted on the underside of the low-pressure piston. On Saturday there was some thumping on both cranks, though the brasses had been set up by Mr. Weldon, the chief engineer of the boat, on full 64in. leads, on Saturday night both big ends got an extra nip up, and on Sunday and Monday the forward crank ran in perfect silence, without a trace of heating, or water being necessary, but the after crank had an obstinate thump on the bottom centre. On Monday morning, therefore, the low-pressure slide valve, which weighs about 2½ cwt., was drawn, and a large washer, $\frac{1}{16}$in. thick, dropped down the rod to rest on the lower nut, thus virtually giving a little more lead below and a little less above. The result was found to be very satisfactory, for although the thump was not removed, it was greatly reduced. If it does not entirely disappear when the brasses have been again adjusted, another washer will be put in. With the miserable coal on board, a Welsh anthracite, a large proportion dead slack which ran freely through the fire-bars, it would have been useless to test for economy.

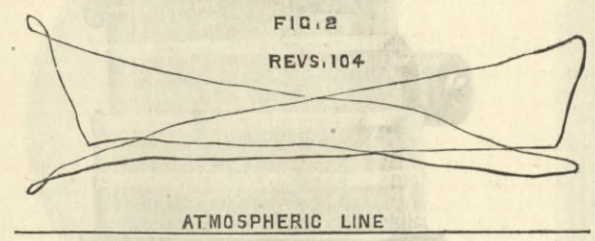
Diagram Fig. 1 is from the high-pressure cylinder, and shows a maximum pressure of 122 lb. above the atmosphere, revolutions 108. It was taken a few minutes after starting when the steam was well up. Diagram Fig. 2 is from the intermediate cylinder. The pressure was 93 lb.,

FIG. 1



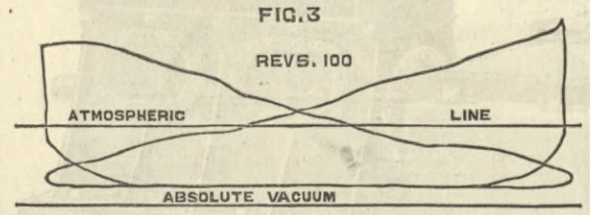
revolutions 104. Diagram Fig. 3 was taken when the revolutions were 100 and the pressure but 85 lb. These diagrams were taken at various times. There was only one indicator available, and the arrangement of pulleys or fair

FIG. 2



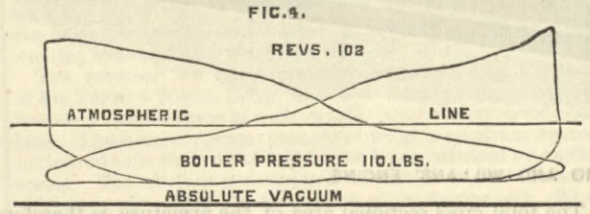
eads for the cord took some time to adjust, so that it was impossible to get a number of diagrams from all three cylinders in a short time. This is, however, a matter of small importance, as they serve to illustrate varying

FIG. 3



conditions. The diagrams have been calculated for the conditions under which they were taken. No. 1 shows 64·2-horse power, No. 2 shows 23·8-horse power, and No. 4 shows 98-horse power. The gross power, therefore, is 186.

FIG. 4.



With the normal working pressure of 120 lb., the engine indicates about 200-horse power.

Certain points about the performance of this engine are worthy of special notice. In the first place, in spite of the jacketting, the condensation in the high-pressure and intermediate cylinders was very great. The stuffing-box of the latter being a little slack, a continual stream of hot water poured from it. Neither in it nor in the high-pressure cylinder was it possible to obtain dry steam when the indicator cock was opened. The jacket was kept carefully blown, but this did not appear to make the smallest difference. Diagrams were taken with the jacket full of water and full of steam. No alteration could be detected. From the low-pressure cylinder, on the contrary, not a drop of water could be obtained. The steam was to all intents and purposes quite dry. The few drops of water formed about the indicator cock when it was opened disappeared in a moment. From the stuffing boxes—the tail rod comes through the top of the cylinder—no water ever drips after the engine has been once warmed up. The frigorific influence of the condenser is here absolutely *nil*. Furthermore, the curious fact is shown by the diagrams that the pressure in this cylinder seems to be little affected by that in the boiler. This statement is so remarkable that we make it with hesitation, yet we cannot see how an error could have occurred. The indicator was in perfect order, and diagrams taken on two different days and under different conditions tell the same story. Comparing diagram Fig. 4 with Fig. 3, and it will be seen that while the maximum pressure in the latter is 16 lb. at one end, and 18 lb. at the other, the pressures for No. 4 are 18 lb. and 15 lb., or practically the same. But the boiler pressure for Fig. 3 was 85 lb. only, and the revolutions 100, while for Fig. 4 the pressure was 110 lb., and the revolutions 102. Thus a difference of boiler pressure of 25 lb. had no effect in the low-pressure cylinder. We believe that a similar phenomenon has been remarked with Perkins' engines. Of course this only obtains within certain limits, as was proved by the fact that when the engine was much throttled and run at half speed there was little or no work done in the low-pressure cylinder, as was evinced first by the cessation of thump on the crank pin, and the moment after by the cracking of water against the cylinder covers, showing that under these conditions the condensation in the low-pressure cylinder became profuse.

We may call attention now to the very small power developed in the intermediate cylinder. We have a 10in. cylinder developing very nearly three times as much power as a 16in., and it may be asked, is it worth while to incur all the expense and weight of this cylinder seeing how very little it contributes to the general duty? The principal object secured by the intermediate cylinder is to equalise the strains on the two cranks, and the success which has attended Mr. Taylor in this respect shows with what care and discrimination his calculations were made. The fact remains, however, that very little power is got out of the intermediate cylinder, which really plays to some extent the part of the receiver used in ordinary compound engines, and we therefore give the preference to the three-crank triple engine. On the other hand, however, it must not for one moment be forgotten that the three-crank engine takes up more space in a ship and is more expensive to build and to maintain than the tandem type. What type ought to be adopted depends entirely on the ruling conditions.

It will be said that we have advanced nothing to show why the triple expansion gear engine is more economical than the double expansion engine. This, however, would extend this article to a wearisome length. What we have to say on the subject shall be said at another time. Meanwhile we have, we believe, placed some facts not without interest before our readers, and a discussion of these facts, and the deductions to be drawn from them, in our correspondence columns, would no doubt elicit information concerning the performance of other triple expansion engines which would prove very useful.

THE PRESERVATION OF TIMBER.

THE following is a summary of a voluminous report of the Committee of the American Society of Civil Engineers on the preservation of timber. The report itself was presented at the convention of the Society at Deer Park, Md., June 24th.

After a brief statement of the labours of the Committee and of the evident necessity for the introduction of preserving processes on account of rapidly diminishing supplies of timber, a short history of the progress of the art is given, showing three principal methods of working, viz.:—(1) Steeping. (2) Vital suction or hydraulic pressure. (3) Treatment in closed vessels by steaming, vacuum, pressure, &c.

The experience in the United States is given in five tables, comprising the results, more or less conclusive, of 142 authenticated trials or experiments. In each case these are referred to at more or less length in the text, sufficiently to give the reasons for success or failure, and the lesson taught. The five heads corresponding to the tables are:—(1) Kyanising, or use of corrosive sublimate; (2) Burnettising, or use of chloride of zinc; (3) Creosoting, or use of creosote oil; (4) Boucherie, or use of sulphate of copper; (5) Miscellaneous, or use of various substances.

Of the first, Kyanising, it is stated that an absorption of four or five pounds of corrosive sublimate per 1000ft., board measure, is considered sufficient, and it would now cost about 6 dols. per 1000ft. It is not recommended except in situations where the air can circulate freely about the wood, as in bridges and trestles; but in very damp locations—as for ties when in wet soil and pavements—its success is doubtful. Its cost when first used led to cheating, which for a time brought discredit upon it.

Burnettising the committee do not consider the best adapted to use where the timber is exposed to the washing action of water, as this removes the preservative; but, on account of its cheapness, it is probably to be preferred at the present time to any other process for the preservation of railroad ties. The Wellhouse, Thilmany, and other modifications of the process aim at making the chloride insoluble, but are yet on trial. This process has been largely and successfully introduced in Germany. Experience shows the life of soft wood ties to be doubled and trebled by its use. Its cost in this country is about 5 dols. per 1000ft. broad measure, or 20c. to 25c. per tie, and for the latter purpose the committee particularly recommend it. The work must be well done; but some of the failures were from doing it too well—that is, from using solutions of too great strength, thus making the timber brittle. A solution of 2 per cent., by weight, of chloride of zinc in water, is recommended.

Creosoting, or the injection of timber with hot creosote oil in a cylinder under pressure, is considered to be the very best process which has been fully tested, where expense is not considered. It is as yet the only one known which is sure to prevent the destructive attacks of the teredo or other marine animals, and to give absolute protection against decay in very wet situations. It is a somewhat expensive process, requiring for protection against the teredo from 10 lb. to 20 lb. per cubic foot of timber, and costing from 12 dols. to 20 dols. per 1000ft., B.M. For resisting decay alone a cost of 10 dols. to 14 dols. is sufficient.

The Boucherie process, in which green timber is impregnated with sulphate of copper either by vital suction, hydraulic pressure, or a vacuum, when well done, using a solution of 1 lb. of sulphate to 100 lb. of water, has proved fairly successful. Under the head of "miscellaneous," are classed forty-one experiments with almost as many substances, sulphate and pyrolignite of iron, lime, resin, oil, tar, &c., but with as yet no commercial success. The general principles laid down are, to select the process with reference to the subsequent exposure. Use open-grained, porous timber, and for that reason in general the cheaper woods. Extract the sap and water to make room for the material to be injected, natural seasoning, except for the Boucherie process, being very desirable. Steaming takes the place of seasoning. Use enough of the antiseptic to insure a good result, and then let the timber dry before using, as its durability will thus be increased. Do not hasten the work if it is to be well done. Protect ties or timber in the track as far as may be from water by drainage. Contract only with reliable parties of established reputation, under a skilled inspector, who must be in constant attendance when the magnitude of the order warrants.

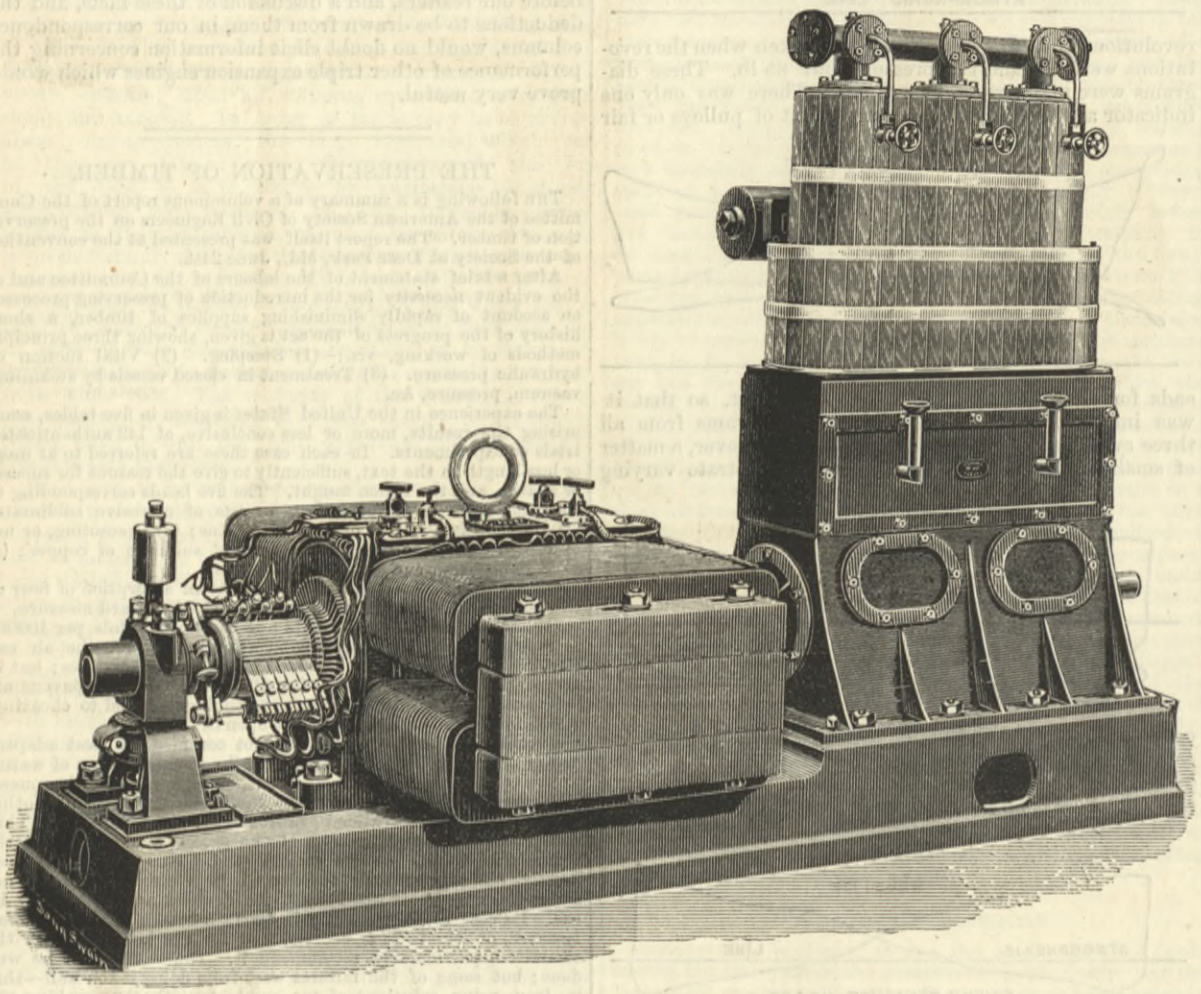
There is at the close a discussion of the question, Will any preserving process pay? This is answered in the affirmative. The chairman of the committee gives a careful estimate in one of the appendices in an actual case in this country; another general estimate is given based on European experience, and three other separate appendices give different methods of examining the question of economy and comparing values. Other appendices—to the number of twenty in all—treat of the general question of destruction and conservation of forests, and give reports of the personal experience of a number of engineers, with methods pursued, apparatus used, &c.

SUGAR PRODUCTION.—In 1884 the production of sugar over the world, so far as it came under the cognisance of statistics, was about 4,600,000 tons—say 2,100,000 tons of cane—and 2,500,000 tons of beetroot sugar. This quantity was in excess of consumption, and resulted at December 31st last in a surplus of about 200,000 tons, which surplus had increased by May 1st to 230,000 tons, or 5 per cent. over consumption, in visible stocks. There has been no falling off in consumption, which in the United Kingdom has for upwards of forty years increased at an average of about 3 per cent. per annum. The increase in America is at the rate of 6 per cent., and over the world the average increase is about 200,000 tons per annum.

ELECTRICAL ENGINEERING AT THE INVENTIONS EXHIBITION.

No. V.

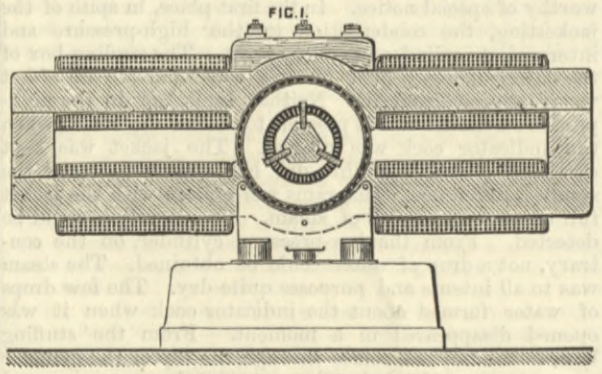
HAVING in our four previous articles treated this subject from a general point of view, we must now confront it more closely and describe some of the exhibits in detail. In doing this the question presents itself, In what order should we describe them? Should the most novel, or the largest, or the most well known, or the best dynamos, be described first? Any such distinction would be unwise and, perhaps, unfair; for, apart from the obvious impossibility of finally saying what is best or most novel in an exhibition which is still incomplete, we hold that it is not within our province to pronounce judgment on the exhibits. Our duty is to critically describe and bring facts before our readers, who must then judge for themselves. To avoid making any unfair distinction, we propose to describe the dynamos in the same order as the exhibitors supplied us with the information. Those who were most ready to give figures and show us details enable us to describe their dynamos first, whatever may be our own opinion as to excellence or novelty. At the same time, the readiness of a maker to publish details might perhaps be taken as a proof of the excellence of his machine, or at least as a proof that the maker is satisfied with it, and thinks it will bear public scrutiny with advantage. When an exhibitor absolutely refuses to make known the details of his machine, we may take it that either he fears comparison with others, or to have his patents infringed, or be perhaps himself sued for infringing; or last, but not least, he is unwilling to give to the world information which might enable other people to improve their dynamos. There can be no doubt that a close study of all the machines exhibited would enable every individual maker to find something to improve in his particular machine, for we cannot believe that a condition of finality has already been reached in this branch of electrical engineering. Some of the machines exhibited this year seem as near perfection as anything could well be; but so was it last year, and yet improvements were made. It is reasonable to assume that other improvements are still possible, though we may at the present moment hardly see how there can be room for them. We hold that every improvement introduced by one maker must indirectly benefit all the other makers, and must directly benefit the cause of electric lighting in general. But we are digressing, and must turn to our task of describing particular exhibits.



22-UNIT CROMPTON DYNAMO AND WILLANS' ENGINE.

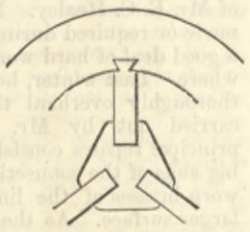
Messrs. R. E. Crompton and Co. show various machines of their new type and a collection of Bürgin armatures, illustrating how the former was gradually developed. It is interesting to note that Bürgin departed from the Gramme type of armature simply for mechanical reasons. He used to say that a Gramme machine was in reality not a mechanical machine, but rather a scientific apparatus; and, in so far as the attachment of the core of the armature was concerned, he was no doubt right. In the ordinary Gramme machine the armature is held by being driven over a wooden hub, and the power in the spindle has to be transmitted to the outer armature wires by friction pure and simple. To overcome this difficulty Bürgin made the core hexagonal and held it by a gun-metal star—or spider, as it is technically termed—the spokes of which were forced into the corners, thus making the connection between the spindle and the core mechanically perfect. Each side of the hexagonal core was wound with insulated copper wire; and in this respect the machine was not mechanically perfect, for the copper wire had to be carried through the field simply by friction. In the original Bürgin machines this presented *no* difficulty, as the length of the core, measured parallel to the spindle, was only about 1in., and therefore it was easy to coil the copper on with sufficient grip to withstand the comparatively small force which could be exerted over 1in. of its length. On account of the projecting corners of this hexagonal core, the magnetism can only travel round it in a somewhat jerky fashion, or, to speak more scientifically, the magnetic field is considerably disturbed, and lines of force are shaken more or less violently by the passage of these corners along the polar surfaces. If only one such hexagon were used the current would be very jerky indeed, and heavy sparking at the brushes would take place. To overcome this difficulty Bürgin uses a number of hexagons, mounted spirally on the same spindle, and each of which is so light in comparison to the field magnets that the disturbing influence of the corners of the armature is only small. Yet the disturbance exists, and is evidenced by some slight sparking at the commutator. We have said above that Bürgin departed from the Gramme machine for mechanical reasons. Messrs. Crompton have gone back to the Gramme armature for electrical reasons. The evolution of their modern machine out of the original Bürgin machine is very interesting, and is illustrated by a number of armatures exhibited. We find here the original ten-ring Bürgin armature, the core of each ring being 1in. wide and $\frac{1}{2}$in. thick radially. The total cross sectional area of the armature is therefore 5 square inches on each side, whilst the perimeter of the first turn of copper wire on each ring is a little over 3in. The electro-motive force of the machine is proportional to

FIG. 1.



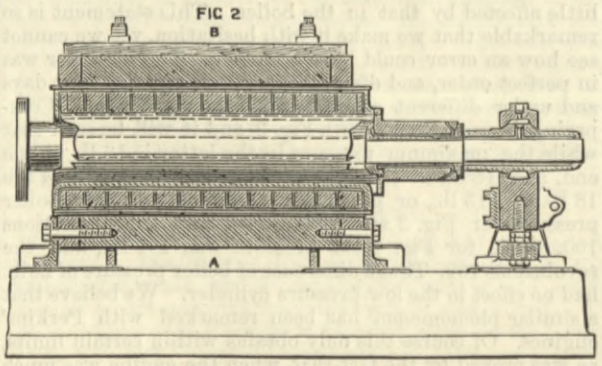
CROMPTON'S 21-UNIT MACHINE.

the area of the core, and the resistance of the armature is proportional to the perimeter. Say we double the dimensions of the core, making it 2in. by 1in., we shall have twice the electro-motive force in each ring and twice the resistance. But since the resistance of the armature absorbs only a small fraction of the total electro-motive force, there will be a decided gain in employing heavier rings. This was found experimentally by Messrs. Crompton, whose first step in this direction was to increase the size of the original rings to $1\frac{5}{16}$in. by $\frac{5}{8}$in. Eight such rings can be got into the same space as ten of the old form, and the total area is 6·5 square inches, giving an increase of electro-motive force of about 30 per cent. The eight-ring armature is shown on Messrs. Crompton's stand. To push the rings more closely together the original spiral arrangement was abandoned, or rather modified in such way that rings 1, 3, 5, 7, 2, 4, 6, 8 formed the spiral. This brings the corners of one hexagon nearly to the middle of the winding of the neighbouring hexagons, thus utilising the space available to greater advantage. The idea of this improvement is due to Mr. Crabb, foreman of the Chelmsford Works. In subsequent machines the idea of increasing the area of the core and reducing the number of rings was carried still further, and we find armatures with seven, five, and even only four rings exhibited. The core of the latter is $3\frac{5}{8}$in. wide and $1\frac{1}{4}$in. thick. With such a heavy core, however, the disturbing influence of the corners of the rings on the field was excessive, and the machines could not be made to run without sparking. The number of parts in the commutator was only twenty-four, and this increased the evil still further. The remedy was evidently to abandon the Bürgin hexagon, and to go back to the original circular core of the Gramme machine. Thus the disturbing influence of the projecting corners was avoided, and the commutator could be made with any convenient number of parts. Theory and experiment having meanwhile shown the advantage of a large mass of iron in the armatures, the core of the latter was made much heavier, as customary in the Gramme machines. In consequence of this and of the employment of wrought iron field magnets, a comparatively small number of turns of copper wire on the armature core suffices to produce the desired electro-motive force, and in machines built for an electro-motive force of 100 to 120 volts, only one layer of wire is necessary on the outer circumference of the armature. The distance between the outer surface of the core and the inner surface of the polar cavities has therefore been much reduced—it measures now only from $\frac{5}{16}$in. in small machines to $\frac{1}{2}$in. in larger machines—and a circuit of low magnetic resistance has been obtained. We must at once mention that this arrangement is not confined to the machines of Messrs. Crompton alone, but nearly all the good modern dynamos of the Gramme or Siemens type are now made so that the magnetic resistance of the air space is exceedingly low. The peculiarity of the machine of Messrs. Crompton is in the way the core is supported. We have said that the original Gramme machine was defective in this respect, and our readers will naturally ask how it is that, in spite of this defect, so many Gramme machines are yet successfully at work? Our answer is that a machine may be weak and yet not break down, and that in machines of older design the strain was not concentrated as at present into a minimum of space. In comparison to the power absorbed those antiquated dynamos are very bulky, having comparatively large surfaces along which an attachment by simple friction can be made; whilst in modern machines the field is so strong and the power so concentrated, that nothing but the most positive mechanical attachment will do. Messrs. Crompton build up the core of their armature of thin charcoal iron discs, about twenty-five to the inch. Every alternate disc is coated on both sides with Stannic paint, by which means the discs are insulated from each other. Notches are stamped out on the inner circumference, into which fit the dovetailed outer edges of phosphor bronze bars, the inner edges of which are fitted into grooves in the spindle as shown in the annexed sketch. Thus the driving power is delivered by a positive mechanical attachment into the armature core. We give in Fig. 1 a transverse section through the machine which is used for the lighting of Old London. It is driven direct by a Willans engine, as will be seen from our engraving, Fig. 2. Fig. 3 is a perspective view of the complete arrangement. The core of the armature of this machine is 28in. long, and $2\frac{1}{2}$in. deep, the external diameter being 12in. There are 120 turns of wire on it, and at a speed of about 450 revolutions the external electro-motive force is 110 volts. In this machine every $1\frac{3}{4}$ yards of wire on the armature produces about 1 volt in the external circuit, a fairly good performance. This is, however, not the best Messrs. Crompton's machines can do. We have received from them particulars of two machines lately erected at Buckingham Palace, where every $1\frac{1}{2}$ yards of armature wire produces 1 volt in the external circuit at a speed of 440 revolutions per minute. We give below the details of the tests:—



Speed.	External Current.	External E.M.F.
392	229	97
380	229	94
440	229	110

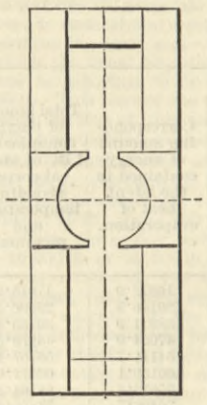
FIG 2

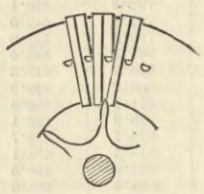


CROMPTON'S 21-UNIT MACHINE.

The dimensions are: Armature core, 28in. long, $2\frac{1}{2}$in. deep, 12in. diameter, wound with ninety-six turns of copper tape 0·300in. by 0·180in.; bore of pole pieces, $12\frac{1}{16}$, giving an air space of 0·47in.; density of current in armature wires, 2100 ampères per square inch; resistance of armature cold, ·021 ohm. The field magnets are arranged vertically, their cores being 24in. wide by $4\frac{1}{2}$in. thick, whilst the length over all is 3ft. 6in. They are compound wound, the main wire being 0·265 square and the shunt wire 0·120 round. The exciting power in one half of the magnets is 11,000 to 12,000 ampèreturns. There is one bearing for the dynamo spindle at the commutator side, the other end of the spindle being provided with a solid flange coupling forged on, by which it is bolted to the coupling on the shaft of the Willans engine. The portion of the spindle inside the core is triangular in shape, to admit of letting in the radial bars without unduly contracting the opening round the shaft by which air may enter. The core is subdivided lengthways by twelve air

spaces intended for internal ventilation. The makers state that a machine precisely similar to that here described has given an electrical output at the terminals of 25,300 watts, the proportion between external and internal electrical energy being 91 per cent. The electrical efficiency of output of the machine is 76½ per cent. of the indicated power of the engine. This is a very good performance, and is ascribed partly to the great care taken in the manufacture and partly to the quality of wrought iron used. What an important item the iron magnets are in a modern dynamo the visitor can see from a large magnet exhibited on Messrs. Crompton's stand. The annexed sketch shows this to a scale of 1 : 25. The polar cavity is 3ft. long and 14⅛in. bore; the magnet cores are 23in. wide by 7in. thick. On the same stand will be found a small arc dynamo, new pattern, a small dynamo for incandescent lighting giving an output of about 4000 watts and a larger machine of 7000 watts, also the first Bürgin machine made by the firm and a later type, which is still being made for arc lighting when required. A disc armature, made under Mr. Crompton's patent, is also exhibited, and proves that the firm do not shrink from exhibiting an invention which has failed alongside of their successful machines, and are thus assisting materially in the object of this Exhibition. The invention consists in the so-called "step winding," and has for its object to more completely utilise the space available for winding in disc armatures. As will be seen from the annexed sketch, the disc is covered by long and short coils, holes being left through which the wire of the short coils passes. The difficulties of insulation in these holes, and on the inside of the disc where the coils come necessarily very close together, were, however, so great that the design had ultimately to be given up. Even had these difficulties proved less formidable, it is doubtful whether the system of step winding has any advantages over the winding employed in the new "Brush" machine, where the triangular spaces left between the coils are utilised by letting the body of the core project into them. In this way is obtained not only a very substantial support for the armature coils in the direction of the driving force, but the magnetic resistance of the core and air space is reduced in a similar manner as in a Pacinotti armature.

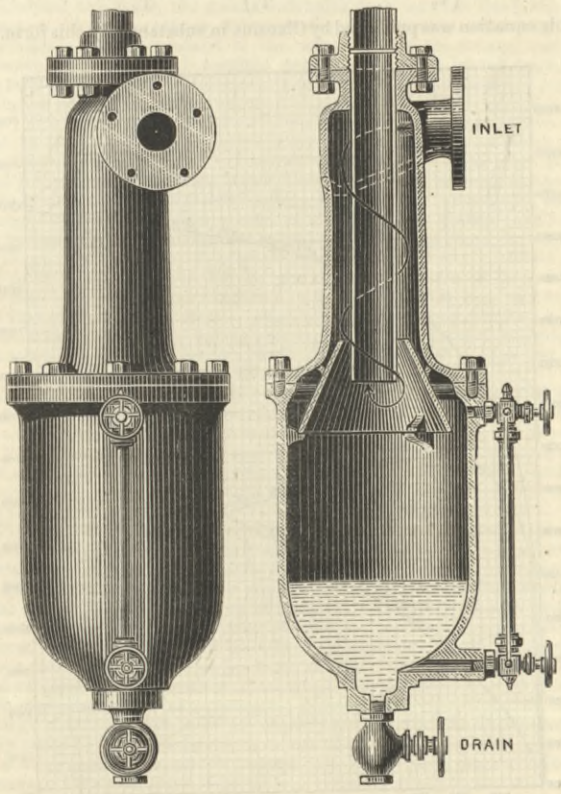




On Messrs. Crompton's stand will also be found a large collection of arc lamps, switches, measuring instruments, and various accessories used in connection with the electric lighting industry. These exhibits we shall describe in a future article.

SEPARATOR FOR STEAM BOILERS.

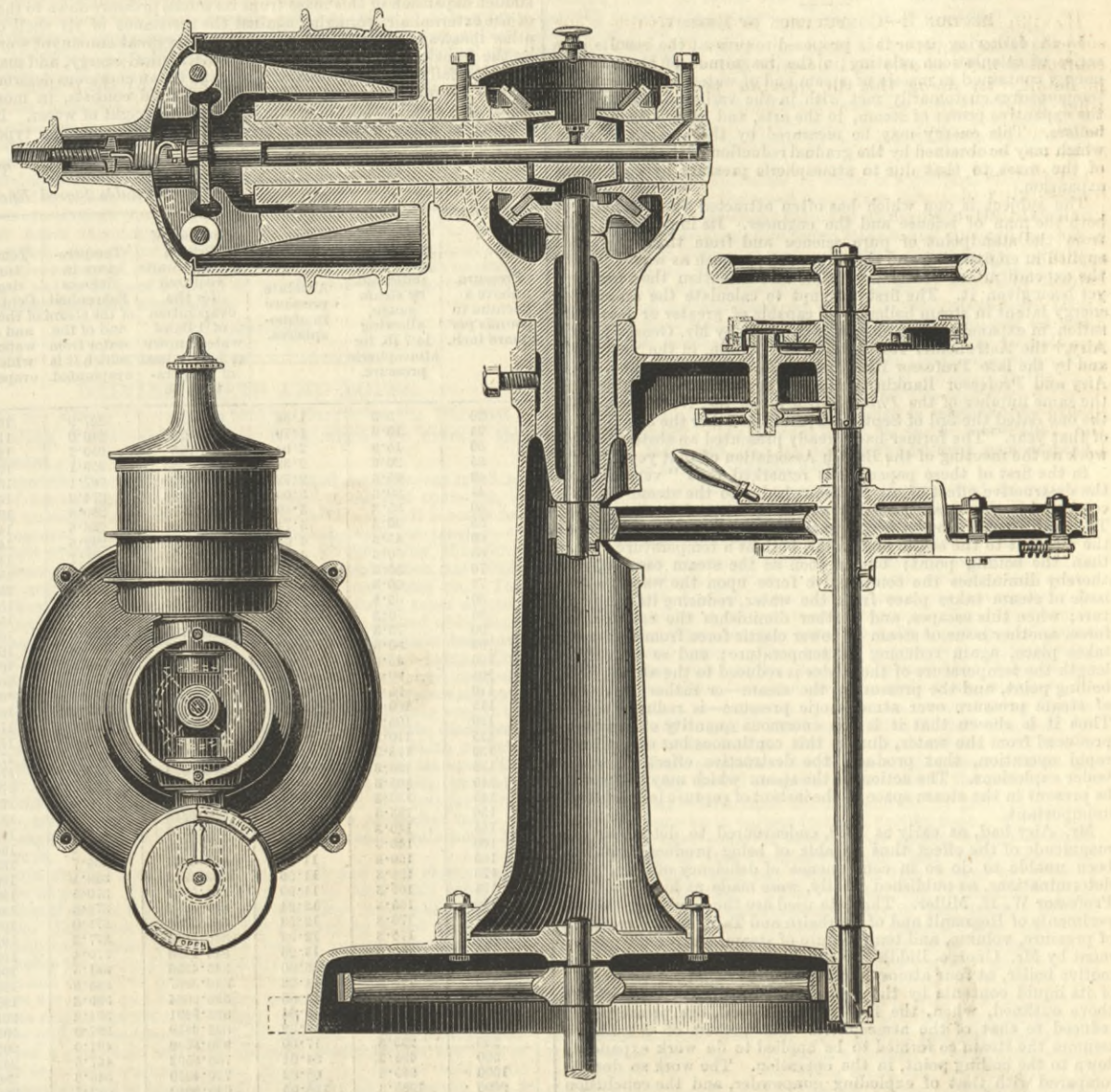
THE separator shown by the accompanying engravings is made by the Stratton Separator Company, Cortlandt-street, New York, and is for use on steam pipes between boiler and engine, or any other apparatus requiring dry steam. It consists of a casing, to which steam is admitted at the top. In this



casing the steam pipe proper is attached; it is open at the bottom, and the current of live steam entering the casing is carried round it several times, parting with whatever water it may contain, and finally entering the main steam pipe at right angles to its original entrance. The object is to avoid direct draught upon the steam space of the boiler, so diverting the current and changing its direction that water, whether by priming or of condensation, falls by gravity into a suitable receptacle. This is shown in the section. The device has been in use for some years, and has proved efficient.

A NEW pier has been opened at St. Ann's-on-the-Sea. It is 350 yards long, and has cost about £18,000. Beyond the pier is an extension for steamers.

HETT'S TURBINE GOVERNOR.



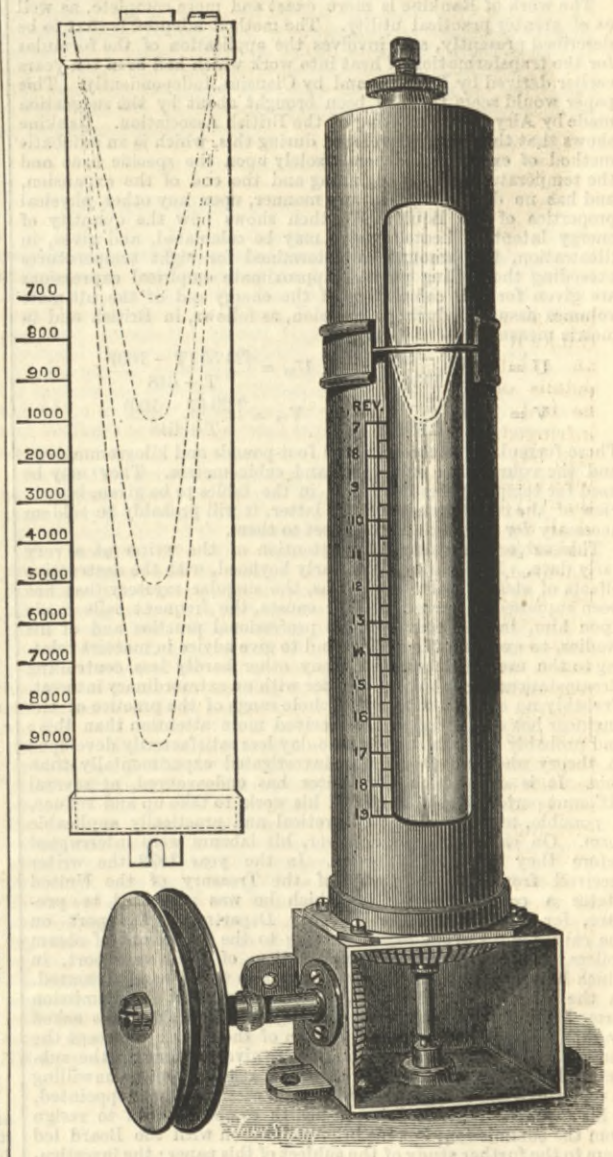
WATER-WHEEL governors of the old form, although theoretically chronometric, and therefore superior to the steam engine governor, are not found in practice to give a sufficiently steady motion for the finer provisions of the textile manufactures, and they are totally unsuited for electric lighting purposes. The subject has received a great deal of attention at the hands of turbine makers and others, and their efforts have met with varying success. But no governor previously constructed can be said to give a regular speed to the turbine, whilst silent working and durability are attained.

The governor we illustrate above is patented by Mr. Hett, of the Turbine Works, Brigg, and it is intended to possess the necessary qualifications of a thoroughly trustworthy speed regulator. The governor proper consists of weights revolving round a horizontal axis, their centrifugal force being balanced by a spiral spring. The whole is enclosed in a case which is made to act as a driving pulley, receiving the motion of the driving belt. When revolving at the proper speed the weights are in mid position, and nothing is in motion but the governor proper. Should the speed increase, the weights fly outward, and in doing so, press the cone into the conical recess in the mitre wheel. The governor now carries the bevel wheel round with it, putting the whole train of wheels in motion, and gradually closing the turbine gates until the velocity is reduced to the proper speed. The weights collapse slightly, and the cones disengaging the train is thrown out of gear, and the wheels rest until a further fluctuation of the load affects the speed, when the governor again calls them into action. Similarly when the speed decreases the weights are drawn in by the spring, and at the same time the opposite cone comes into contact, the train of wheels being set in motion in the opposite direction, thus opening the turbine gates.

Silence and durability are secured by the absence of any motion in the gear, except when the governor is actually engaged in adjusting the gates. To prevent any danger of the governor moving the gates too far, a clutch is provided, which enables the wheel to slip round the spindle when anything obstructs the movement of the gates. It also allows the governor to be thrown out of action when the turbine is to be stopped, both stopping and starting being done by hand.

HEDGES' SPEED GAUGE.

THE accompanying engraving illustrates a novelty in the way of speed indicators, which has been introduced by Mr. Killingworth Hedges as a simple and cheap instrument for reading the speed of dynamos or other quick running machinery. The instrument, termed the Vortex Indicator, is simply a removable glass tube, which is revolved in a metallic case furnished on its outside with a sliding ring. The tube being partly filled with water, when revolved the water has a tendency to creep up the side of the glass and imprison the air therein contained, carrying it down in a parabolic form, which is elongated as the speed increases. The bottom of the bubble gives the speed, which is easily ascertained by getting the two fine wires of the sliding ring in line, the revolutions being marked on the case. Mr. Thomas Blakesley, M.A., has investigated this instrument mathematically, and has devised a formula by which the angular velocity of the water which causes the depression for any given speed can be ascertained without experiment. The depression is always proportioned to the speed, so that the calibration of the instrument is far simpler than those other forms of speed indicators in which the ordinates vary with the increase of speed. As far as we are aware, Mr. Hedges' instrument is unlike all others in having the divisions at equal distances, and should prove of great utility for registering the speed of locomotives, and perhaps may be adapted for ship work. Several of these indicators are at work in the electric light shed of the Inventions Exhibition. They can also be tested at the offices



of the Globe Electrical Company, Dartmouth-street Westminster.

SOUTH KENSINGTON MUSEUM.—Visitors during the week ending June 20th, 1885:—On Monday, Tuesday, and Saturday, free, from 10 a.m. to 10 p.m., Museum, 8777; mercantile marine, Indian section, and other collections, 2157. On Wednesday, Thursday, and Friday, admission 6d., from 10 a.m. to 6 p.m., Museum, 1830; mercantile marine, Indian section, and other collections, 138. Total, 12,902. Average of corresponding week in former years, 18,939. Total from the opening of the Museum, 24,096,512.

STEAM BOILERS AS MAGAZINES OF EXPLOSIVE ENERGY.*

By ROBERT H. THURSTON, Hoboken, N.J.

SECTION I.—COMPUTATION OF ENERGY.

IN the following paper it is proposed to present the results of a series of calculations relating to the magnitude of the store of energy contained in masses of steam and of water, when heated to temperatures customarily met with in the various applications of the expansive power of steam, in the arts, and especially in steam boilers. This energy may be measured by the amount of work which may be obtained by the gradual reduction of the temperature of the mass to that due to atmospheric pressure by continuous expansion.

The subject is one which has often attracted the attention of both the man of science and the engineer. Its importance, both from the standpoint of pure science and from that of science applied in engineering and the minor arts, is such as would justify the expenditure of vastly more time and attention than has ever yet been given it. The first attempt to calculate the amount of energy latent in steam boilers, and capable of greater or less utilisation in expansion by explosion, was made by Mr. George Biddle Airy,† the Astronomer Royal of Great Britain, in the year 1863, and by the late Professor Rankine‡ at about the same time. Mr. Airy and Professor Rankine published papers on this subject in the same number of the *Philosophical Magazine*, November, 1863, the one dated the 3rd of September, and the other the 5th October of that year. The former had already presented an abstract of his work at the meeting of the British Association of that year.

In the first of these papers, it is remarked that "very little of the destructive effect of an explosion is due to the steam which is combined in the steam chamber at the moment of the explosion. The rupture of the boiler is due to the expansive power common at the moment to the steam and water, both at a temperature higher than the boiling point; but as soon as the steam escapes, and thereby diminishes the compressive force upon the water, a new issue of steam takes place from the water, reducing its temperature; when this escapes, and further diminishes the compressive force, another issue of steam of lower elastic force from the water takes place, again reducing its temperature; and so on, till at length the temperature of the water is reduced to the atmospheric boiling point, and the pressure of the steam—or rather the excess of steam pressure over atmospheric pressure—is reduced to 0." Thus it is shown that it is the enormous quantity of steam so produced from the water, during this continuous but exceedingly rapid operation, that produces the destructive effect of steam boiler explosions. The action of the steam which may happen to be present in the steam space at the instant of rupture is considered unimportant.

Mr. Airy had, as early as 1849, endeavoured to determine the magnitude of the effect thus capable of being produced, but had been unable to do so in consequence of deficiency of data. His determinations, as published finally, were made at his request by Professor W. H. Miller. The data used are the results of the experiments of Regnault and of Fairbairn and Tate, on the relations of pressure, volume, and temperature of steam, and of an experiment by Mr. George Biddle, by which it was found that a locomotive boiler, at four atmospheres pressure, discharged one-eighth of its liquid contents by the process of continuous evaporisation above outlined, when, the fire being removed, the pressure was reduced to that of the atmosphere. The process of calculation assumes the steam so formed to be applied to do work expanding down to the boiling point, in the operation. The work so done is compared with that of exploding gunpowder, and the conclusion finally reached is that "the destructive energy of one cubic foot of water, at a temperature which produces the pressure of 60 lb. to the square inch, is equal to that of 1 lb. of gunpowder."

The work of Rankine is more exact and more complete, as well as of greater practical utility. The method adopted is that to be described presently, and involves the application of the formulas for the transformation of heat into work which had been ten years earlier derived by Rankine and by Clausius, independently. This paper would seem to have been brought about by the suggestion made by Airy at the meeting of the British Association. Rankine shows that the energy developed during this, which is an adiabatic method of expansion, depends solely upon the specific heat and the temperatures at the beginning and the end of the expansion, and has no dependence, in any manner, upon any other physical properties of the liquid. He then shows how the quantity of energy latent in heated water may be calculated, and gives, in illustration, the amount so determined for eight temperatures exceeding the boiling point. Approximate empirical expressions are given for the calculation of the energy and of the ultimate volumes assumed during expansion, as follows, in British and in metric measures:—

$$U = \frac{772\,(T - 212)^2}{T + 1134{\cdot}4}; \qquad U_m = \frac{423{\cdot}55\,(T - 100)^2}{T + 648};$$

$$V = \frac{36{\cdot}76\,(T - 212)}{T + 1134{\cdot}4}; \qquad V_m = \frac{2{\cdot}29\,(T - 100)}{T + 648}.$$

These formulæ give the energy in foot-pounds and kilogrammetres, and the volumes in cubic feet and cubic metres. They may be used for temperatures not found in the tables to be given, but, in view of the completeness of the latter, it will probably be seldom necessary for the engineer to resort to them.

This subject attracted the attention of the writer at a very early date. Familiarity, from early boyhood, with the destructive effects of steam boiler explosions, the singular mystery that has been supposed to surround their causes, the frequent calls made upon him, in the course of his professional practice and of his studies, to examine the subject and to give advice in matters relating to the use of steam, and many other hardly less controlling circumstances, invested this matter with an extraordinary interest. Probably no subject within the whole range of the practice of the engineer has demanded or has received more attention than this; and probably no such subject is to-day less satisfactorily developed in theory and less thoroughly investigated experimentally than this. It is one which the writer has endeavoured, at several different periods in the course of his work, to take up and reduce, if possible, to a consistent theoretical and practically applicable form. On each occasion, however, his labours were interrupted before they were fairly begun. In the year 1872 the writer received from the Secretary of the Treasury of the United States a communication in which he was requested to prepare, for the use of the Treasury Department, a report on the causes and the conditions leading to the explosions of steam boilers, and he began the preparation of such a report, in which he proposed to incorporate the facts to be here presented. In the year 1875, the writer, then a member of a commission formed by the Government to investigate the subject, was asked by the Cabinet officer having direction of the matter to accept the chairmanship of the commission, and to give his time to the subject under investigation. For sufficient reasons he was unwilling to undertake the work, and an older and wiser head was appointed, at his request. A little later ill-health compelled him to resign from the commission, but his brief connection with the Board led them to the further study of the subject of this paper; the investigation was, however, again interrupted, and has not since been taken up in the systematic manner then proposed.

In this paper it is proposed to limit the subject to the investigation of the quantity of energy stored in some of the familiar and commonly used forms of steam boilers which are now everywhere seen endangering, to a greater or less extent, the lives and property of all who may be either permanently or temporarily within range of them. A steam boiler is a vessel in which is confined a mass of water and of steam at a high temperature, and at a pressure greatly in excess of that of the surrounding atmosphere. The sudden expansion of this mass from its initial pressure down to that of the external air, occurring against the resistance of its shell or other masses of matter, may develope a very great amount of work by the transformation of its heat into mechanical energy, and may cause, as daily occurring accidents remind us, an enormous destruction of life and property. The enclosed fluid consists, in most cases, of a small weight of steam and a great weight of water. In a boiler of a once common and still not uncommon marine type, the writer found the weight of steam to be less than 250 lb.—114 kilogs.—while the weight of water was nearly 40,000 lb.—18,144 kilogs. As will be seen later, under such conditions, the quantity of energy stored in the water is vastly in excess of that contained in the steam, notwithstanding the fact that the amount of energy per unit of weight of fluid is enormously the greater in the steam. A pound of steam, at a pressure of six atmospheres—88·2 lb. per square inch—above zero of pressure, and at its normal temperature, 177 C.—319 deg. Fah.—has stored in it about 125 British thermal units—32 calories—or nearly 100,000 foot-pounds of mechanical energy—13,825 kilog. metres—per unit of weight, in excess of that which it contains after expansion to atmospheric pressure. A pound of water accompanying that steam, and at the same pressure, has stored within it but about one-sixteenth as much available energy. Nevertheless, the disproportion of weight of two fluids is so much greater as to make the quantity of energy stored in the steam contained in the boiler quite insignificant in comparison with that contained in the water. These facts will be fully illustrated by the figures to be hereafter presented. The quantity of work and of energy which may be liberated by the explosion, or utilised by the expansion, of a mass of mingled steam and water, has been shown by Rankine and by Clausius, who determined this quantity almost simultaneously, to be easily expressed in terms of the two temperatures between which the expansion takes place.

When a mass of steam, originally dry but saturated, expands from an initial absolute temperature T_1 to a final absolute temperature T_2, if J is the mechanical equivalent of the unit of the heat and H is the measure, in the same units, of the latent heat per unit of weight of steam, the total quantity of energy exerted by unity of weight of the expanding mass is, as a maximum—

$$U = J\,T_2 \left(\frac{T_1}{T_2} - 1 - \text{hyp. log. } \frac{T_1}{T_2} \right) + \frac{T_1 - T_2}{T_1} H \quad . \quad . \quad . \quad (A).$$

This equation was published by Rankine a generation ago.* When a mingled mass of steam and water similarly expands, if M represents the weight of the total mass and m is the weight of steam alone, the work done by expansion will be measured by the expression—

$$U = M\,J\,T_2 \left(\frac{T_1}{T_2} - 1 - \text{hyp. log. } \frac{T_1}{T_2} \right) + m \frac{T_1 - T_2}{T_2} H \quad . \quad . \quad (B)$$

This equation was published by Clausius in substantially this form.†

TABLE I.

Available Stored Energy in Water and Steam.

Pressure above a vacuum in pounds per square inch.	Same pressure as indicated by steam gauge, allowing 14·7 lb. for atmospheric pressure.	Absolute pressure in atmospheres.	Number of British thermal units required for the evaporation of 1 lb. of water known as latent heat of evaporation, H.	Temperature in degrees Fahrenheit of the steam and of the water from which it is evaporated.	Temperature in degrees Centigrade of the steam and of the water from which it is evaporated.	Corresponding absolute temperature in degrees Fahrenheit.	Corresponding absolute temperature in degrees Centigrade.	Amount of energy contained in 1 lb. of water which may be liberated by explosion or expansion to 212 deg. Fah.	Corresponding amount of energy contained in the latent heat of evaporation.	Total amount of energy contained in 1 lb. of steam at corresponding temperatures and pressures.
20	5·3	1·36	954·415	227·9	108·8	689·0	382·8	145·9	16872·9	17018·8
25	10·3	1·70	945·825	240·0	115·5	701·2	389·5	439·7	29156·8	29596·5
30	15·3	2·04	938·925	250·2	121·2	711·4	395·2	813·5	38921·9	39735·4
35	20·3	2·38	932·1523	259·1	126·1	720·3	400·1	1223·4	47054·9	48278·3
40	25·3	2·72	926·4728	267·1	130·1	728·3	404·6	1645·7	54111·7	55757·4
45	30·3	3·06	921·3343	274·2	134·5	735·4	408·5	2112·9	60158·1	62271·0
50	35·3	3·40	916·6316	280·8	138·2	742·0	412·2	2550·4	65613·8	68164·2
55	40·3	3·74	912·2906	286·8	141·5	748·0	415·5	2999·9	70428·7	73428·6
60	45·3	4·08	908·2472	292·5	144·7	753·7	418·7	3449·2	74884·6	78333·8
65	50·3	4·42	904·4621	297·7	147·6	758·9	421·6	3899·8	78850·5	82750·3
70	55·3	4·76	900·8991	302·7	150·4	763·9	424·4	4361·1	82577·7	86938·8
75	60·3	5·10	897·5269	307·3	152·9	768·5	426·9	4815·8	85923·6	90739·4
80	65·3	5·44	894·3304	311·8	155·4	773·0	429·4	5206·5	89138·7	94345·2
85	70·3	5·78	891·2862	316·0	157·7	777·2	431·7	5638·9	92073·3	97712·2
90	75·3	6·12	888·3758	320·0	160·0	781·2	434·0	6058·1	94814·7	100872·8
95	80·3	6·46	885·5887	323·8	162·1	785·0	436·1	6474·2	97447·2	103921·4
100	85·3	6·80	882·9144	327·5	164·1	788·7	438·1	6885·2	99787·6	106672·8
105	90·3	7·14	880·3429	331·1	166·1	792·3	440·1	7290·3	102163·3	109453·6
110	95·3	7·48	877·8653	334·5	168·0	795·7	442·0	7689·0	104334·9	112023·9
115	100·3	7·82	875·4721	337·8	169·8	799·0	443·8	8087·3	106421·7	114509·0
120	105·3	8·16	873·1555	340·9	171·6	802·1	445·6	8483·1	108325·4	116808·5
125	110·3	8·50	870·9115	344·0	173·3	805·2	447·3	8864·9	110219·9	119084·8
130	115·3	8·84	868·7351	347·0	175·0	808·2	449·0	9252·6	112025·6	121278·2
135	120·3	9·18	866·6223	349·9	176·6	811·1	450·6	9627·0	113745·7	123372·7
140	125·3	9·52	864·5661	352·7	178·1	813·9	452·1	9992·6	115382·1	125374·7
145	130·3	9·86	862·5679	355·5	179·7	816·7	453·7	10361·0	117003·5	127364·5
150	135·3	10·20	860·6213	358·1	181·1	819·3	455·1	10536·5	118477·2	129003·7
155	140·3	10·54	858·7276	360·7	182·6	821·9	456·6	11085·9	119939·4	131025·3
160	145·3	10·88	856·8740	363·2	184·0	824·4	458·0	11444·2	121323·6	132767·8
165	150·3	11·22	855·0654	365·7	185·4	826·9	459·4	11823·4	122697·8	134521·2
170	155·3	11·56	853·2942	368·1	186·7	829·3	460·7	12141·3	123995·5	136136·8
175	160·3	11·90	851·5670	370·5	188·0	831·7	462·0	12508·7	125284·7	137793·4
180	165·3	12·24	849·8698	372·8	189·3	834·0	463·3	12821·4	126499·1	139320·5
185	170·3	12·58	848·2086	375·0	190·5	836·2	464·5	13182·0	127642·4	140824·4
190	175·3	12·92	846·5844	377·2	191·7	838·4	465·7	13367·1	128778·8	142145·9
195	180·3	13·26	844·9938	379·4	193·0	840·6	467·0	13844·1	129908·3	143752·4
200	185·3	13·60	843·4326	381·5	194·1	842·7	468·1	14153·3	130967·4	145120·7
210	195·3	14·28	840·3967	385·6	196·4	846·8	470·4	14830·8	133003·2	147834·0
220	205·3	14·66	838·5864	389·8	198·7	851·0	472·7	15463·1	136003·3	151466·4
230	215·3	15·64	833·9691	394·2	201·2	855·4	475·2	16180·3	137134·2	153314·7
240	225·3	16·32	832·6419	397·9	203·3	859·1	477·3	16790·2	139094·3	155884·5
250	235·3	17·00	830·3630	401·0	205·0	862·2	479·0	17314·4	140516·0	157830·4
500	485·3	34·01	780·8592	467·6	242·0	898·8	516·0	30055·5	165892·7	195948·2
1000	985·3	68·02	720·4350	546·8	286·0	1008·0	560·0	48671·5	179212·0	227883·5
2000	1985·3	136·05	643·9049	643·7	339·8	1104·9	613·8	75777·2	194221·3	269998·5
3000	2985·3	204·08	590·8038	708·3	375·7	1169·5	649·7	96116·3	193555·0	289671·3
4000	3985·3	272·10	544·6774	763·7	405·9	1223·9	679·9	114408·6	189201·7	303700·3
5000	4985·3	340·13	505·7339	807·8	431·0	1269·0	705·1	130494·2	183305·9	313800·1
6000	5985·3	408·16	471·8473	845·9	452·1	1307·1	726·1	144413·4	176656·9	321070·3
7000	6985·3	486·19	439·9985	881·2	471·7	1342·4	745·7	157944·2	169333·3	327277·5
8000	7985·3	544·21	409·4533	914·3	490·1	1375·5	764·1	170832·0	161392·6	332224·6
9000	8985·3	612·24	382·6347	945·2	507·3	1406·4	781·5	183998·6	153998·0	337142·6
10000	9985·3	680·27	355·2491	971·4	521·8	1432·6	795·8	193787·0	145376·8	339164·2
100000	99985·3	6802·72	305·3040	2163·4	1184·1	2624·6	1458·1	—	—	—

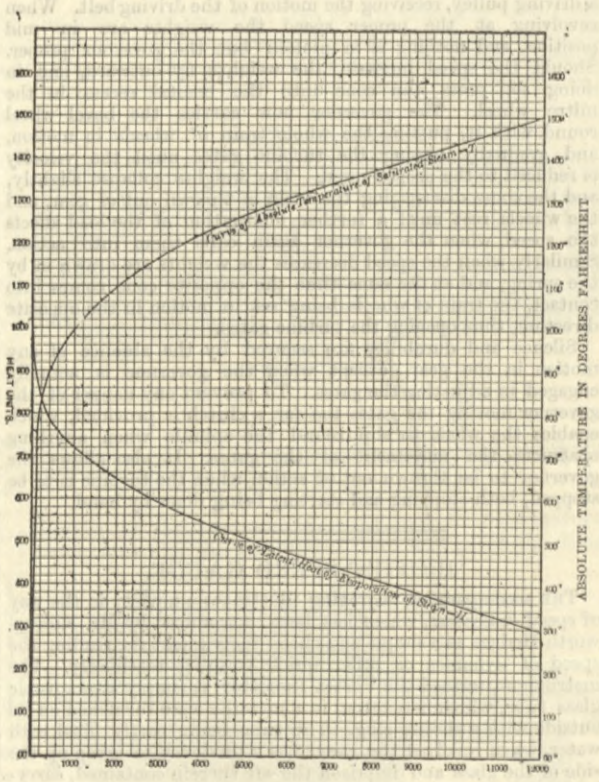


Fig. 58

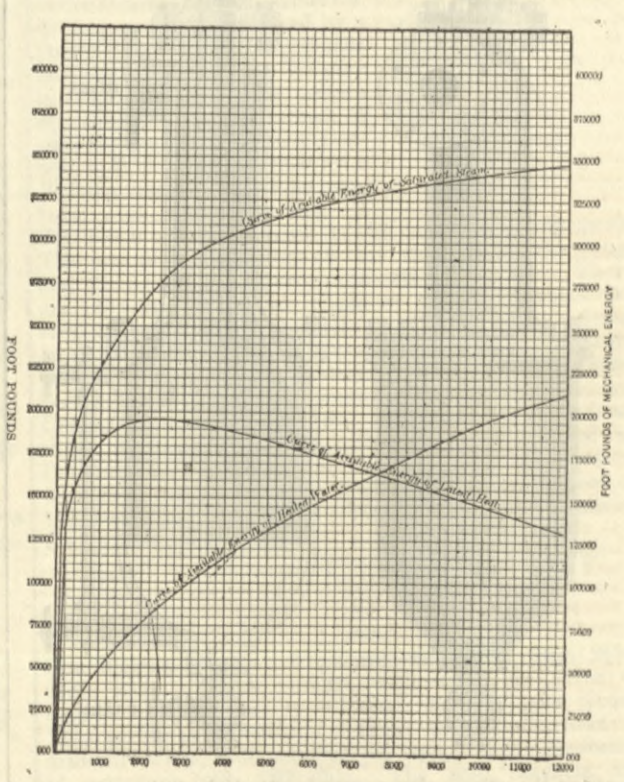


Fig. 59—*Absolute pressure in foot-pounds per sq. in.*

It is evident that the latent heat of the quantity m, which is represented by m H, becomes zero when the mass consists solely of water, and that the first term of the second member of the equation measures the amount of energy of heated water which may be set free, or converted into mechanical energy by explosion. The available energy of heated water, when explosion occurs, is thus easily measurable.

As has already been stated, this method was first applied by Rankine to the determination of the available energy of heated water for several selected temperatures and pressures. It has long been the intention of the writer to ascertain the magnitude of the

* Read before American Society of Mechanical Engineers.

† "Numerical Expression of the Destructive Energy in the Explosions of Steam Boilers."

‡ "On the Expansive Energy of Heated Water.

* "Steam Engine and Prime Movers," p. 387.

† "Mechanical Theory of Heat," Browne's Translation, p. 283.

quantities of energy residing, in available form, in both steam and water, for the whole usual range of temperatures and pressures familiar to the engineer, and also to carry out the calculations for temperatures and pressures not yet attained, except experimentally, but which are likely to be reached in the course of time, as the constantly progressing increase now observable goes on. The maximum attainable, in the effort to increase the efficiency of the steam engine and in the application of steam to new purposes, cannot be to-day predicted, or even, so far as the writer can see, imagined. High pressures like those adopted by Perkins and by Alban may yet be found useful. It was therefore proposed to carry out the tables to be constructed far beyond the limit of present necessities. It was further proposed to ascertain the weights of steam and of water contained in each of the more common forms of steam boilers, and to determine the total and relative amounts of energy confined in each under the usual conditions of working in every-day practice, and thus to ascertain their relative destructive power in case of explosion. This part of the work is reserved for description in a succeeding section of this paper. The present section is devoted to the first part of the subject.

At the commencement of this work, the writer employed the ate Mr. W. G. Cartwright, M.E., as computer, and, with his aid, prepared tables extending from 50 lb. per square inch to 100, at intervals of 10 lb., up to 250 with intervals of 25 lb., then 300, and up to 1000 lb. per square inch by 100 lb., and with larger intervals up to 10,000 lb. or 20,000 lb. The available energy of the heated water was computed, the energy obtainable from the so-called "latent heat," and their sum, *i.e.*, the available energy of steam per unit of weight. In the course of this work, each figure was calculated independently by two computers, and thus checked. As a further check, the figures so obtained were plotted, and the curve representing the law of their variation was drawn. This was a smooth curve of moderate curvature, and an incorrect determination was plainly revealed, and easily detected, by falling outside the curve. Three curves were thus constructed which will be given later: (1) The curve of available energy of heated water; (2) the curve of available energy of latent heat; (3) the curve of available energy of steam. The second of these curves presents an interesting peculiarity which will be pointed out when studying the forms of the several curves and the tables of results.

The work was interrupted by more pressing duties, and was finally resumed in the spring of 1884 and completed in the form now presented. The computers of the more complete tables here given were Messrs. Ernest H. Foster, M.E., and Kenneth Terrance, M.E., who, pursuing the same method as was originally adopted for the earlier computations, have revised the whole work, re-calculating every figure, extending the tables by interpolation, and carrying them up to a still higher pressure than was originally proposed. The tables here presented range from 20 lb. per square inch—1·4 kilogs. per sq. cm.—up to 100,000 lb. per square inch—7030·83 kilogs. per sq. cm.—the maximum probably falling far beyond the range of possible application, its temperature exceeding that at which the metals retain their tenacity, and in some cases exceeding their melting points. These high figures are not to be taken as exact. The relation of temperature to pressure is obtained by the use of Rankine's equation, of which it can only be said that it is wonderfully exact throughout the range of pressures within which experiment has extended, and within which it can be verified. The values estimated and tabulated are probably quite exact enough for the present purposes of even the military engineer or ordnance officer. The form of the equation, and of the curve representing the law of variation of pressure with temperature, indicates that, if exact at the familiar pressures and temperatures, it is not likely to be inexact at higher pressures. The curve, at its upper extremity, becomes nearly rectilinear.

The table which follows presents the values of the pressures in pounds per square inch above a vacuum, the corresponding reading of the steam gauge—allowing a barometric pressure of 14·7 lb. per square inch—the same pressures reckoned in atmospheres, the corresponding temperatures as given by the Centigrade and the Fahrenheit thermometers, and as reckoned both from the usual and the absolute zeros. The amount of the explosive energy of a unit weight of water, of the latent heat in a unit weight of steam, and the total available heat energy of the steam, are given for each of the stated temperatures and pressures throughout the whole range in British measures, atmospheric pressures being assumed to limit expansion. The values of the latent heats are taken from Regnault, for moderate pressures, and are calculated for the higher pressures, beyond the range of experiment, by the use of Rankine's modification of Regnault's formula.

Studying the table, the most remarkable fact noted at the lower pressures is the enormous difference in the amounts of energy, in available form, contained in the water and in the steam, and between the energy of sensible heat and that of latent heat, the sum of which constitutes the total energy of the steam. At 20 lb. per square inch above zero—1·36 atmos.—the water contains but 145·9 foot-pounds per pound; while the latent heat is equivalent to 16,872·9 foot-pounds, or more than 115 times as much; *i.e.*, the steam contains 116 times as much energy in the form of heat per pound, as does the water, from which it is formed, at the same temperature. The temperature is low; but the amount of energy expended in the production of the molecular change resulting in the conversion of the water into steam is very great, in consequence of the enormous expansion then taking place. At 50 lb., the ratio is 20 to 1; at 100 lb. per square inch it is 14 to 1, at 500 it is 5 to 1; while at 5000 lb. the energy of latent heat is but 1·4 that of the sensible heat. The two quantities become equal at about 7500 lb. At the highest temperature and pressure tabled, the same law would make the latent heat negative; it is, of course, uncertain what is the fact at that point.

At 50 lb. per square inch, the energy of heated water is 2550·4 foot-pounds, while that of the steam is 68,184, or enough to raise its own weight to a height in each case of a half mile or of 12 miles. At 75 lb. the figures are 4816 and 90,739, or equivalent to the work demanded to raise the unit weight to a height of four-fifths, and of about 17 miles, respectively. At 100 lb. the heights are over 1 mile for the water, and above 20 miles for the steam.

Plotting the tabulated figures and determining the form of the curve representing the law of variation of each set, we obtain the peculiar set of diagrams exhibited in the accompanying engraving. In Fig. 58 are seen the curves of absolute temperature and of latent heat as varying with variation of pressure. They are smooth and beautifully formed lines, having no relation to any of the familiar curves of the text-books on co-ordinate geometry. In Fig. 59 are given the curves of available energy of the water, of latent heat, and of steam. The first and third have evident kinship with the two curves given in the preceding illustration; but the curve of energy of latent heat is of an entirely different kind, and is not only peculiar in its variation in radius of curvature, but also in the fact of presenting a maximum ordinate at an early point in its course. This maximum is found at a pressure of about one ton per square inch, a pressure easily attainable by the engineer.

Examining the equations of those curves, it is seen that they have no relation to the conic sections, and that the curve, the peculiarities of which are here noted, is symmetrical about one of its abscissæ, and that it must have, if the expression holds for such pressures, another point of contrary flexure at some enormously high pressure and temperature. The formula is not, however, a "rational" one, and it is by no means certain that the curve is of the character indicated; although it is exceedingly probable that it may be. The presence of this characteristic point, should experiment finally confirm the deduction here made, will be likely to prove interesting, and it may be important; its discovery may possibly prove to be useful.

The curve of energy of steam is simply the curve obtained by the superposition of one of the two preceding curves upon the other. It rises rapidly at first, with increase of temperature, then gradually rises more slowly, turning gracefully to the right, and finally becoming nearly rectilinear. The curve of available energy of heated water exhibits similar characteristics, but its curvature is more gradual and more uniform.

Comparing the energy of water and of steam in the steam boiler with that of gunpowder, as used in ordnance, it will be found that at high pressures the former become possible rivals of the latter. The energy of gunpowder is somewhat variable with composition and perfection of manufacture, and is very variable in actual use, in consequence of the losses in ordnance due to leakage, failure of combustion, or retarded combustion in the gun. Taking its value at what the writer would consider a fair figure, 250,000 foot-pounds per pound, it is seen that, as found by Airy, a cubic foot of heated water, under a pressure of 60 lb. or 70 lb. per square inch, has about the same energy as 1 lb. of gunpowder. The gunpowder exploded as energy sufficient to raise its own weight to a height of nearly fifty miles, while the water has enough to raise its weight about one-sixtieth that height. At a low red heat water has about forty times this latter amount of energy in a form to be so expended. One pound of steam, at 60 lb. pressure, has about one-third the energy of 1 lb. of gunpowder. At 100 lb. it has as much energy as two-fifths of a pound of powder, and at higher pressures its energy increases very slowly.

(*To be continued.*)

DRIVING BELTS AND ROPES.

AT the Millers' Convention, held in Glasgow on the 16th inst., Mr. John Tullis read a paper, from which we extract the following:—

A modern flour mill is now one connected machine—so much so that from the time the wheat is subjected to the first operation, it must travel onward from one grade to another until it is ready for the market. A single hitch of half an hour with one machine or one belt will disarrange the entire mill. To the miller, therefore, the best of belting is a very important consideration, and little hints regarding the preservation of it may be of some use. The question for consideration is—"Whether belts or ropes are the best and cheapest method." First cost is often quoted when comparing ropes and belts. There is no doubt that main belts are much more expensive than driving ropes of cotton or hemp. But we must also look at the first cost of rope pulleys, and compare them with the price of belt pulleys. When these values are considered, I believe the belt-driven mill will be started for very little more money than a rope-driven mill. If the speeds, diameters, and widths are properly calculated, giving 1in. of width of belt, travelling at 500ft. per minute, 1-horse power to transmit, the result will be eminently satisfactory. Well-made, properly-stretched leather belts will run as straight as a line, last for thirty years, and be good for cutting up into smaller sizes after that. A mill engineered after this fashion has a long and comfortable life before it.

Main driving belts.—The belt is a soft and most elastic transmitter of power. It absorbs less power in itself than ropes. A number of textile ropes on one pair of pulleys never pull altogether as one. Each individual rope has a travelling speed of its own; consequently, there must be a loss of power, whereas a belt transmits the power from one pulley to another in one solid grasp. Belts and ropes both drive well when the distances from centre to centre are great, and the pulleys large in diameter. But a rope has no chance against a belt when the shafts are near each other, or the pulleys less than 4ft. 6in. in diameter. Under these circumstances a good belt will give splendid results, while the best of ropes are a constant annoyance. Main-driving leather belts should be manufactured so that when the joint is made while the belt is in its place, it ought to present the appearance of an endless belt. After having been taken up once or twice during the first year, good belts such as these require very little attention during the subsequent years of their long life. If the belt is driving in a warm engine-room it ought to get a coating of curriers' dubbing three times a year. All belts having much work to do ought to present a clammy face to the pulley, and this condition can be best maintained by applying one coating of dubbing and three coatings of boiled linseed oil once a year. This oil oxidises and the gummy surface formed gives the belt a smooth, elastic driving face. A belt looked after in this way will always run slack, and the tear and wear will be inconsiderable. On the other hand, dry belts have to be kept tighter, because they slip and refuse to lift the work. The friction of the running pulley "burns the life" out of the belt while this slipping is going on. The driving face is made as hard as millboard, and as well polished as a millstone. Bushes are ground down, shafting worn, oil consumed, the belt killed and condemned, because the disease has been misunderstood. If a belt is wanted to do more work than was originally intended, by, say, an addition to the machinery of the mill, a very good plan of getting power is to run a second belt upon the top of the one in use. Do not connect them in any way, and the outside belt will work for itself, and do a large proportion of the driving. By way of experiment, I have made four 6in. single belts, running independently on the top of one another over 4ft. driver and driven pulleys, transmit over 80-horse power, the belts travelling at a speed of 1800ft. per minute. Each of these belts did its own share of the work, and while running over its own circumference each gained a little over 30ft. per minute upon the one below; so that the outside belt travelled over 90ft. per minute more than the inside belt. The best leather for making belting is proved to be that known as "Orange Tan." This leather is made from the heaviest and best-grown Highland ox hides. During the process of tanning, instead of swelling, as is the case with all bark tannages, this leather becomes thinner in substance, and weighs 45 per cent. less than if tanned with oak bark. The breaking strain, according to Lloyd's proving house test, is 45 per cent. greater than oak-bark tanned leather. There are life and spring in it not found in any other leather. For driving machinery this leather stands first. Long belts should never be made heavy, because the weight makes them swing to a certain extent. The heavier the belt the greater the oscillation. Double-orange tan belts will work as steady as ribbons up to 350ft. long. The Singer Manufacturing Company, when designing their new Glasgow factory, were nearly deciding in favour of ropes for the long-distance driving. However, after testing the orange tan leather as to weight, working, and breaking strain, the decision was—"There's nothing like leather." There can be seen working at this factory every day between thirty and forty main driving belts up to 30in. wide; nearly a dozen of them are long, being 150ft. by 19in., and of double orange tan. They run as straight and as steady as a line, and have only been once taken up. Now comes the answer to the question often asked as to which side of a leather belt ought to run next the pulley. It is well known that by running the grain or smooth side next the pulley there is a considerable gain in driving power. However, by using the boiled linseed oil, as before mentioned, the flesh will soon become as smooth as the grain, and the driving power fully as good. A belt working with the grain side next the pulley really has a much shorter life than the belt running on the flesh side.

Patent leather chain belting.—Arched to suit the curve of the pulley, leather chain belting is proving to be one of the best belts ever invented. According to this manufacture, the entire face of the belt comes in equal contact with the entire face of the pulley. No unequal strain comes upon the rivets, as they have a level bed to lie upon. This belt is made a little thicker at the edges than in the centre. It can be made to suit any curve of pulley. All that is wanted is a templet of the pulley on which the belt has to work. This class of belt transmits 25 per cent. more horse-power than a flat belt of the same width. Many engineers are in doubt on this point. In practice, however, the truth of this statement has been proved to be quite correct. A flat belt always retains a cushion of air between itself and the pulley, which prevents perfect grip. This air escapes through the spaces in the chain belt, and the edge leather takes full charge of the power which it has to turn. I will only mention one example. Mr. John Smalley, of Mellor, Lancashire, was troubled with a 28in. flat double belt not being able to transmit the power of his engines, therefore a quantity of the machinery had to stand idle. A belt of this class was made specially to test this question. That belt is now doing over 25 per cent. more work than the flat double belt could do. It works very steadily, driving as easily as possible. It is the most rapidly joined belt of any. The links have only to be interlocked, the rivet connection made, and then you have an endless belt which runs so straight and steady that it looks like what a belt ought to be. Quite a number of these belts are driving three and four roller mills, and are considered by the millers using them to be perfection.

Half-twist belts.—This class of drive is sometimes the cause of much annoyance. A short belt has a poor life, and if the power wanted demands a wide belt, then the strain upon the outside of the belt becomes so great that bevel wheels and upright shafting have to take the place of a belt. In using ordinary flat belts for this kind of drive, it will be observed that a large portion of the belt assumes a slack appearance on the inside of the twist, which leaves the pulley and does no work. Several plans have been tried to overcome this difficulty, such as splitting the belt up into two or three widths, and securing them with cross connecting straps. But none have been so successful as the patent thick-sided and tapered chain belt. The links may be 1in. deep at the one side, tapering to $\frac{3}{8}$in. deep at the other. By this formation a twist belt can be made to any width. It comes in contact with every inch of the pulley. The strain is taken up by the heavy side, the slackness is taken out, and the belt seems to work as well as if there were no twist to contend with.

Cotton belts.—These are very good for many sorts of drives, such as paper mills, dye works, wet spinning flax mills, and all sorts of works in which steam and water are present in abundance. They also answer well for outside driving. At our own works we have our own make of cotton belts, transmitting power across yards from one building to another, in all weathers, with no other covering than a coat of boiled linseed oil, applied every two months. In warm countries these belts do remarkably well. The objectionable fraying of the edges has now been cured by applying our patent projecting leather edge. This edging is now securely rivetted on with the copper wire machine, and is so placed that it meets the thrust of the shifting fork, and saves the cloth from being cut.

Accumulations or lumps on pulleys and belts.—Dust should never be allowed to gather into a cake either on pulley or belt, for if so, the fibre of the leather gets very much strained. The belt is prevented from doing its work, because this stranger defies the attempt made by the belt to get a proper hold of the pulley.

Leather ropes.—Ever since the introduction of grooved pulleys, leather has come up in various forms of driving rope. Up till now none of them have come to anything as against cotton or hemp rope. There is the ordinary cable laid hide rope, the strands of which soon cut themselves into pieces by pressure and internal friction. There is also the "Coombe" rope, which is made of a multitudinous body of long leather strands twisted together; the friction and pressure also soon cut them up. Then there is the V-shaped solid leather rope, which is much too stiff and hard. The bottom plies get all cut and broken by the outside strain. There is the V-shaped rope with two or more plies of solid leather, with friction sections rivetted on these plies. The openings left between these sections are meant to make this rope more pliable, and less liable to cut. It has done some work, but is not a success. There is the square solid leather rope that is now being made, the faults of which are the same as those of the solid leather V-rope. However, there is nothing like perseverance. The outcome of this desire to improve is the patent V-shaped chain rope. This rope seems to possess all the qualities required to enable it to become the driving rope of the future. (1) It can be put on in a very short time, and can be shortened in a few minutes. (2) It offers four times the working contact of a round rope. (3) It will work well, whether long or short. (4) It will work well over small and large diameters. (5) This rope can be made to fit any form of groove. (6) Where textile ropes give trouble, we are willing to run a number of these on twelve months' approbation.

LAUNCHES AND TRIAL TRIPS.

ON June 13th Messrs. Oswald, Mordaunt, and Co., Southampton, successfully launched the iron sailing ship Halewood, of 2100 tons net register, and of the following dimensions:—Length, 274ft. 3in.; breadth, 40ft. 1in.; depth of hold, 24ft. 9in. The vessel has been built for Messrs. R. W. Leyland and Co., of Liverpool, and exceeds the highest requirements of both Lloyd's and Liverpool Underwriters' Registry. She is full rigged, and fitted with skysail on main mast. Ample accommodation is provided for captain and officers in full poop; large iron deckhouse is fitted amidships for petty officers and crew. She is fitted with Emerson and Walker's combined capstan windlass for working anchors and chains.

On the 17th inst. the same firm launched the Ormerod, an iron screw steamer, built for Colonel Thursby, and intended for general cargo carrying, being specially designed to carry a large cargo on a light draught, and of the following dimensions:—Length, extreme, 178ft.; breadth, 25ft. 3in.; depth to floors, 12ft. 11$\frac{3}{4}$in. She is schooner-rigged, and has a large bridge and topgallant forecastle. Accommodation for captain and officers will be provided in bridge, saloon being in front, whilst the crew will be berthed in forecastle below main deck. She is fitted with three steam winches, by Messrs. Clark, Chapman, and Co., quartermaster steam steering gear amidships, wheel and pinion aft, Harfield's patent windlass and anchor crane for working anchors. The ship's frames were started on April 16th, and by the 18th of June she had her engines and boilers on board. She is built on the cellular principle, and to class 100A. She has an additional floor between, each deep floor is cellular bottom, 1$\frac{1}{2}$in. deeper and $\frac{1}{16}$in. thicker than ordinary floors for a vessel of highest class, thereby greatly increasing strength of ship, whilst in engine and boiler space all the floors run to tank top. Her shell is in excess of Lloyd's requirements for highest class; having no reduction in way of tank, the sheer strake increased in breadth and thickness, bilge strake increased $\frac{1}{8}$ for 70ft. each side amidships, iron deck plating all fore and aft increased in thickness at hatchways and engine and boiler casings. Her hatchways are 3ft. above deck, having large iron web plates for additionally strengthening same. The vessel has during construction been under the superintendence of Captain George Richards, who will command the vessel after completion. The engines have been built by the same firm, and are of inverted surface condensing compound, with cylinders 21in. and 42in. diameter, 30in. stroke, with one large steel boiler, made of Siemens-Martin steel, and to carry 100 lb. pressure.

TENDERS.

ENGINE, PUMPS, AND TANK FOR WEST HAM UNION.

	£	s.	d.
T. Middleton and Co., S E.	850	0	0
Tylor and Sons, E.C.	746	10	0
Brown, Tottenham, N.	745	0	0
Jeaks and Co., W.C.	725	0	0
Warner and Sons, E.C.	630	0	0
Scott and Sons, E.	589	0	0
J. and F. May, W.C.	570	0	0
H. Lowe, Hackney, E.	550	0	0
Bennett and Sons, E.C.	515	0	0
T. Horn and Sons, S.W.	492	0	0
W. Harris, Forest-lane, E.—accepted	492	0	0

AMERICAN NOTES.

(*From our own Correspondent.*)

New York, June 12th.

There are some probabilities that the enormous exportation of copper from this port will fall off. Lake is selling at 11 dols. 30c.; Baltimore offered at 11 dols. 60c.; tin-plate is in active demand at 4 dols. 15c.; tin, 19 dols. 40c. Western miners are anxious to make contracts for early delivery. The exporters and importers are not disposed to take any risks in the present unsettled condition of the market. The American iron market is extremely unsettled. It was thought a few weeks ago that prices would remain firm at the figures then reached, but a further fluctuation is now in progress which points to a lower range of prices all through the list. Sales of Pennsylvania foundries are being made at 16 dols. for No. 2, and 17.50 dols. for No. 1. Foundries are offered in large lots at these prices shaded. Several furnace companies have negotiations pending for their summer production. The iron makers of that region are endeavouring to secure lower freight rates for ore, coal, and iron, and anticipate a successful answer to their requests. Prices of coal average from 2 dols. to 2 dols. 25c. A reduction of 50c. to 75c. per ton is asked. The transporting companies have the monopoly of the mining and transporting interests, and charge whatever they please, and this has had the effect of keeping half the furnaces of the Schuylkill Valley idle. It is estimated that iron can be made at 2 dols. per ton lower in that valley if justice was done producers. The anthracite coal combination is suffering from the competition of bituminous coal, and that fuel is now a drug in all Eastern and Western markets. Prices to-day are lower than ever before known. Several mining companies are barely obtaining cost of mining and shipping. Companies using anthracite are now trying bituminous, and the anthracite interests are compelled to recognise the competition. The rail mills throughout Eastern Pennsylvania are fairly employed on large and small orders at from 26 dols. to 28 dols. The mills are almost bare of orders, and are offering medium iron at 1 dol. 60c. The Western nail mills have not yet resumed, and the Eastern Nail Association is in its two weeks' suspension for this month. The Dolphin, John Roach's war ship, made another trial on Thursday, with what results it is not known.

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

(*From our own Correspondent.*)

The condition of the finished ironworks at Midsummer gives hope of fair employment for the ironworkers at the chief establishments after the quarter has turned. There is an encouraging demand for sheets of all descriptions, and to this demand the requirements of the galvanisers largely contribute. India, Australia, and certain of the South American markets are ordering galvanised sheets with some freedom, and certain of the best situated makers decline at present to book further forward at current rates. The orders from the colonies for a few brands of bars of high quality are larger than has lately been noticeable, and it is gratifying that the report this week by cable of the state of the Sydney market indicates some revival. Business in hoops is a little brisker, but the inquiries for tube strips do not much increase.

Sheets of the Woodford brand are quoted £8 for 20 b.g.; £9 10s. for 24 g.; £11 for 26 g.; and £11 10s. for 28 g. Woodford Crown qualities stand at £9 10s. for 20 g.; £11 for 24 g.; £12 10s. for 26 g.; and £13 for 28 g. Woodford best are £11, £12 10s., £14, and £14 10s., according to gauge. Siemens-Martin close annealed steel sheets are £13, £14 10s., £16, and £16 10s., according to gauge; and Woodford charcoal sheets are quoted £16 for 20 g.; £17 10s. for 24 g.; £19 for 26 g.; and £19 10s. for 28 g.

Common bars are now quoted at as low as £5 5s.; but it is to be remembered that this figure is still 5s. more than the quotations for Welsh bars delivered in this district, and is some 13s. or 15s. per ton above the price which Welsh makers are getting at works. Welsh bars are freely offered at £5 per ton, delivered here—a figure which does not mean much more than £4 10s. or £4 12s. to the Welsh makers. Sheets, singles, are quoted £6 7s. 6d. to £6 17s. 6d., according to quality and state of makers' order books; while doubles are £7 to £7 2s. 6d. Nail sheets are £5 10s. to £5 15s.

The Midsummer quarterly meetings are fixed to be held in Wolverhampton and Birmingham respectively a fortnight hence, and it is hoped that the merchants and other buyers from the leading commercial and manufacturing centres of the kingdom who will attend those gatherings, will place orders which may sensibly contribute to the activity at the works.

It is most probable that at the quarterly meetings the present quotations for marked bars, of £7 10s. per ton, and 12s. 6d. extra for the Earl of Dudley's brand, will be redeclared, notwithstanding the protests of some makers. In that event his Lordship's prices will be:—For rounds, £8 2s. 6d. lowest quality; £9 10s. single best; £11 double best; and £13 treble best. Rivet and T-iron, £10 10s. for single best; £12 for double best; and £14 for treble best. Angles, and also strips and hoops from 14 to 19 w.g., £8 12s. 6d. lowest quality; £10 single best; £11 10s. double best; and £13 10s. treble best. Strips and hoops of ⅜in. and 20 w.g., £9 12s. 6d., £11, £12 10s., and £14 10s., according to quality; and of ½in., £10 12s. 6d., £12, £13 10s., and £15 10s. respectively. Messrs. N. Hingley and Sons' bars are likely to stand at:—Netherton crown best, £7 10s.; Netherton crown best horseshoe, £7 10s.; best rivet, £8; double best plating, £9; double best crown Netherton, £8 10s.; treble best crown Netherton, £9 10s. These bars applied to rounds and squares ½in. to 3in., and flat bars 1in. to 6in. Angles were 10s. per ton extra, and tees 20s. per ton extra.

Good all-mine pig iron is quoted from 55s. to 57s. 6d., which is rather higher than Shropshire metal. Two or three of the best Staffordshire makers refuse to book orders at less than 60s., a figure which they contend is relatively 10s. per ton lower than the official rates for marked bars. Hematites of first quality are realising from 50s. up to 54s., while second qualities are 45s. Native part-mine pigs are 37s. 6d. up to 44s., and cinder pigs, 32s. 6d. up to 35s.

A meeting of the arbitrators and commissioners appointed under the South Staffordshire Mines Drainage Acts was held in Wolverhampton on Wednesday to hear appeals from mineowners against the arbitrators' draft award for levying in the Tipton district a rate of 3d. per ton on fire-clay and limestone, and 6d. per ton on ironstone, coal, slack, and other minerals. The applications of about nine appellants for graduations of the rate were heard, but the Court decided to reserve its decisions.

The difference between the masters and men at the Samson Colliery, Oldbury, has been adjusted this week by the men consenting to pay the increased contribution from 2d. to 3d. per week towards the Employers' Liability Insurance Corporation.

Railway rolling stock and other railway material firms note with satisfaction the further contracts which are upon the market on account of the Indian services. Iron underframes, underframe and body ironwork, and roofing, are required for the Nizam's Guaranteed State Railways Company, chiefly for carriages of 24ft. long and 5ft. 6in. gauge. Steel rails and axle boxes are needed by the Scinde, Punjaub, and Delhi Railway; fish-plates and bolts for the Indian State Railways; and crank axles and steel tires for the Great Indian Peninsular service.

Pipe founders hereabouts will attempt to secure the contract for between ten and eleven miles of cast iron water pipes which are just now offered on account of the Sutton-in-Ashfield Waterworks, Nottinghamshire. The contracts for about 7000 yards of cast iron sewage and air mains, and for air-compressing machinery and boilers offered by the sanitary authority of Henley-on-Thames, are scarcely likely to affect this district because of the very heavy cost of conveyance.

The Birmingham Chamber of Commerce have been in communication with the Board of Trade touching the proposed intention of the Russian Government to raise the import duties upon certain articles manufactured in Birmingham, and the desirability of giving early additional publicity of the intention of foreign Governments to increase import duties as soon as possible after the official receipts of such intelligence by the home Government. The reply of the Board of Trade, after referring to the Russian tariff, contains the further satisfactory information that the question of giving additional publicity to particulars of this nature in the way desired by the Birmingham Chamber of Commerce is now under the consideration of the Board of Trade and the Lords of her Majesty's Treasury.

The increased duties in Russia will, Messrs. Nettlefolds, of Birmingham, are of opinion, disadvantageously affect their trade with that country, but they believe that if they can only be placed under the most favoured nation clause as regards Spain, their increased trade with that country would go a long way towards compensating for the decline with Russia.

The application of the Birmingham and Western District Tramways Company for a provisional order empowering them to make additional lines, so that they could carry traffic from the South Staffordshire lines into the heart of Birmingham, came before a Committee of referees of the House of Commons a few days ago. The Birmingham Tramways and Omnibus Company applied for a *locus standi* against the Bill; but after hearing counsel's statement the Committee announced that they did not think that a sufficient case had been made out to allow the application.

The mills in North Staffordshire are receiving inquiries for deliveries of iron needed next quarter. This fresh business will be very welcome. The aggregate demand from Liverpool and London merchants for the colonies and the European markets is slightly better; but the works could execute a great deal more work without being in any way pressed. Bars are the description in best demand, and next to these hoops. Ironmasters alive to the changes in customers' views are giving increased attention to the steel question, and are making arrangements for entering into the steel business. The prices of merchant bars average from £5 5s. to £5 15s., while crown qualities are from £6 10s. to £7 10s. Plates are £6 17s. 6d. to £7 5s., delivered at Liverpool; and sheets, £6 12s. 6d. to £7. Common pigs do not command more than 37s. 6d. per ton.

The miners employed at the Hanley and Bucknall Colliery, in North Staffordshire, have accepted a reduction of 10 per cent. in wages. The masters at first proposed a drop of 12½ per cent., but a settlement has been come to on the terms mentioned. The men at the Podmore Hall Colliery, of Mr. W. Y. Craig, M.P., have also agreed to a similar reduction under the special circumstances mentioned last week.

Messrs. John Knight and Co., of Cookley, Worcestershire, manufacturers of sheets, tin plates, and tin sheets of iron, steel, and charcoal qualities, are just now increasing their business, and removing to more convenient premises at Brierley Hill, in the centre of the celebrated ten-yard thick coal district of the Earl of Dudley. The works will be carried on as heretofore, but with increased facilities.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester.—With the close of the half-year there is the usual tendency to taper off in the weight of buying until after stock-taking or balancing, and this has given a quieter tone to the market during the past week than perhaps fairly represents the actual condition of trade. There is, however, a continued absence of improvement, or even prospect of improvement, which produces a generally depressed feeling that gives, if anything, an unduly prominent tone to the market. Although business comes forward slowly, and, for the most part, in comparatively small transactions, it represents in the bulk a moderate trade actually doing. The chief complaint is that no better prices are obtainable, and, as in the face of constant reiteration that prices have got to the bottom, they have persistently continued to go lower, buyers naturally have no confidence in the future, and this is shown in the continued hand-to-mouth character of the business doing, which is, in fact, to a large extent really the meaning of the present bad trade.

There was less than an average attendance on the Manchester iron exchange on Tuesday, the holiday season accounting for the absence of some of the principal buyers and sellers, and business was flat, with very low prices ruling for both pig and finished iron. During the last few days Lancashire makers of pig iron have been booking orders to a moderately large extent, which will render unnecessary any further pressure to sell for the present, but to secure these orders they have had to come a little below their quoted rates of 39s. to 39s. 6d., less 2½, for forge and foundry qualities delivered equal to Manchester. In district brands quoted prices vary, according to quality, from 38s. to 38s. 6d. up to 40s. to 40s. 6d., less 2½, delivered into this district, but no weight of business is reported even at the minimum rates. For outside brands prices rule very low. Scotch iron lying at Lancashire ports is offering at very little over the price of warrants at Glasgow, and good foundry brands of Middlesbrough can be got at about 41s. to 41s. 6d. net cash, delivered equal to Manchester.

For hematites there is still only a very poor demand, and prices rule extremely low.

In the finished iron trade orders still come forward very slowly either for home requirement or for shipment, and with very few exceptions forges are not kept going more than about four days a week on small orders coming in from hand to mouth. Where business is done it is still on an extremely low basis of prices, which average £5 5s. to £5 7s. 6d. for good ordinary qualities of Lancashire and North Staffordshire bars, £5 15s. to £5 17s. 6d. for hoops, and £6 17s. 6d. to £7 per ton for sheets.

The condition of the engineering trades remains without material change, the reports from most branches being that new orders are scarce and that generally works are getting slack.

Government orders in connection with special tools for ordnance and other work continue to be given out in this district, and Messrs. Craven Brothers have received an order for a powerful gun-boring machine similar in general construction to the exceptionally large tools of this class previously made by the above firm, a description of which has been given in The Engineer. The machine which they are now making is to bore 30in. in diameter, 55ft. long, and will weigh about 150 tons.

A new swivel tool holder—Gavin Jones' patent—has been introduced by Messrs. Hulse and Co., of the Ordsal Works, Salford. These tool holders are the invention of a well-known Indian engineer, and they are applicable to all machine tools in which steel bar tools in general are used. In these swivel holders the two adjustments of the tool are effected separately and independently of each other. A cutter may be fixed, taken out, or replaced without disturbing the previous angular adjustment, and the cutter can be swivelled to any angle horizontally without disturbing its position in relation to the work.

The Manchester Association of Employers, Foremen, and Draughtsmen, have arranged an excursion for Saturday to Lancaster, and a visit to the Lancaster Wagon Works, and to the extensive Art Furniture Works of Messrs. Gillow and Co. The excursion will also be diversified by visits to Lancaster Castle and Morecombe.

An ingeniously designed illuminating power register—Thorp's patent—for showing instantly the illuminating power of gas and at the same time recording it—has been introduced by T. G. Marsh, of Oldham. The instrument effects its purpose by photographing a jet of gas. A sheet of sensitive paper revolves on a cylinder, and in doing so takes the photograph of the jet through a slot. The sensitive paper is ruled off to give the hours of the day and night, and the height of shadow or photograph gives the illuminating power at the various periods. Thus, by looking at the register paper the quality of the gas at any particular moment may be instantly ascertained, and these registers or diagrams when filled afford a useful continuous record.

The coal trade generally of this district is in a depressed condition, and four days a week is the full average time at which the pits are kept running. House-fire coals are now in very limited demand, with stocks accumulating. Common round coals for steam and forge purposes continue a drug and bad to sell; engine classes of fuel also meet with only a dull inquiry, and notwithstanding the lessened quantity of round coal now being screened, slack is still plentiful in the market. Quoted rates are without much change, but the actual selling prices are easier, and to secure orders of any weight for delivery over the next two months sellers are prepared to make concessions upon present rates. At the pit mouth best coal averages 8s. to 8s. 6d. per ton; second qualities, 6s. 9d. to 7s. 3d.; common round coals, 5s. to 5s. 6d.; burgy, 4s. 3d. to 4s. 9d.; good slack, 3s. 6d. to 3s. 9d.; and common sorts, 2s. 6d. to 3s. per ton.

For gas coal there has been a tolerably good demand, and contracts for cannel have been placed at about last season's rates.

The shipping trade is only moderate, and at Liverpool there are a good many complaints as to the scarcity of orders. Prices are without material change, and good qualities of steam coal delivered at the Garston Docks or the high level, Liverpool, average about 7s. to 7s. 3d. per ton.

The terrible disaster at the Clifton Hall Colliery, near Manchester, has naturally been a matter of very painful interest in this district during the past week. The only actually ascertained facts so far, which can be regarded as having a probable connection with the explosion, are the admitted use of naked lights and the firing of shots in the mine; but until a full inquiry is held it would be premature to comment upon any of the theories which are set up as to the real cause of the calamity. It will not, however, be out of place to draw attention to the absence of any permanent relief fund in the Manchester district, such as the West Lancashire districts and other important mining centres in the country have long since established for providing efficient relief to the sufferers, not only on occasions of great disaster, but also by the constantly recurring smaller accidents which, more than the large explosions, swell the great total of lives lost in mining operations. The collieries in the Manchester district have been content to go on with the old system of pit clubs, which no doubt meet the requirements so long as no exceptional disaster overtakes any of the pits. When, however, a calamity like the present occurs the sufferers are at once thrown upon the generosity of the public for relief. That this relief is on such occasions freely forthcoming is only a proof of the deep sympathy for the sufferers which disasters like the present must always arouse, but that such appeals should practically be the only resource for providing relief is somewhat a reflection upon the important mining district of Manchester, in the face of what other districts have long since done for themselves. Quite recently a grant from the surplus of the Hartley fund, which was secured for the Manchester district, afforded an opportunity for establishing a system of permanent relief, but the old system was allowed to go on. The present disaster, with its deplorable loss of life, should lead to some efforts being made in the direction followed in other parts of the Lancashire coal-field with such beneficial results.

Barrow.—The orders which have been booked for hematite pig iron during the past few days have not in any way improved the position of makers, who have still every reason to complain of the scarcity of orders, and who it is expected will have to reduce the output of their furnaces if the orders are not extended and if the amount used in the district by steel makers and others is not increased. As a matter of fact, the position of steel makers, which earlier in the year was satisfactory when compared with last year, is now no more satisfactory than that of producers of pig iron, and the scarcity of orders for steel of course affects the iron trade to an equal extent. As a consequence of this condition of things there is a disposition to increase the stocks of iron held by makers and consumers. Prices of iron are very steady, but they are unchanged at 43s. 6d. per ton net for mixed parcels of Bessemer iron net at works, and 42s. to 42s. 6d. per ton for forge and foundry samples. There is a very dull tone in the general trade in steel, and orders for special qualities come to hand very slowly. The shipbuilding industry in the district is in anything but a satisfactory position, and there is a great scarcity of orders from all quarters. Engineers in the marine department are still busy, but in the general trades there is no improvement. Iron ore and coal dull. Earl Spencer will unveil a bronze statue, by Bruce Joy, to Lord F. Cavendish at Barrow, on Tuesday next.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

In spite of a firmer tendency at Birmingham on Thursday, with rather more business doing, and the additional fact that Scotch iron is a little dearer, the iron trade here remains as depressed as ever. Consumers still hold back in the hope that lower prices may yet rule, and stocks are certainly not diminishing in the more important districts. A similar remark applies to the coal trade. Quotations at the Birley Collieries—Sheffield Coal Company—are as low as they have ever been, viz., hand-picked Silkstone branch coal, 10s. 10d. per ton; best screened Silkstone house coal, 7s. 11d.; screened Silkstone seconds, 5s.; screened Silkstone nuts, 4s. 2d. Travelling much in the colliery districts, I can notice a perceptible diminution of coal-laden wagons in the sidings; but there is still a goodly stock of accumulations, and it is idle, with the diminished export trade from this district, to anticipate any brisk business in the Yorkshire coal-field this season in the absence of any sudden revival of trade in the iron and heavy industries, of which at present there are few indications.

The Sheffield Chamber of Commerce has decided to give careful consideration to the Bill which has been introduced into Parliament by the Manchester Association on the question of rating machinery. The subject came before them in the form of a circular from the Associated Chambers of Commerce. The Council of the Chamber will be called together in about two months' time to consider the proposed measure. It was mentioned in the Chamber that a letter had been received from the Under Secretary of State for India, intimating that the Government contemplated spending £1,000,000 in addition to the amount usually spent on works—principally railways—in India. All efforts to get British goods placed on a more favourable footing in Spain have not yet been abandoned, notwithstanding the failure of recent negotiations. The Council of the Sheffield Chamber have resolved that their secretary should again communicate with the Secretary of State for Foreign Affairs, making urgent representations on the subject.

The Cutlers' Company has achieved a victory in regard to the use of the word "Sheffield." A deputation was recently appointed to wait on Earl Granville on the subject, but a communication has been received stating that the services of the deputation will not be required, inasmuch as his lordship had directed that the points raised with regard to the use of the word "Sheffield" by the Cutlers' Company should be brought before the next International Convention by the British delegates. This amounts to a concession of all that the Cutlers' Company are contending for.

The Industrial Exhibition to be opened here on Wednesday by Prince Albert Victor of Wales will be the first ever held to illustrate the handicrafts of Sheffield. There will be over 1400 exhibits of industrial processes of great technical interest, and general visitors will find as sources of attraction collections of quaint armour and steel work of great historic importance.

THE NORTH OF ENGLAND.

(From our own Correspondent.)

THE Cleveland pig iron trade is still without signs of improvement. At the market held at Middlesbrough on Tuesday last, prices were rather more in favour of consumers than on the previous market day, but the amount of business done was extremely small. There is some competition amongst merchants for the few small lots want for immediate delivery, and though the buyers usual quotation for No. 3, g.m.b., is 32s. 3d. per ton, they do not refuse 32s. 1½d. For forward delivery, 32s. 3d. is quoted. The demand for forge iron has slackened, and the price is now 32s. per ton. Makers still quote 33s. for No. 3, and as they do not seem inclined to take less, they make very few sales.

Warrants are 32s. to 32s. 3d. per ton. Some speculators appear to think things are about at the worst, inasmuch as they are cautiously purchasing and putting into store.

Messrs. Connal and Co.'s stock at Middlesbrough, after having steadily decreased during the last eight years, is now increasing. On Monday last the quantity held was 52,694 tons, being 1464 tons increase during the week.

Exports of pig iron from the Tees to Scotland continue good, but there is no improvement in foreign shipments. The quantity sent away this month up to Monday last was 58,891 tons, being about 10,000 more than during May.

The manufactured iron trade is in a stagnant condition. There are few orders in the market, and makers are consequently unable to run their mills full time. Prices are unaltered, being as follows:—Ship-plates, £4 17s. 6d. to £5 per ton; angles, £4 12s. 6d. to £4 15s.; and common bars, £4 15s. to £4 17s. 6d., in trucks at makers' works, less 2½ per cent. discount.

Messrs. Bolckow, Vaughan, and Co. have just received an order for 15,000 tons of steel rails for Indian railways. This will keep the Eston rail mills fully occupied for five to six weeks.

A new company was registered on the 15th inst. called the Haverton Hill Salt Company. The capital is to be £22,500, in £50 shares. It is intended to lease land at Billingham, opposite Newport, in order to work the rock salt.

The Scarborough and Whitby railway is nearly completed. It was inspected by the directors and engineer of the North-Eastern Railway Company on the 22nd inst. The formal inspection by the Board of Trade will be made shortly, and it is believed the line will be opened for traffic next month.

Boys cannot as a rule be expected to have more sense than their fathers. Messrs. Bolckow, Vaughan, and Co., had occasion recently to discharge five putter boys at their Westerton pit for some misconduct. This was resented by their comrades, not only there, but also at all other pits of the company. To the number of 124 they struck without notice, thereby putting themselves in the wrong. Summonses were taken out against each and all, and the Bishop Auckland magistrates had no option but to inflict fines which, with expenses, amounted to 39s. each. They authorised the company to pay themselves these sums out of any wage balances they might have in hand. Poor boys! They had often seen their elders strike, and sometimes successfully, and they did not anticipate a result so disastrous to themselves. No doubt many a father would also have to suffer by reason of the loss of his son's wages; and properly, for unless men had countenanced the boys' strike it would hardly have taken place. A great meeting of sympathisers with the lads was held after the decision of the court was known. Indignation was expressed that the miners' paid agents had not given more assistance, and they were accused of caring more for political manœuvres than for attending to their proper duties. Finally a resolution was passed to ask Messrs. Bolckow, Vaughan, and Co. to refund the fines and costs, in which case it was said the men and boys would all return to work. It is exceedingly improbable that this cool request will be granted.

Grievous complaints are heard on every side from North-country shipowners, to the effect that they cannot keep their ships employed except at a loss. The war scare brought numbers of idle vessels into action, but since it passed away freights have sunk to their old level, and there is nothing for it but to lay them up again. Consequently in the Tyne, the Wear, and at the Hartlepools numbers of vessels now entering remain, and do not leave again. The officers and crews are paid off and walk about the streets in the vain hope of finding fresh engagements.

The return of vessels built under Lloyd's survey and launched during the month of May has just been issued. It gives a total of 49 vessels and 44,379 tons, as against 55 vessels and 52,654 tons for May, 1884. Of the 49 vessels, 14, or 29 per cent., were of steel, and the remainder of iron. Seventeen vessels and 22,666 tons were turned out from yards on the North-east coast, and 18 vessels and 16,846 tons from Clyde yards. It therefore appears that the latter district has for the time time being lost its former leading position of North-east rivers. The Wear has outstripped the Tyne and Tees, as well as the Hartlepool having launched eight ships and 12,770 tons. On the whole, the returns, though far from satisfactory, are not so bad as many persons feared they would be.

NOTES FROM SCOTLAND.

(From our own Correspondent.)

THE Scotch pig iron trade continues very quiet, and it is not anticipated that there will be much improvement now during the summer months. In warrants this week only a moderate business was done, and the demand for makers' iron was slow. The past week's shipments of pigs amounted to 7957 tons, as compared with 9916 in the preceding week and 12,731 in the corresponding week of last year. There is an addition of about 850 tons for the week in the stock of pig iron in Messrs. Connal and Co.'s Glasgow stores.

Business was done in the warrant market on Friday at 41s. 1½d. cash. The tone was flat on Monday, when the cash quotation receded to 40s. 10½d. a ton. On Tuesday forenoon transactions were noted at 40s. 10d. to 40s. 10½d. cash, the market being steady at the latter figure in the afternoon. On Wednesday the market was depressed at 40s. 9½d. to 40s. 10d. cash. To-day —Thursday—there was a slightly better feeling, with the transactions up to 41s., closing at 40s. 11d. cash.

On account of the continued dulness in the market the quotations of makers' iron are again somewhat lower as follows:—Gartsherrie, f.o.b. at Glasgow, per ton, No. 1, 47s. 6d.; No. 3, 44s. 6d.; Coltness, 49s. and 47s. 6d.; Langloan, 48s. 6d. and 47s. 6d.; Summerlee, 47s. 6d. and 44s. 6d.; Calder, 52s. 6d. and 45s.; Carnbroe, 46s. 6d. and 44s. 6d.; Clyde, 46s. 3d. and 42s. 3d.; Monkland, 41s. 3d. and 39s. 3d.; Quarter, 40s. 6d. and 38s. 6d.; Govan, at Broomielaw, 41s. 3d. and 39s.; Shotts, at Leith, 48s. 6d. and 48s.; Carron, at Grangemouth, 51s. and 47s.; Kinneil, at Bo'ness, 43s. 6d. and 42s. 6d.; Glengarnock, at Ardrossan, 46s. 6d. and 41s. 6d.; Eglinton, 41s. 6d. and 38s. 6d.; Dalmellington, 44s. and 41s. 6d. The total shipments of Scotch pigs to date are 220,668 tons, against 273,189 tons in the same period last year.

The export trade in manufactured iron and machinery is upon a moderately good scale, and there is altogether a large amount of work in hand for abroad.

In the coal trade there is less activity than of late, but it is no unusual thing for the business to contract about the middle of the summer. The week's shipments of coals included 16,900 tons at Glasgow, 129 at Greenock, 3259 at Irvine, 7102 at Irvine, 8703 at Ayr, and 18,121, at Grangemouth.

Towards the end of last week a mass meeting of colliers was held in Hamilton, when it was stated 10,000 men were idle that day, and taking them at four tons each, it was alleged that this meant about 40,000 tons of coal kept out of the market in consequence of their meeting. Probably this statement was an exaggeration; but, at any rate, the masters are finding little difficulty in meeting orders, which are neither so large nor so pressing as they were a few weeks ago. The meeting agreed to affirm a former resolution to start on the eight-hours day; it was also resolved—"That all districts demand back the last reduction of 6d. by 1st July, and that the reports be given in to a conference and mass meeting to be held on the following day." It was likewise resolved —"That no miner in this county—Lanark—but will do his utmost to prevent any iron or coal master, or any other employer of labour, from entering the reformed Parliament through his vote at the ensuing general election, at which the miners of this country will possess an enormous power."

The Linwood district of Renfrewshire, which a short time ago and for many years was a busy mining locality, has had its aspect entirely changed by the closing of pits. Two belonging to Messrs. Dixon were closed on Saturday, and there are only one or two collieries open, owned by Messrs. Dunlop and Co. The iron is by no means exhausted, and the stoppage of the two pits referred to was not anticipated.

At a meeting of the Executive Board of the Fife and Clackmannan Miners' Association at Dunfermline on Saturday, a letter was read from the Coalmasters' Association, refusing to concede an advance of wages. It was determined to hold a series of meetings to bring pressure to bear upon the employers in the matter.

WALES & ADJOINING COUNTIES.

(From our own Correspondent.)

GLASGOW has secured the contract for making 25,000 tons of pipes for Cardiff new waterworks. The joint tender of Thomas Edington and Sons and Mr. D. Y. Stewart, of Glasgow, was accepted. It came to £97,349 16s. 11d.

I hear that the trial pits have shown capital bottom, so the work will commence forthwith. The sooner the better is the general voice.

The leading industry of Wales, coal, is still in the ascendant, and the large averages I have reported are fairly maintained in the case of Newport and Swansea, but not quite so well in the case of Cardiff. That port on two occasions of late has shown the astonishing total foreign exports of coal of 180,000 tons, but in each case the fall next week was to the extent of 30,000 or 40,000 tons. This was the case last week; yet shippers and coalowners are quite satisfied. They do not expect yet to reach an average 180,000 tons, but believe it is coming. At present a fair average of 140,000 tons is maintained. The great mass of exports is composed of the best four-feet, six-feet, and nine-feet. Small steam, too, figures well. Small bituminous is not sought after with any spirit, and house coal is somewhat quieter. The buoyancy in the trade generally is a good prompter to speculation, and new companies are being formed with spirit. One such I note as promoted by Cardiff men. This is the Phœnix, with a capital of £30,000 in £50 shares, to acquire the Tyla Coch, Nant Ddyrus, and Penwlli. Last week an attempt was made to dispose of some good mineral ground in Monmouthshire, but in the majority of cases the bids did not reach the reserve, and as the reserve was, in the opinion of some of the leading coalowners present, fixed too high, there was no change of ownership.

A large demonstration of Neath and Swansea colliers took place on Saturday at Swansea, when resolutions in favour of trades unions and of certain alterations being carried out in the Mines Regulation Act of 1872 were carried without opposition. I find that these suggested alterations are coming to the front in most parts of the district, and it is probable will make an appearance in official quarters before long. The changes proposed are—(1) to give the colliers the right of appointing as check weigher any person they may choose, whether in the employment of the firm or not; (2) to institute proceedings against owners or management for the neglect of duty or breach of the Mines' Act, in a similar way to the power possessed by the manager to proceed against the workman; (3) that relatives of persons killed in or about the mine shall be able to appear in person, or by deputy, before a coroner's jury, and give evidence, this being conducive to giving increased attention to the security of life and limb.

The sluggishness in all pertaining to iron and steel continues, though the exports, especially from Newport, last week showed better than of late. The total exported, principally rails from the Monmouthshire works, was composed of 1164 tons for Montreal; La Guayra, 610 tons; Valparaiso, 1000 tons; Valencia, 910 tons, and some small parcels to the Continent.

Two fatal accidents happened at Cyfarthfa Steel Works, and two at Dowlais, this week.

The total iron ore received at Newport and Cardiff from Bilbao and other quarters was under 20,000 tons. Prices about the same.

In tin-plate a tolerably good trade has been kept up. The prevailing complaint is low price; and I hear that buyers are ready to place an abundance of orders if prices can be arranged, but as that will entail a further drop it will be resisted.

Prices are too low at present to give anything like a living profit. For ordinary cokes 13s. 6d. is the quotation; steels are dull; charcoals and ternes in demand at firmer quotations, and good inquiry prevails for large sheets and squares. These specials are sought after as paying a shade better and making up for the dead level of ordinary make. How some of the smaller works manage to exist is a marvel, and rumours of struggles and coming disasters are rife.

I have just been favoured with a comparison of iron and coal returns. They are interesting as showing that Cardiff in May reached its highest total yet. Coal exports from Cardiff, May, 699,495 tons; January, 559,595 tons. Newport, May, 164,565 tons; January, 131,505 tons. Swansea, May, 79,100 tons; January, 80,802.

During the five months of 1885 Cardiff has exported 18,877 tons of iron and steel, and Newport 47,335, thus showing the lead of the Monmouthshire works.

In the matter of patent fuel, Cardiff sent in the same period 90,633 tons, and Swansea, 125,875 tons.

I see that the East Usk preamble has been proven.

This week a portion of the Rhondda and Swansea Bay line will be opened for passenger traffic, that from Aberavon to Pontrhydyfew. It has been already worked for mineral traffic.

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 number of the Specification.*

Applications for Letters Patent.

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

16th June, 1885.

7287. BOILER TUBES, J. Pickering, Stockton-on-Tees.
7288. TOOL HOLDERS, H. Parkin, Manchester.
7289. GAS LIGHTING APPARATUS, H. Fourness, Manchester.
7290. SECURING STICKS of CHILDREN'S CHAIRS, C. A. Doran, London.
7291. STOVE GRATES, J. Webster and H. Hudson, Halifax.
7292. MAKING NETS, H. B. Barlow.—(*J. H. Coevoet, France.*)
7293. CHALK-HOLDER, W. Glassey, Liverpool.
7294. DRAWING CORKS, J. H. Smiles, Stockton-on-Tees.
7295. DRIVING MECHANISM, A. Nicholas, Birmingham.
7296. FOLDING HEADS of CARRIAGES, C. E. Harrison, Birmingham.
7297. AMBULANCE STRETCHERS, A. Peck, Liverpool.
7298. BERTHS, J. G. Davison, Liverpool.
7299. SPUR WHEELS, J. Sharp, Birmingham.
7300. BICYCLES, &c., J. Carey and S. Dorset, Wolverhampton.
7301. DOUBLE-ACTING STEAM ENGINES, L. J. Todd, London.
7302. HATS, G. Richardson, London.
7303. FEED MOTION for DRILLS, J. F. Allen, London.
7304. STRETCHER FRAMES, A. D. Shattuck, London.
7305. LOOMS, S. Walker and G. Leek, Radcliffe.
7306. VENTILATORS, J. A. Macmeikan, London.
7307. ALUMINIUM, A. K. Huntingdon, London.
7308. STAND for BOOKS, T. F. Jordan, London.
7309. ACTUATING FOG HORNS, C. Wells, London.
7310. CARRIAGE SIGNALS, S. A. Varley, London.
7311. PRESSES for TILES, G. M. Garrard, London.
7312. ELECTRO-DYNAMIC MOTORS, T. J. Handford.—(*F. J. Sprague, U.S.*)
7313. OVENS, G. H. Leech and J. H. Hoyle.—(*R. Leech, U.S.*)
7314. VELOCIPEDES, P. A. Newton.—(*C. S. Leddell, U.S.*)
7315. BUTTON HOLES, A. W. L. Reddie.—(*P. Groom, U.S.*)
7316. DIRECT-ACTING ENGINES, A. W. L. Reddie.—(*D. S. Hines, W. A. Perry, and C. C. Worthington, U.S.*)
7317. SULPHURIC ACID, B. C. Molloy, London.
7318. FILTERING, &c., LIQUIDS, G. H. Ellis, London.
7319. SHUTTLES for LOOMS, W. Mitchell, London.
7320. FILLING BOTTLES with GASEOUS LIQUIDS, J. J. Varley, London.
7321. ELECTRIC LAMPS, C. A. Day.—(*F. Schaefer, Bavaria.*)
7322. BREECH-LOADING FIRE-ARMS, L. Armanni, London.
7323. TRAVELLING and other TRUNKS, E. Bullivant, London.
7324. STRAINING PILLARS and WINDERS, W. Bayliss, London.
7325. FROST and SNOW SHOES for HORSES, &c., J. J. Snook.—(*P. E. R. L. de Ladébat, France*)
7326. SMALL-ARMS and ORDNANCE, G. Rowell, London. —*10th February*, 1885.
7327. AUTOMATIC FIRE ALARM and HEAT INDICATOR, A. Hudson, London.
7328. STEAM GENERATORS, J. Y. Johnson.—(*N. J. V. Cadiat, France.*)
7329. BOOT and SHOE UPPERS, P. M. Justice.—(*W. A. Reed, United States.*)
7330. KITCHEN RANGES, R. Hunter and J. Turnbull, Glasgow.
7331. CUTTING WEBS of PAPER into STRIPS, P. Stewart, Glasgow.
7332. DRILLING or PERFORATING COAL, &c., C. Burnett, London.
7333. DREDGING or GRAB BUCKETS, C. W. Hunt, London.
7334. SAFETY LAMPS, A. M. Clark.—(*J. L. Williams and J. Holland, United States.*)
7335. SADDLES, A. M. Clark.—(*M. L. Eckles, United States.*)
7336. EXTENSIBLE TABLES, A. M. Clark.—(*A. E. French, United States.*)
7337. BOTTLE STOPPERS, A. M. Clark.—(*W. Stewart, United States.*)
7338. ELECTRIC MOTORS, C. A. Jackson, London.
7339. FIRE-PROOF CEILINGS and FLOORS, H. R. Snelgrove, London.
7340. GOVERNORS for STEAM ENGINES, &c., J. Scott, London.
7341. CODD'S BOTTLES for AERATED LIQUIDS, W. A. Barlow, London.
7342. MIDDLINGS PURIFIERS, H. Simon, London.
7343. ANÆSTHETICS, H. J. Haddan.—(*R. J. Hunter, United States.*)
7344. HOSE, J. McGregor, London.
7345. CASKS, &c., J. C. W. Stanley, E. Majer, and C. T. Craig, London.
7346. GLOVES or GAUNTLETS used in FOOTBALL PLAYING, W. Sykes, London.
7347. PATENT CARTRIDGE BOX, L. G. Bachmann, Liverpool.
7348. HINGES, W. Riches, London.—*5th May*, 1885.
7349. RAILWAY TIES, A. J. Boult.—(*E. D. Dougherty, United States.*)
7350. LAMPS, A. J. Boult.—(*J. C. F. Renisch, Germany*)
7351. RIDING and PACK SADDLES, T. J. Wint, London.
7352. DESSICATING VEGETABLE and ANIMAL MATTER, B. L. Ryder, London.
7353. SHUTTLES, A. J. Boult.—(*J. P. Thompson, United States.*)
7354. AUTOMATIC RAILWAY or other COUPLING, T. V. Riordan, London.
7355. CARBONATE of SODA, &c., H. H. Lake.—(*A. Kayser, A. B. Young, and H. Williams, United States.*)
7356. FELTING HAT BODIES, &c., H. H. Lake.—*J. T. Waring, United States.*)
7357. METAL OPEN-WORK, H. H. Lake. -(*J. F. Golding and G. B. Durkee, United States.*)
7358. COKE OVENS, A. M. Chambers and T. Smith, London.

17th June, 1885.

7359. DRIVING WIRE NAILS in BOOTS, &c., H. H. Lake —(*H. S. Bacon, United States*)
7360. TIME and SIDERIAL COMPASS, B. M. Dawes, Farnborough Station.
7361. BEAMING YARN MACHINES, C. Catlow, Halifax.
7362. SHOP COUNTERS, W. Parnall, Bristol.
7363. POCKET-KNIVES, W. E. Ilcys.—(*C. Küpper, Germany.*)
7364. ARTICLES made from SPAR, REFUSE MARBLE, &c., E. S. and D. F. Tucker, Manchester.
7365. IRON and STEEL, J. E. Stead, Yorkshire.
7366 CRUSHING and PULVERISING BONE, J. Beales, Manchester.
7367. OPENING and CLOSING UMBRELLAS, W. E. Heys. —(*J. Sachs and Co., Germany.*)
7368. LETTING-OFF MOTION for LOOMS, T. Watson and G. Kirk, Belfast.
7369. TEACHING CHILDREN to WALK, J. Scarrot, F. Herbert, and W. Horrox, Sheffield.
7370. CONVERTING LINEAL into ROTARY MOTION, A. T. Collier, London.
7371. READY-RECKONING BOOKS, S. Reid, Newcastle-upon-Tyne.
7372. BICYCLES, &c., E. Easthope, Wolverhampton.
7373. ELECTRIC VIBRATING BELLS, W. R. Wynne, London.
7374. SECURING HANDLES of TABLE CUTLERY, W. E. Darwin, London.
7375. HAND CARRIAGE, J. G. Wilson.—(*M. L. B. Madden, Straits Settlements.*)
7376. WATER BOILERS, C. D. Yates, London.
7377. BULL TAMER, N. T. Hewens, London.
7378. TREATMENT of BREWERS' WASTE, A. G. Salomon, London.
7379. BREECH-LOADING FIRE-ARMS, W. R. Wickham, London.
7380. COFFEE POT, C. Odé and P. Niel, London.
7381. CASE for HANDKERCHIEFS, &c., J. C. Mewburn.—(*F. R. Grumel, France.*)
7382. DECORATING WALL HANGINGS, A. H. Reed.—(*W. Sochejsky, United States.*)
7383. WHEELS for VEHICLES, F. Bird, London.
7384. LIGHTING RAILWAY CARRIAGES by ELECTRICITY, L. J. Crossley and R. Hanson, London.
7385. WARMING RAILWAY CARRIAGES, L. J. Crossley and R. Hanson, London
7386. HEATING FEED-WATER, L. J. Crossley and R. Hanson, London.
7387. WASHING CRUSHED ORES, T. Vosper, London.
7388. HOPPER DREDGERS, A. Brown, London.
7389. SAFES, D. R. Ratcliff, London.
7390. ELECTRIC ARC LAMPS, O. Romanzo, London.
7391. WATER WASTE PREVENTING CISTERNS, W. B. Ollis, London.
7392. GASSING YARNS, J. W. Dawson, London.
7393. CONSUMING SMOKE in STEAM BOILERS, W. Kneen, London.
7394. SAFETY LOCK, J. Y. Johnson.—(*C. A. Le Masson, L. I. Desmeules, and L. V. Thomas, France.*)
7395. CONNECTING TUBES, H. H. Lake.—(*Société L. Lerède et Cie., France.*)

18th June, 1885.

7396. KNITTING MACHINES, J. A. Claringburn, London.
7397. CIRCULAR KNITTING MACHINES, E. Hewitt, J. Marriott, and H. Perrons, London.
7398. RING SPINNING and DOUBLING MACHINES, G. Young, Manchester.
7399. SEPARATION of SUSPENDED MATTERS from WATER, W. P. Thompson.—(*F. C. Glaser, Germany.*)
7400. LOWERING DREDGERS, &c., W. Cooper and J. Holdsworth, Hull.
7401. POULTRY FEEDING and DRINKING, D. Tuley and A. Grant, Hatfield.
7402. COT and BASSINETTE BODIES, W. P. Hoskins, Birmingham.
7403. CORRUGATED METALLIC TUBES, D. B. Morison and H. Cheesman, Hartlepool.
7404. SPRINGS of WEAVING SHUTTLES, J. Whitaker, Keighley.
7405. EXPANSION BRUSH for CLEANING the INSIDES of ROUND BOTTLES, M. McCrainor and J. Clegg, Bury.
7406. FILLING GAPS in BOOK SHELVES, J. A. Bennett, Bath.
7407. PORTABLE, &c., MUSIC STANDS, &c., J. Fielden, Rochdale.
7408. COUPLING SHAFTS, H. MacColl, Glasgow.
7409. OVAL or ELLIPTICAL SOLDERING MACHINE, W. J. Brooke, Lowestoft.
7410. WASTE PREVENTING BALL VALVE and LEVER for CISTERNS, J. Morley, Saltley.
7411. PHOTOGRAPHIC LENSES, J. H. Steward, London.
7412. MEASURING ANGLES and RANGE FINDING, J. H. Steward and W. Dredge, London.
7413. ARTIFICIAL PRODUCTION of CODEIA, D. B. Dott, Glasgow.
7414. BOXES for HOLDING TWINE, J. Darling and D. Osborne, Glasgow.
7415. APPLIANCE for HOLDING TOILET PAPER, &c., C. Anderson, Glasgow.
7416. STOPPERING BOTTLES, E. Stiff and G. J. Chambers, London.
7417. FACILITATING the SETTING of TYPES by HAND, C. G. Fischer, London.
7418. EXTRACTING THISTLES from WOOL, W. Spence.—(*P. Dubois, France.*)
7419. CONDUITS for ELECTRICAL WIRES, T. Sington and W. T. Olive, Manchester.
7420. SMOKE-CONSUMING APPARATUS, E. Entwistle and A. Pilkington, Blackpool.
7421. STEAM BOILERS, R. S. Boyer, London.
7422. RECORDING by PHOTOGRAPHY the DEGREE of ACCURACY in AIMING ORDNANCE, C. Wells, London.
7423. FILING, &c., PAPERS, J. S. Fairfax and J. Lyons, London.
7424. PICKERS for LOOMS, S. Mitchell, London.
7425. CANS for BEER, &c., W. Akroyd and J. Driver, Halifax.
7426. CUTTING PILE FABRICS, J. E. Bennett and J. Sternberg, London.
7427. WASHING WEARING APPAREL, G. Thornton and J. Brittain, London.
7428. CHAINS for TRANSMITTING MOTIVE POWER, G. Thornton and J. Brittain, London.

CULINARY UTENSILS, W. Dobson, London.
. SYPHON TRAP, R. Rae, Glasgow.
7431. LUBRICATING APPARATUS, B. J. B. Mills.—(*L. Dusert, France.*)
7432. QUARTZ CRUSHING MACHINE, T. D. Williams, London.
7433. MACHINERY BELT FASTENERS, W. J. Brewer, Westminster.
7434. FASTENING WINDOWS, &c., W. J. Brewer, Westminster.
7435. PROPELLING FISHING VESSELS, H. J. C. Keymer, London.
7436. FORKS, W. Simons, London.
7437. TRICYCLES, &c., W. J. Lloyd and W. Priest, London.
7438. DRYING WASHED COAL, S. Butler, London.
7439. TESTING ELECTRIC BATTERIES, B. M. Drake and J. M. Gorman, London.
7440. MEASURING ELECTRIC CURRENTS, B. M. Drake and J. M. Gorham, London.
7441. RAISING WATER, H. J. Allison.—(*W. Robarts, Cape of Good Hope.*)
7442. LUBRICATORS, A. J. Boult.—(*P. Macabies, France.*)
7443. RECEIVING MONEY and ISSUING TICKETS on TRAM-CARS, &c., J. M. Kelly, London.
7444. COMPOUND STEAM ENGINES, H. Turner, Bradford.
7445. PORTABLE CANDLESTICKS, W. E. Rogers, London.
7446. WATER-SOFTENING PROCESSES, P. A. Maignen, London.
7447. STEP LADDERS, H. D. Hatfield, London.
7448. TRICYCLES, J. E. Holloway, London.
7449. CORSET FASTENINGS, H. J. Haddan.—(*A. Rammoser, Germany.*)
7450. WHEELS, H. J. Haddan.—(*L. Renault, U.S.*)
7451. DESTROYING PARASITES on SHEEP, &c., R. V. Tuson, London.
7452. TOOL for TURNING SEGMENTS of SPHERES, C. C. Ellison, London.
7453. CHAINS, C. D. Abel.—(*M. L. A. de Briey Comtesse de Montebello, France.*)
7454. SAPONACEOUS MATERIAL for WASHING, P. Brintini, London.
7455. STOPPER for BOTTLES and JARS, C. I. C. Bailey, Fulham.
7456. FIXING CLOSET PANS to TRAPS, C. I. C. Bailey, Fulham.
7457. MAKING, &c., WATER and OIL GAS, C. I. C. Bailey and S. C. Dean, Fulham.
7458. CARDBOARD, H. H. Lake.—(*A. D. Beaunier, France.*)
7459. GAS-BURNERS, A. M. Clark.—(*J. Danischevski, France.*)
7460. COUPLINGS, &c., J. H. Betteley, London.
7461. GALVANIC BATTERIES, A. R. Upward and C. W. Pridham, London.
7462. BLOOD ALBUMEN, T. Nordenfelt, London.
7463. FAST PILE FABRICS, S. C. Lister and J. Reixach, Bradford.
7464. RAILWAY COUPLING, T. Wood, London.

19th June, 1885.

7465. LETTER BOXES, R. Grimmond, Manchester.
7466. SPIROMETER, J. W. Waddington, Bradford.
7467. WATER-CLOSETS, H. W. Buchan, Edinburgh.
7468. HAMMOCK or SWING CHAIR, R. C. Allan, Witton, near Birmingham.
7469. LATHE for TURNING CHILLED IRON ROLLS, &c., G. F. Thompson, Chester.
7470. OIL LAMPS, J. H. Ross and A. Mackenzie, jun., Dublin.
7471. EARTH CLIPS for FORMING ELECTRICAL CIRCUITS, A. Whalley, Halifax.
7472. STEAM MERRY-GO-ROUNDS, W. H. Tasker, Blackpool.
7473. CLOCKS and CLOCK DIALS, W. T. Story, Halifax.
7474. VALVES for STEAM, &c., J. Dawson and G. A. Senior, Halifax.
7475. BENCH VICE, E. K. Dutton.—(*C. J. Hermann, Germany.*)
7476. COMBINED MEASURING and DRAWING TAP, D. Bell, Whitby.
7477. REVOLUBLE ELEVATUBLE EMITTER, P. H. Clague, Liverpool.
7478. PUTTING UP BLINDS or CURTAINS, H. Cooper.—(*P. Massino, Russia.*)
7479. RAILWAY SIGNALS, H. Cooper.—(*J. C. Cumming, Russia.*)
7480. SCHOOL SLATES, J. Manger, London.
7481. BUTTON FASTENINGS, J. and H. G. Taaffe, Brighton.
7482. BURIAL CASKETS, J. C. House, London.
7483. MORTISING MACHINES, J. B. Hamond, London.
7484. CRICKET BATS, R. F. J. C. Allen, London.
7485. PIGMENTS, A. McLean, London.
7486. METAL FENCING, F. W. Bompas, London.
7487. AERATED MINERAL WATERS, G. E. Vaughan.—(*F. Tiedemann, Denmark.*)
7488. SENSITIVE FILMS, PLATES, &c., for PHOTOGRAPHIC PURPOSES, A. J. Boult.—(*G. Eastman and W. H. Walker, United States.*)
7489. TROUSERS' STRETCHERS, &c., J. H. Hamilton and A. E. Gosnell, London.
7490. COUPLINGS for SHAFTS, &c., M. Lohmann and M. Stolterfoht, London.
7491. FIREWOOD, J. Draper, London.
7492. MINERS' PICKS, &c., W. R. Carr, J. Urwin, and J. F. Barlow, London.
7493. INSTANTANEOUS WATER-HEATERS, A. Sweet, London.
7494. BLUE COLOURING MATTER, H. J. Haddan.—(*R. Worms, Saxony.*)
7495. PREPARING FODDER, &c., H. J. Haddan.—(*C. H. Voigt, Saxony.*)
7496. ISOLATING SUBSTANCES, F. Schulte, London.
7497. COFFERS, H. Pahle, London.
7498. COMPOSITION for COATING BRICKWORK, &c., H. H. Lake.—(*S. Roebuck, United States.*)
7499. DRESSING and TRAVELLING BAGS, W. Candland, London.
7500. GAS ENGINES, E. Capitaine and O. Brünler, London.
7501. DRILLSTOCK for WATCHMAKERS, G. Cornioley, London.
7502. HORSEY TOBACCO POUCH, W. S. Mackie, London.
7503. KEYS, E. Tomlinson, London.
7504. BOOTS and SHOES, G. A. Sweetser, London.
7505. DRIVING BELTS or BANDS, &c., W. F. Thomas, London.
7506. FLUSHING CISTERNS, G. F. Redfern.—(*P. Carette, France.*)
7507. REGISTERING RECEIPTS of MONEY, J. T. Parlour, London.
7508. CLOTH CLAMPS for BUTTON-HOLE SEWING MACHINES, A. Anderson.—(*The Singer Manufacturing Co., United States.*)
7509. FEEDING MECHANISM for SEWING MACHINES, A. Anderson.—(*The Singer Manufacturing Co., U.S.*)
7510. CONTINUOUS MANUFACTURE of LIGHT METALS by ELECTROLYSIS, P. Jensen.—(*J. Ohmholt and the Chemische Fabrik Cossnitz, Böttiger, and Seidler, Germany.*)
7511. GALVANIC BATTERIES, Baron de Overbeck.—(*F. Hornung, Germany.*)
7512. CHECKING TRAMWAY FARES, C. Wyndham and C. H. Russell, London.

20th June, 1885.

7513. ENVELOPES, W. P. Thompson.—(*T. Kerckhoff, Germany.*)
7514. FASTENING DEVICE for CAUSTIC SODA DRUMS, &c., G. H. Bolton, Liverpool.
7515. FASTENINGS for SLEEVE LINKS, S. W. Witham, Bradford.
7516. CUFF SUSPENDER, J. L. Tourton, London.
7517. COMPRESSING and TRUSSING HAY, &c., R. Hoodless, West Stockwith.
7518. PROPELLING WHEELS by HAND or FOOT POWER, H. James and G. Robinson, Manchester.
7519. REEDS used in LOOMS, G. and E. Ashworth, Manchester.
7520. PENTAGRAPH MACHINES, G. Moulton, Manchester
7521. FOOT BATH with PORTABLE FOOT REST, D. W. Fessey, London.
7522. STOPPER for JARS, BOTTLES, &c., D. W. Fessey, London.
7523. BUTTON FLYS or FLAPS and SOFT TOPS for BOOTS and SHOES, D. W. Fessey, London.
7524. SOLITAIRE or STUD, W. A. White, Birmingham.
7525. MANUAL FIRE-ENGINES, J. C. Merryweather and C. J. W. Jakeman, Greenwich.
7526. SECURING DOOR KNOBS on SPINDLES, J. Dougherty, Liverpool.
7527. DECOLORISED SOLUTION of IODINE, H. N. Draper, Rathmines.
7528. CRUSHING ROLLERS, R. Burns, Rugeley.
7529. GUILLOTINE PAPER-CUTTING MACHINES, H. P. Trueman and J. G. New, Birmingham.
7530. CYLINDER PRINTING MACHINES, H. P. Trueman and J. G. New, Birmingham.
7531. SPRING MATTRESSES, J. T. B. King, Manchester.
7532. YIELDING TAB CONNECTIONS for BRACES, &c., J. Cadbury and J. G. Rollason, Birmingham.
7533. SOLIDIFYING SYRUPS, A. Ralu, J. Grathvohl, and H. A. Browne, London.
7534. UTILISING SWEET POTATOES and YAMS, A. Ralu, J. Grathvohl, and H. A. Browne, London.
7535. DISTILLING SPIRITS from SWEET POTATOES and YAMS, A. Ralu, J. Grathvohl, and H. A. Browne, London.
7536. PERFORATING INSTRUMENTS, D. Gestetner, London.
7537. TYPE-WRITERS, R. Hennell and H. F. Witherby, London.
7538. MINERS' KNIFE, &c., D. Hickie, London.
7539. BUTTON-HOLE SEWING MACHINES, G. and G. Browning, Glasgow.
7540. PIANOFORTE ACTIONS, G. H. Brockbank, London.
7541. GAS MOTOR ENGINES, J. Shaw, London.
7542. CONSTRUCTION of BUILDINGS or STRUCTURES, J. D. Overing and A. R. Tulip, London.
7543. MOUTHPIECE and LID for POWDER MAGAZINES, &c., R. Hudson, London.
7544. GOVERNORS for STEAM ENGINES, J. W. Macfarlane, Glasgow.
7545. SHIPS' RIDING BITTS, W. H. Harfield and W. Eames, London.
7546. CHIMNEY COWLS, W. J. Griffiths and A. Gibbs, London.
7547. APPLYING BRONZE to PAPER, W. B. Silverlock, London.
7548. SYCHRONISERS for CLOCKS, C. H. Pond, London.
7549. PREPARING NEWSPAPERS to ENSURE their being FOLDED to TYPE REGISTER, H. Harrild, jun., and A. Woods, London.
7550. LAMP, A. Kiesow, London.
7551. PREVENTING the OVER-BOILING of LIQUIDS, A. Kiesow.—(*J. Schreiber and Neffen, Austria.*)
7552. WINDOW SASH FASTENINGS, J. Sharp, London.
7553. UMBRELLAS and PARASOLS, E. B. Gaze, London.
7554. STEERING SHIPS, &c., C. B. C. and S. O. C. Coles, London.
7555. ADVERTISING SHEETS and PAPERS, &c., W. Wattis, Liverpool.
7556. WEAVERS' HARNESS, J. W. Horrocks, London.
7557. SECURING TABLES to CHILDREN'S CHAIRS, J. G. Wilson.—(*P. Diehl and Co., U.S.*)
7558. WINDOW SCREENS, J. G. Wilson.—(*P. Diehl and Co., United States.*)
7559. BILLIARD BOARDS, W. S. Dackus and W. A. Dackus, London.
7560. SANITARY PANS, J. W. Mulliner, London.
7561. VENTOMETER, J. A. Allison, Plaistow.
7562. WOOD COAL VASES or BOXES, A. C. Nicholls, London.
7563. RETORTS, A. M. Clark.—(*A. Coze, France.*)
7564. BOARDING, &c., LEATHER, W. Paul, London.
7565. COMBINATION of COFFEE, MILK, and SUGAR, H. Brown, London.
7566. STUFFING-BOXES, S. H. Sparkes, London.
7567. BRAKE APPARATUS, H. Studdy, London.
7568. GUN BARRELS, H. H. Lake.—(*G. V. Fosbery, Belgium.*)

22nd June, 1885.

7569. BALL and ROLLER BEARINGS, F. H. Anderton and G. W. Elliott, Sheffield.
7570. CIGARS, C. H. Wood, Sheffield.
7571. BESSEMER CONVERTER BOTTOMS, &c., G. A. Jarvis and A. E. Tucker, Shifnal.
7572. STAIR EYES, C. Longbottom, Bradford.
7573. ILLUMINATING, O. Fahnehjelm, Liverpool.
7574. STUDS, J. C. W. Jefferys, London.
7575. TAKING SOUNDINGS, J. Ackerley and B. Parr, Manchester.
7576. DECK LIGHTS or ILLUMINATORS, H. Cooper.—(*Lieut.-Col. Sokoloff, Russia.*)
7577. SHEDDING MOTION for ACTUATING HEALDS, J. Clayton and T. Richmond, London.
7578. PERFORATED MUSIC SHEETS, F. E. P. Ehrlich, London.
7579. SYPHON TRAPS, W. Bruce, Glasgow.
7580. COMBINATION TOILET STAND, E. Bond, London.
7581. COMPRESSED GASEOUS COMPOUND, E. Captaine and O. Brünler, London.
7582. TELEGRAPHY, T. J. Handford.—(*T. A. Edison, United States.*)
7583. SIGNALLING on RAILWAYS, T. J. Handford.—(*T. A. Edison and E. T. Gilliland, United States.*)
7584. TELEGRAPHY, T. J. Handford.—(*T. A. Edison, United States.*)
7585. RAISING WATER, &c., J. H. Greene, Kew.
7586. BLANK BOLTS, &c., J. Leyland, London.
7587. WATER-WASTE PREVENTER CISTERN, W. Farrow, Chelmsford.
7588. BREAKING ELECTRIC CIRCUITS AUTOMATICALLY, G. Wilkinson, London.
7589. CORRUGATED FLUES of BOILERS, J. D. Morrison and T. J. Robson, London.
7590. GELATINE, E. Hoefling, London.
7591. EFFECTING the CLOSING of MANHOLES, J. Simonis, London.
7592. FOUNDATION and FASTENER for TILES, &c., R. G. Robson, London.
7593. COMPRESSING HAY, J. Bamber, London.
7594. PREVENTING PRIMING in STEAM BOILERS, W. Campbell, sen., Glasgow.
7595. SUPPORTING ELECTRIC LIGHTING APPLIANCES upon GAS FIXTURES, H. H. Lake.—(*C. A. Hussey, U.S.*)
7596. COLOUR PRINTING, J. Greth and H. de Barranca, London.
7597. PURIFYING COPPER PRECIPITATES, J. Y. Johnson.—(*E. Deligny, France.*)

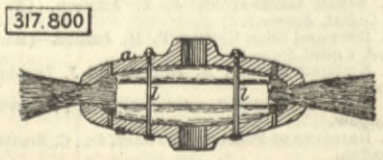
SELECTED AMERICAN PATENTS.

(From the United States' Patent Office Official Gazette.)

317,800. POLISHING WHEEL, *William A. Knipe, Haverhill, Mass.—Filed September 1st*, 1884.

Claim.—(1) As an improved article of manufacture, the rotary polishing wheel, composed of the plates *a a*, having central apertures to receive a stud or arbor and detachably secured together, and the radiating bunches

317.800

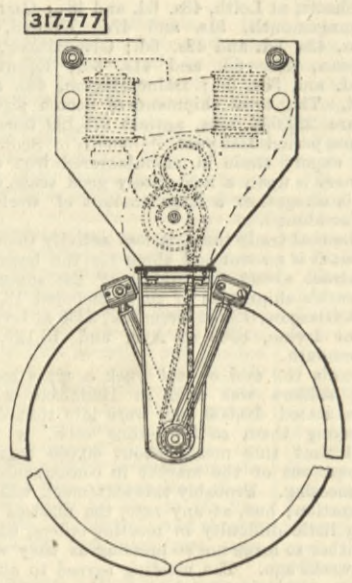


of yarn or thread clamped between the proximate faces of the plates, substantially as described. (2) In a rotary polishing wheel, the combination of the plates *a a*, having concave inner surfaces, and central arbor receiving orifices, the radiating bunches of yarn or thread clamped between the impinging faces of said plates, and bolts *l l*, connecting said plates between said faces and the central orifices, as set forth

317,777. ELECTRIC LAMP, *Charles F. Heinrichs, New York, N.Y.—Filed December 13th*, 1884.

Claim.—(1) In an electric lamp, a pair of curved carbon pencils mounted upon movable arms insulated from each other and combined with moving and regulating mechanism whereby said pencils, when the lamp is in operation, are caused to approach each other and to maintain the arc constantly at substantially the same point. (2) In an electric arc lamp, a pair of curved carbon pencils mounted upon movable arms insulated from each other and depending in a vertical plane, electro-magnets in the lamp circuit with pawl and ratchet mechanism and gearing connecting the same to a shaft, connection between said shaft and the shaft on which the pencil arms are pivotted, whereby the pencils are allowed to drop and approach each

317,777

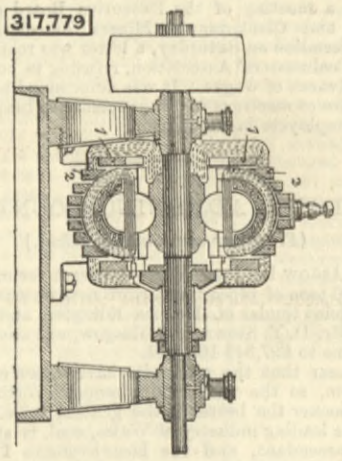


other by gravity, and their position determined, all substantially as shown. (3) In an electric arc lamp, a pair of curved carbon pencils mounted upon a pair of arms moving in opposite directions, an electro-magnet in the lamp circuit, with mechanism, substantially as described, connecting the same with differential devices, and suitable mechanism between said differential devices and the shafts on which the carbon holders are mounted, whereby the pencils are allowed to approach each other and their position determined, substantially as described.

317,779. DYNAMO-ELECTRIC MACHINE, *Charles F. Heinrichs, New York, N.Y.—Filed December 15th*, 1884.

Claim.—(1) In the hereinbefore described apparatus, a ring armature channelled or recessed on the side or sides away from the inducing magnet and wound with insulated wire, substantially as described. (2) In the hereinbefore described apparatus, a channelled ring armature having the channelled or recessed side away from the inducing magnet and wound with insulated wire, substantially as described. (3) In the herein-

317,779

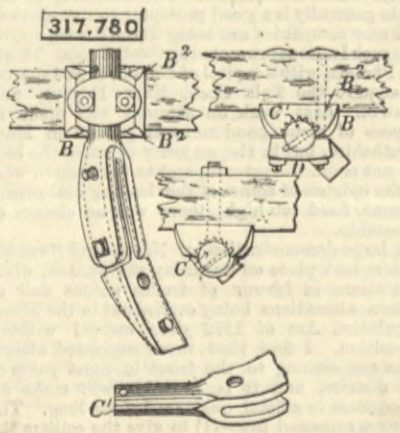


before described apparatus, a core formed of an annular shell or section, and of wires wound circumferentially thereon, the ends being secured at equal spaces from each other and the sections piled one upon another, substantially as set forth. (4) A core formed of a shell of substantially channel shape, having flanges 1 2 2 and the sections of wire wound thereon, substantially as described.

317,780. CULTIVATOR TOOTH, *Francis M. Helms and Christopher C. Trinkle, Veedersburg, Ind.—Filed October 11th*, 1884.

Claim.—The combination of the beam, the plate B, provided with flanges B^2, overlapping the upper and lower edges of the beam, and having a concavity in its outer face formed with a series of vertical serrations, the standard fitted to such concavity and having a rib

317,780

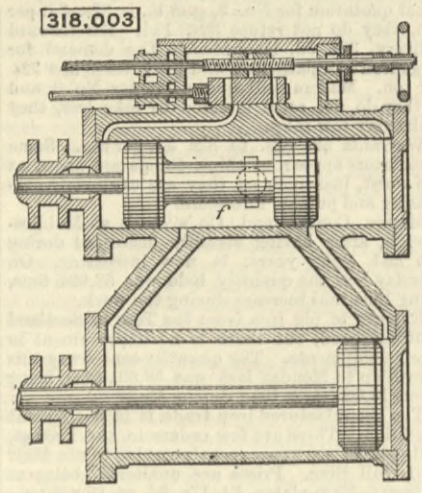


C^1, formed to engage the vertical serrations, the plate D, provided on its inner side with a concavity fitted to the outer side of the standard, and fastenings whereby the plate D is clamped against the standard, and the rib of the latter is held in engagement with the serrations of the plate B, substantially as set forth.

318,003. COMPOUND STEAM ENGINES, *John F. Krieger and John H. Bickershoff, Cincinnati, Ohio.—Filed February 20th*, 1885.

Claim.—(1) In a compound engine, the combination of high and low pressure cylinders, the former carrying a double piston operating as a controlling induction and eduction valve for the latter, an exhaust port opening from the high-pressure cylinder between the pistons thereof, and an induction valve arranged to govern the admission of steam to the high-pressure cylinder, whereby the steam is solely exhausted from the engine, first from the high-pressure into the low-pressure cylinder, and then back and outward through the sole exhaust port between the pistons of the high-pressure cylinder, as set forth. (2) In a compound engine of the class described, the combination of the high-pressure and low-pressure cylinders and their pistons and connecting ports, having its sole exhaust

318,003

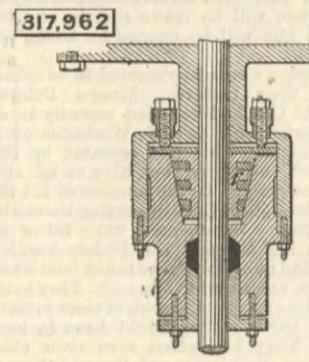


rom the high-pressure cylinder into the low-pressure cylinder, and from thence outward between the high-pressure pistons, with an induction valve governing the high-pressure cylinder, arranged to retain the residual or unexhausted steam in the high-pressure cylinder as a cushion for its piston, substantially as set forth. (3) In a compound engine of the class described, having its sole exhaust from the high into the low-pressure cylinder, and from thence outward through the high-pressure piston, an adjustable cut-off valve, arranged as described, in combination with the induction valve, high and low-pressure cylinders, connecting ports, and single exhaust port *f*, substantially as and for the purpose set forth.

317,962. STUFFING-BOX, *Alexander T. Ballantine' Geneva, Ohio.—Filed March 14th*, 1884.

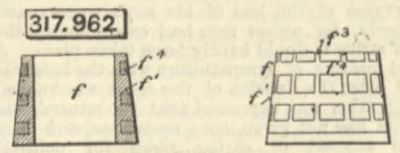
Claim.—(1) In a stuffing-box, a flexible tapering packing ring of hard metal, having an opening in its

317,962



side wall and a series of slots cut in its tapering surface, all filled in with soft metal, as and for the

317.962



purpose stated. (2) In a stuffing-box, the flexible tapering packing ring $f f^1$ of hard metal, having the slots f^3 and f^4 and opening f^2 filled in with soft metal, as and for the purpose stated.

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