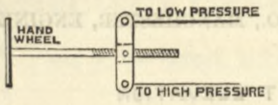
STEAM ENGINES AT THE INVENTIONS EXHIBITION.

No. I.

THE Inventions Exhibition was opened on Monday by the Prince and Princess of Wales with all proper form and ceremony. As usual, exhibitors had left a great deal to be done nearly at the last moment. It was done, however, and the Exhibition was more complete on Monday than any of its predecessors on their opening days. It is to be hoped, however, that not a little remains to be effected. For some cause there are large spaces in the buildings completely empty, not so much as a packing-case being visible. We presume that these will be filled ultimately; the effect at present is dreary and deplorable. The Middle, South, and North Courts, the Central Gallery devoted to music, and some other departments, leave nothing to be desired; yet the effect is, on the whole, in a sense disappointing. Perhaps too much was expected. It was intended that the Exhibition should bring before the public examples of the work done by the great inventive power of the nation; but either the inventive power of the nation has achieved less than was imagined, or the Exhibition has failed to attract exhibitors. Possibly the truth lies between the two. It is one thing, moreover, to invent; another thing to get the public to believe in the value of the invention, or manufacturers to take the invention up, and spend money on it. All this, however, is in the nature of a digression from the main object of this article, which is intended to tell our readers something about the steam engines exhibited.

These are comparatively few in number. The largest is a horizontal, in the West Central Gallery—America—by Messrs. Hick, Hargreaves, and Co., of which we shall have more to say. It is a fine engine, with modified Corliss valves. The cylinder is 20in. diameter, 4ft. stroke, making 60 revolutions. The fly-wheel is grooved for ropes, and the engine drives a long overhead shaft, giving motion to machinery which does not nearly load it. At the end of the North Court, not far from where the bakeries stood last year, is a compound engine by Messrs. Galloway. The high-pressure cylinder, 14in. diameter, is put over the low-pressure, 24in. diameter, which is horizontal, while the small cylinder is inclined, so that one overhung crank answers for both cylinders. The stroke is 3ft.; revolutions, 75. This engine drives a line of shafting running overhead along the gallery, and is supplied with steam by three large Galloway boilers, which provide enough for it and for several other engines in the main gallery. The two engines just named, the Galloway engine which drove the machines in the West Gallery last year, and Messrs. Davey, Paxman, and Co.'s engines in the electric light shed, are the largest engines in the place.

The most prominent feature seen on first entering the building from Exhibition-road is the exhibit of the English War Department, which we have fully described in another page. Just beyond this is Mr. Webb's compound locomotive, the Marchioness of Stafford. We have already published very complete sectional diagrams of the first of Mr. Webb's compound engines. These were, however, found to be not quite powerful enough to work the northern section of the London and North-Western Railway, so Mr. Webb designed a new and more powerful type, the first of which, the Dreadnought, attracted a good deal of attention last year when the members of the Iron and Steel Institute visited Crewe. The Machioness of Stafford is similar in all respects to the Dreadnought. An elevation of this engine will be found on page 352, while the front end view on page 349 gives an excellent idea of the unusual appearance presented by the enormous low-pressure cylinder filling up the whole space between the frames. This type of engine has larger grates than any other on the line. The engine has two high-pressure cylinders, 14in. diameter and 24in. stroke, attached to the outside frame plates between the middle and leading wheels, the connecting rods working on to the crank pins in the trailing wheels, and one low-pressure cylinder 30in. diameter and 24in. stroke, placed between the main frames at the front end of the engine, the connecting rod being attached to the single throw crank of the middle pair of wheels. The driving wheels in each case are 6ft. 3in. diameter. The steam is supplied from a regulator in the dome to a T pipe on the smoke-box tube plate, and thence by two 3in. copper pipes, down each side of the smoke-box through the cross back plate of the low-pressure cylinder, and between the frames to the high-pressure cylinders. The exhaust steam is returned by two 5in. pipes running parallel with the others into the smoke-box, and each pipe is carried round the inside of the smoke-box and enters the low-pressure steam chest on the opposite side. Thus the pipes themselves are of sufficient capacity to act as a steam receiver, and being placed in the manner described, the exhaust steam is to some extent superheated by the waste gas in the smoke-box. The final exhaust escapes on either side of the low-pressure steam chest, and thence into the chimney in the usual way, with this difference, that there is only half the number of blasts to urge the fire compared with the ordinary engines, and yet the engine steams very freely with the blast nozzle the same diameter as in the ordinary engines. Arrangement is also made so that steam direct from the boiler can be admitted to the low-pressure cylinder for use when starting, but a relief valve is applied in connection with the steam chest, so that the pressure may never exceed about half that carried in the boiler. The valve gear is Joy's, which does away with all excentric rods, and considerably reduces the number and weight of the working parts. The reversing is effected by an arrangement recently designed by Mr. Webb, by which both the high and low-pressure engines can be reversed simultaneously. This was specially designed to enable the driver to reverse both high and low-pressure engines at the same time, by means of a single screw and wheel. The gear consists of a cast iron bracket, in which is carried a long malleable cast nut, screwed for the greater portion of its length with a quick threaded screw. On the front end of the screw is a double-ended lever, free to turn on its centre, as in the accompanying sketch. To the upper end is attached the long rod leading to the reversing shaft of the low-pressure engine, and to the lower end, the long rod leading to the reversing shaft of the high-pressure engine, or *vice versâ*. To each end of the double-ended lever, and to one side of it, are fixed sliding guides, which work in the main casting, and are secured in position by means of a cast iron cover plate.



This plate is made sufficiently long to form a support for the guides and the screw, when the latter is at the full length of the stroke. The top edge of the upper guide is notched or serrated, and a loose block, with corresponding notches, is inserted in an opening in the casting, through which it can be pressed down on the guides by means of an excentric, or wedge and lever, thus holding it firmly in position; or the block may be held tight by a screw in the ordinary way. The lower guide bar is left plain on both edges, but a plain block is pressed against its lower surface by means of a lever, screw, and wheel, so that it can be held in any position with varying amount of friction. Attached to each of the guides, and working through slots in the cover plate, are indicator figures, which show at a glance the degree of expansion to which the engine is working. The slots also serve to act as stops for the reversing screw. The working of the gear is as follows:—When both engines are in full gear, and it is necessary to cut off steam at an earlier portion of the stroke in the high-pressure engine, let us say, the guide of the low-pressure engine is made fast by pressing down the block on the top edge, then the guide for the high-pressure engine is released, and the screw acting on the centre pin of the double-ended lever can be made to move the rod in either direction until the degree of expansion is obtained. The low-pressure engine can be treated in the same manner by jamming the lower guide, leaving the upper guide free to be acted upon by the screw, as in the case of the high-pressure engine. By this arrangement both engines can be reversed at the same time, and also can be worked independently of each other for the purpose of expansion. One of the features in this class of engines is the adoption of a boiler in which the water space is carried under the fire-grate, so avoiding the necessity of a solid foundation ring. The fire-box tube plate is arranged so that it can be taken out and replaced by a new one without disturbing any other part of the fire-box. The leading axle of the engine is fitted with Mr. Webb's improved form of radial box, which allows a lateral movement of 1¼in. on each side of the centre line, the movement being controlled by a central spring arrangement, which has been extensively adopted, not only for engines, but also for the new carriage stock now being made for the London and North-Western Railway Company, of which a model is exhibited, fitted with the radial gear referred to. The objects to be attained for which the compounds were expressly designed, were the greater economy in the consumption of fuel, and the doing away with coupling rods and the double throw crank, at the same time retaining the advantage of the weights on two pair of wheels for adhesion, without the necessity of coupling them. It will be seen that the arrangement of this system allows the high and low-pressure engines to work independently of each other, so that it is not necessary that the two pair of driving wheels should be of the same diameter, while the disposition of the cylinders practically balances the engine and enables it to run steady at very high speeds. The commercial results obtained with the compound engines on this system, up to the present time, have been, we are informed, very satisfactory, and have shown to great advantage in the case of one of the ordinary type of Metropolitan engines working on the District Railway, which was converted into a compound about twelve months ago. This engine has run over 34,000 miles, the average consumption of coal being, we are told, 23·5 lb. per mile, including the usual allowance made for raising steam; the average consumption of the same type of engine non-compound is 31·4 lb. per mile, when doing similar work, thus showing a very considerable economy in favour of the compound, while the necessity of the frequent starting and stopping of the trains has proved to be no detriment to the engine.

The dimensions of the Marchioness of Stafford will be found on page 350.

Messrs. Manning and Wardle, of Leeds, show a small locomotive fitted with Parnell's valve gear. It will be remembered, no doubt, that Mr. Parnell is the inventor of a very ingenious and successful rock drill, in which the valve is actuated by the compressed air working the drill. This system has been applied by Mr. Parnell to the engine in question. Mr. Parnell for the present withholds information concerning it, we presume with a view to the completion of foreign patents.

Close to this engine are two steam tram-car engines, one by Messrs. Merryweather and Sons, the other a Wilkinson engine. We have not found any other examples of railway locomotives in the building other than those named.

We have already stated that some examples of what are now come to be known as high-speed engines will be at work in the electric light shed. We use the future term still, for some of them have not yet arrived, and some are not yet in place. By high-speed engines we mean engines of the single-acting type capable of running at any high velocities, such as 500 or 600 revolutions per minute. A good many years have elapsed since we pointed out in this journal that if a high-speed reciprocating engine was to be successful it must be single-acting. At the time we wrote nothing of the kind was in existence, but our suggestion bore good fruit, and now types of single-acting engines can be counted by the dozen. One of the engines for the electric light shed is Parsons' patent, invented and patented by the Hon. R. C. Parsons, son of the late Lord Rosse, of great telescope fame. Mr. Parsons' engine is manufactured by Messrs. Kitson, of Leeds, and is in considerable use. Externally it is not a pretty machine; but we may let this pass. Its construction will be fully understood, we think, with the aid of the engravings on page 353, and the following description:—Fig. 1 is a top view, Fig. 2 a sectional elevation, Fig. 3 an end view, and Fig. 4 diagrams illustrating the mode of action of the engine. When a circle of any dimension is made to roll inside a circle of double the diameter, every point in the circumference of the smaller circle describes a straight line, which is a diameter of the smaller circle; points at right angles to each other—that is to say, 90 deg. apart—will describe lines at right angles to each other. In the Parsons engine the cylinders are fixed in a frame, and they are free to rotate round a central axis H, while the crank on which the pistons act rotates round the centre G. Each engine has four single-acting cylinders, placed in pairs at right angles to each, other and cast in one with a circular casing fitted with trunnion bearings, which are really excentric to the crank shaft, as shown in Fig. 2. The crank axle has two cranks, placed opposite to each other, and is free to rotate between the cylinders; but its axis is, as we have said, excentric to that on which the cylinders revolve by a distance equal to the throw of the crank. Each pair of pistons are bolted together in the centre by two bolts, one at either side of the crank-pin bearing, and there are no connecting-rods. The steam is distributed by a cylindrical valve; it works on the face of the cylindrical casting which carries the cylinders. It is contained within a ring which is bolted to the cylinders, and into which the high-pressure steam is admitted through the trunnion and passages formed in the cylinder casing between the admission ports to the cylinders. The back of the valve is made steam-tight by means of a piston ring, which is kept up to the face of the ring by the pressure of the steam. The diameter of this ring is such as to nearly balance the pressure of the valve on the cylinder face. The valve is held in position, but is free to rotate within the bridle, which is capable of keeping the axis of the valve more or less excentric to that of the axis of the cylinder casing. It is thus evident, as the cylinders rotate, the valve admits to each in its turn the high-pressure steam contained within the ring, and exhausts it from its inner edge, similar to an ordinary slide valve. In order to vary the admission of the steam, or reverse the engine, it is only necessary to move the valve more or less excentrically on either side of the axis of the cylinder casing; this movement is effected by the hand-wheel shown. To ensure the protection of the working parts from injury and from dirt, they are all enclosed within a casing, which enables a most perfect system of lubrication to be adopted. The engine is fitted with a small pump, which injects a stream of oil through the pipes to all the working parts. When the oil escapes it falls down to the bottom of the casing, to be again drawn in by the pump. As the oil becomes mixed with a small quantity of condensed water, the bottom of the tank, formed to act as a separator, allows the water—which, owing to its density, falls to the bottom—to drain away through a passage, whilst the oil, which rises to the top, is drawn in by the pump. The centre of gravity of each pair of pistons is at the centre of its crank pin bearing, and each pair is equal in weight to the other pair; consequently they rotate with the crank axle as a balanced system. The valve, cylinders, and cylinder casing are also balanced about their own axes. The engine, therefore, when at a speed of 1200 or 1500 revolutions per minute, is quite steady, and requires no foundations or fixing. The engines are fitted with a very sensitive governor, so that the speed is uniformly maintained under varying conditions. Compared with the ordinary type of engine, that which we have just described is not an economical machine, for it uses 40 lb. of steam per indicated horse-power per hour; but it is in all probability quite as economical as any other of the high-speed engines under consideration. Indeed, economy in such engines is of comparatively small importance, what is wanted being a machine which will run at a tremendous speed for long periods without making a noise or breaking down.

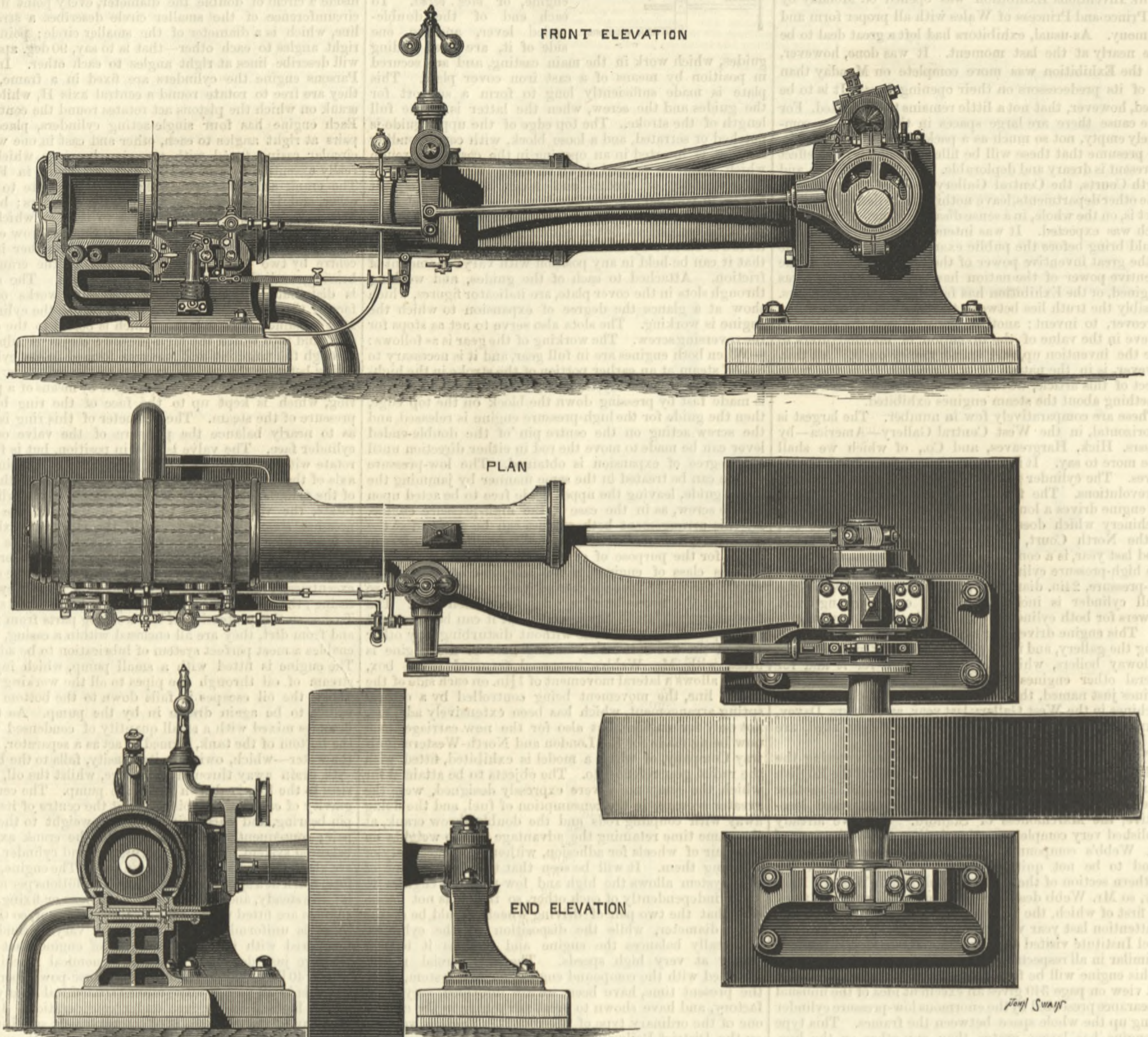
The Coalbrookdale Company shows the "electric" engine—Elwell and Parker's patent. This is an extremely simple little engine. It is single-acting, with a piston slide valve, and is sold at a very moderate price. Its simplicity of construction renders special description entirely unnecessary. It was fully illustrated in our impression for October 24th, 1884.

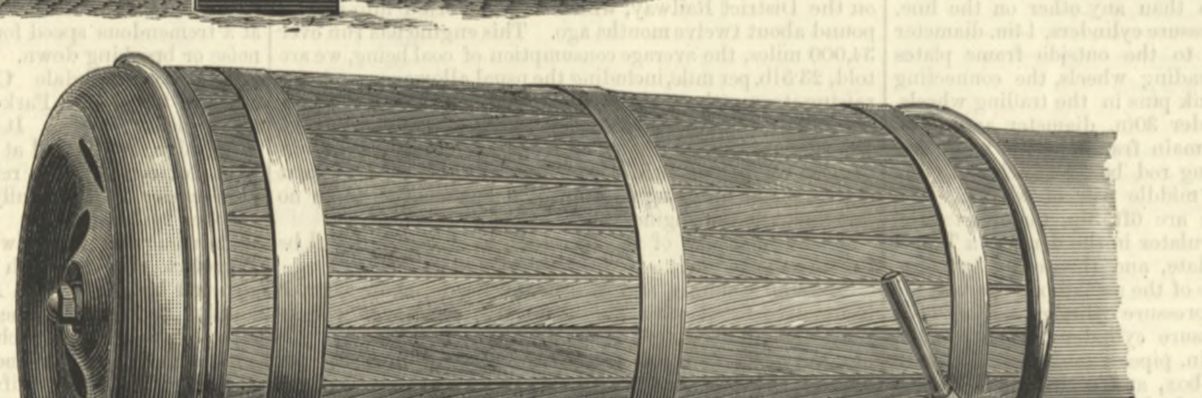
Pursuing our way down the main gallery, we find the Wheelock engine, which we illustrate on page 348, constructed by Messrs. D. Adamson and Co. It is a very highly finished engine and is shown in motion, although it has no machinery to drive. The Wheelock engine has long been known at this side of the Atlantic, and an extremely beautiful example of the type was shown at Paris in 1878. The gear adopted by Mr. Adamson differs in several respects from that of the Paris engine. The construction of the machine will be readily understood from our engraving.

Referring to the illustrations, it will be seen that instead of slide valves four semi-rotative valves below the cylinder are employed. The long spindle main valves A are distributing valves. The cut-off valves B are placed immediately behind the main valves; thus when the valves are opened to exhaust, before steam can pass into the exhaust pipe, it must leak past both the cut-off and main valve faces, a contingency most remote. The main valves are worked directly from the excentric rod K by levers L keyed upon the valve spindles. The cut-off valves are actuated through the bell-crank levers M, keyed to the spindles by a positive motion obtained from the stirrup link T attached to the lever L by a pin, the stirrup link riding on a loose sleeve. On the underside of the upper part of the stirrup link is fixed a hardened steel catch plate which, by the reciprocating motion of the levers L, is made to engage with a hardened steel block at S on the arm of the bell-crank levers M, and thus the cut-off valves are opened. When the point of cut-off is reached, the valves are closed by the balance weights N attached to the lower arm of the bell-crank levers M, the action of the weights being quickened by spiral springs, shown attached to the lower part of the same. The lower ends of these weights are bored out, and drop nearly air-tight on to fixed pistons, so that a dash-pot action is secured. The point of

THE INVENTIONS EXHIBITION—25-H.P. WHEELOCK ENGINE.

MESSRS. D. ADAMSON AND CO., MANCHESTER, ENGINEERS.





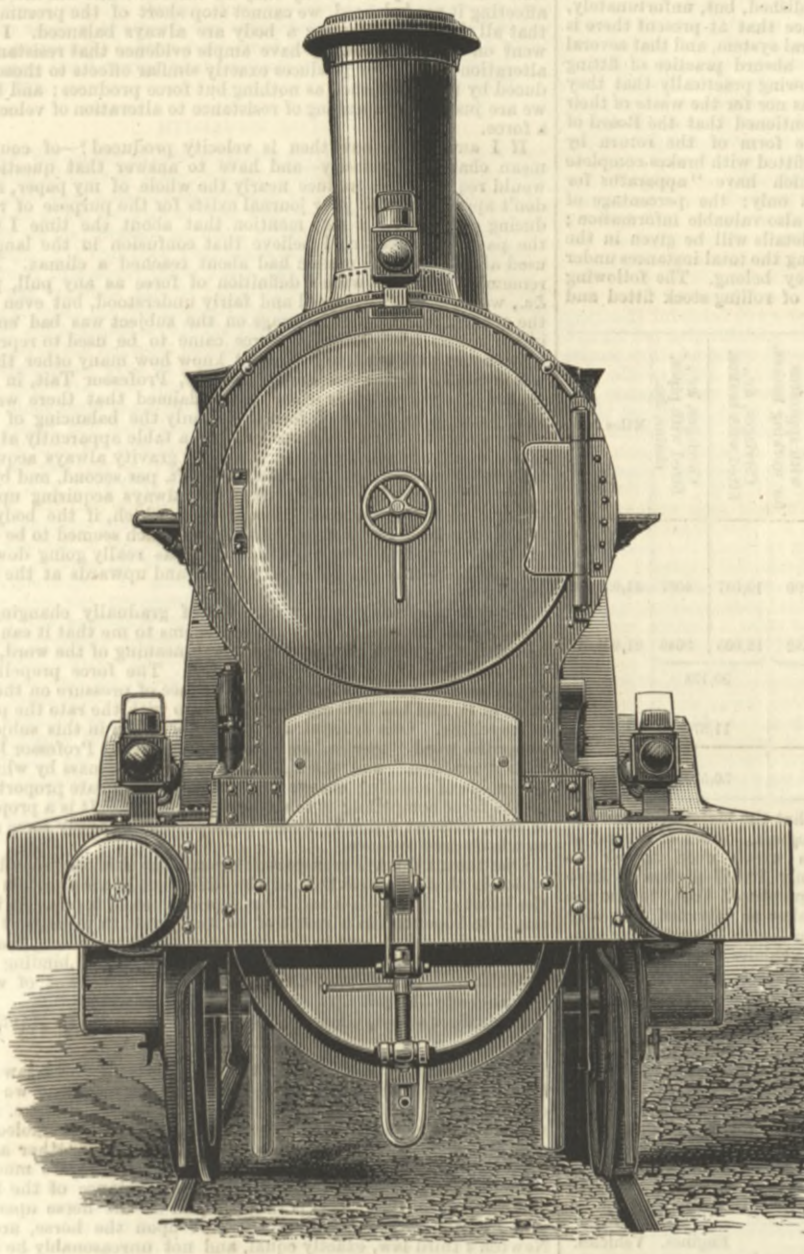
ENLARGED VIEW OF VALVE GEAR

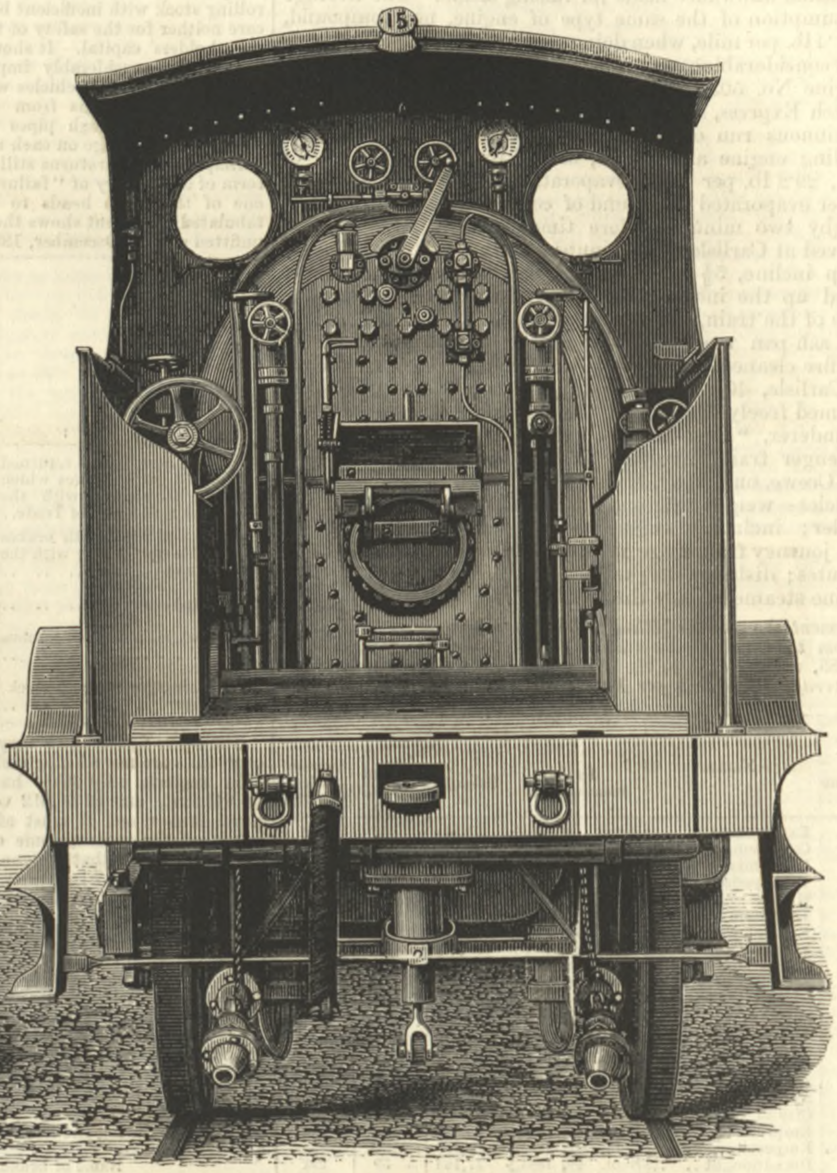
cut-off is determined by tappets or cams P on the loose sleeves, moving freely on the end of a steel bush. Behind the bell-crank levers M, on the lower side of the sleeve, is a lever Q, connected directly with the governor by means of a coupling rod, so that the slightest variation in the action of the governor moves round the sleeves, so altering the position of the tappets P in relation to the stirrup links T, and changing the point at which these are released from contact with the trip blocks at S, which is the point at which cut-off is effected. The drag pins are made slightly excentric, so that the cut-off valves at each end of the cylinder may be regulated to precisely the same point of action. In regulating the speed of the engine, the governor is fixed at mid lift, so that should any accident happen, such as the driving gear or belt giving way, the governor is free to drop to its lowest position, bringing into operation the tappets on the loose sleeves, by which the stirrup links T are prevented from catching the trip blocks S, the cut-off valves are closed, and, steam being shut off, the engine is stopped. The governor is of the loaded parabolic high-speed type, sensitive, and acting directly on the cut-off valves at the least variation in speed of the engine. Both valves A and B are suspended and carried by the hardened steel spindles and bushes. The spindles are securely keyed to the valves, and have collars on their inner end close up to the valve. Symmetrical with these collars are steel bushes, ground a steam-tight fit into the front valve chest bonnets, both collars and bushes being ground to a true valve face, and being thoroughly hardened, forming a frictionless joint. At the rear end of valves, and secured into the back bonnets, are similar spindles moving in steel bushes contained in the valves themselves, thus forming a centre or trunnion for the valve and taking the weight, the valve faces being only in sufficient contact to be steam-tight. To regulate this contact with the greatest nicety, the valves and seatings are taper, allowing of end adjustment in the manner of a plug tap.

We have here a sufficiently simple engine, working with very little noise, extremely well made and of neat design, and giving a very satisfactory diagram. We understand that Messrs. Adamson and Co. have made a considerable number of these

THE INVENTIONS EXHIBITION—COMPOUND LOCOMOTIVE, LONDON AND NORTH-WESTERN RAILWAY.

MR. F. W. WEBB, M.I.C.E., CREWE, ENGINEER.





engines, which are giving every satisfaction. We do not see why they should do otherwise. The engine, we may add, is 25-horse nominal, and would no doubt easily indicate 90-horse power or 100-horse power. The Wheelock engine got, we may add, the grand prize in 1878 in Paris.

Messrs. Goodfellow and Mathews, of Hyde, Manchester, will show three engines driving Messrs. Siemens' installation for lighting the gardens and fountains. The engines are compound tandem triplex, patented by the makers.

Fig. 1 is a longitudinal section of the engine showing the coupling and fly-wheel in section, and the Siemens dynamo, a B^3 machine, in elevation. Fig. 2 is a cross section of the engine, partly through cylinders and partly through valve-boxes. Fig. 3 is an end elevation of the engine on the valve box side.

The high-pressure cylinders are 9in. diameter, and the low-pressure cylinders 18in. diameter, the effective surface of the latter being the annular area between the two circles; the ratio between the pistons is therefore as 1 to 3. The stroke of the engine is 10½in., and working speed 320 revolutions per minute, representing a mean piston speed of 560ft. per minute. The valves B C in Figs. 1 and 2 are 5in. diameter, have a travel of 4in., and are arranged to cut off at about five-tenths of the stroke; the steam is consequently—taking clearances into account—expanded about five times. The crosshead pins C R are 3½in. diameter, 6in. long in the bearings; the crank pin C P is 5½in. diameter, 9in. long; the crank shaft, which is of best mild steel, is 5in. diameter in the body, with bearings 24in. long on the driving side C S and 16in. long on excentric side C S'. The pistons, crosshead pins, and crank pin liners are of hard phosphor bronze; the connecting-rods are of mild steel, rectangular in section, 2ft. 6in. long centre to centre; the bearing surface of the connecting-rod on the crank pin is about 35 square inches. The pistons, connecting-rods, &c., are balanced as shown at B W. The steam branch S is 3¼in. diameter; to the flange is bolted the combined stop and throttle valve V—Figs. 1 and 3—regulated direct by a Pickering high-speed governor; the steam passage P P supplies the three high-pressure cylinders with steam; R R represents the receiver which is common to the three cylinders; and E X is the exhaust passage from the low-pressure cylinders to the atmosphere or condenser, as the case may be. Steam is introduced to the valve chambers through the ports K K; S P are the steam ports of the high-pressure cylinders; through R P the exhaust steam from the high-pressure cylinders passes to the receiver; S P' are the steam ports of the low-pressure cylinders, and the exhaust steam from the low-pressure cylinders passes through E P to the common exit E X. The valves are of phosphor bronze, with steel spring rings and stop bits; D D represent the steel valve spindles, to which the valves are secured by lock-nuts. The lower part—Fig. 1—of the valve spindle is enlarged to the diameter of the valve liner, and is fitted with a phosphor bronze pin of ample bearing surface; this upper valve spindle is hollow, as shown in Fig. 1, for purposes of lubrication. It will be observed that the top piston also has a passage through the prolongation P R, through which the crosshead pin receives its supply of lubricant. The two oil cups G and G' are supplied from the automatic sight-feed lubricator shown in Fig. 3. A third branch on the lubricator leads to the steam pipe immediately above the stop valve. The excentric rods are of steel, rectangular in section; the upper rod is cottered to the phosphor bronze excentric clip, while the two diagonal rods D R are jointed as shown in Fig. 2. In addition to the means of lubrication already mentioned, the crank shaft has a spiral groove cut in it, along which the lubricant is conducted over the whole length of the journals to the centre chamber, the crank pin being thus efficiently lubricated; the crank pin receives a further supply from the lubricator at the end of the crank shaft, which is bored through its entire length.

The construction of the patent flexible coupling will be readily understood from the section in Fig. 1. On each half coupling four prongs P G are cast; these are enveloped by a leather ring formed of a series of links jointed to each other. Any inequality in the wear or setting of the respective shafts is thus provided for without strain on the bearings. The fly-wheel, which also forms a casing for the coupling, is 5ft. diameter.

The engines are so arranged that each part may be got at and examined with the greatest ease, and through the two side doors on the casing the working of the internal parts may be seen. Each engine is calculated to indicate 200-horse power with a boiler pressure of 120 lb. per square inch, representing a total of 600 indicated horse-power, or 500-horse power given off by the three engines. The compactness of these engines is seen from the fact that the total space occupied by the engines and dynamos for this electric installation does not exceed 400 square feet with a maximum head room of 10ft. 6in. above the foundation level. The general arrangement of the plant shows clearly the relative positions of the engines, dynamos, and boilers; the latter, which are of the water-tube type, made by the Babcock and Wilcox Company, are placed in close proximity to the engines. The dynamos are so arranged that any two of the set may be used, the third machine being a spare one.

Besides these engines, Messrs. Greenwood and Batley, of Leeds; Messrs. Alley and Maclellan, of Glasgow; and Deakin and Parker, of Manchester, and many other firms show engines, notices of which we must reserve for a future occasion.

THE INVENTIONS EXHIBITION—COMPOUND LOCOMOTIVE, L. AND N. W. RAILWAY.

ABOVE we give two end views of the compound locomotive Marchioness of Stafford, exhibited by Mr. Webb, to which we have referred at some length in another page and we now give the following particulars of this engine which Mr. Webb has courteously supplied to us. They are certain to prove interesting to a great many of our readers:—The boiler shell, frame plates, axles, tires, pistons and connecting-rods are of steel; inside fire-box of copper, and tubes of brass. The smoke-box tube plate is steel. The axle-box guides are cast iron, except for the leading axle, which is fitted with a radial axle-box, the guides for which are steel plates, stretching across from frame to frame. The axle-boxes are of cast iron in each case, with the brasses fitted in. The leading wheels of the engine are cast steel, the others wrought iron, but patterns are now being made to cast them in steel. The tender wheels are wrought iron, out of the ordinary stock. The stuffing-boxes were arranged in the first engine for metallic packing, but this not giving satisfactory results, has been changed for the ordinary packing throughout the engine; the crossheads are of cast steel, the wearing surfaces being faced with white metal. The guide bars are of wrought steel, not case-hardened. The top and side rows of tubes are reduced from 1⅞in. to 1⅝in., so as to give more metal between the holes, to prevent the plate from cracking, and also to reduce the draught through the outer tubes. The "Dreadnought" class of engines are being worked at 175 lb. pressure per square inch. Butt joints, with inside and outside welts, double rivetted, are used for the longitudinal joints in the boiler shell. The weight of engine, Dreadnought, empty is 39 tons 10 cwt. The weight of the same engine in working order is 42 tons 10 cwt., distributed as follows:—Leading, 12 tons 10 cwt.; low-pressure driving, 15 tons; high-pressure ditto, 15 tons; total, 42 tons 10 cwt. The tender is the standard 1800-gallon tender, with space for five tons of coal. There is nothing special in the design. The weight of the tender empty is 12 tons 1 cwt. The number of each class of Mr. Webb's compounds now in use on the London and North-Western Railway is: Thirty "Compound" class, with 6ft. 6in. wheels, and cylinders 13in. by 24in. and 26in. by 24in. One Metropolitan engine converted; wheels 5ft. 9in., and cylinders same as 6ft. 6in. Three "Dreadnought" class, with 6ft. wheels, and cylinders 14in. by 24in. and 30in. by 24in. There are seventeen others of this type in hand. The compound engines are being introduced on to the Western Railway of France; Autofagasto Railway, South America; Oude and Rohilkund Railway; Austrian State Railway; San Paulo Railway; Buenos Ayres. The Experiment—the first Webb compound which was built—has run 173,802 miles between the dates of February, 1882, and March 20th, 1885. The greatest number of miles run by any engine of the "Compound" class is 95,333, by engine No. 300, from March, 1883, till March 20th, 1885. The number of miles run by the Dreadnought, from September, 1884, to till March 20th, 1885, is 15,477, with trains averaging twelve vehicles, between Crewe and Euston. The aggregate number of train miles which have been run up to March 20th, 1885, by the various compound locomotives on the London and North-Western Railway, is 1,826,031. In the early part of 1884, one of the ordinary type of Metropolitan side-tank condensing engines, working on the District Railway, was converted into a compound engine, with two high-pressure cylinders 13in. by 24in., and one low-pressure cylinder 26in. by 24in. It was sent to work on June 4th, 1884, and up to March 20th, 1885, it had run 33,014 miles, with an average consumption of 23·5 lb. per mile, including the usual allowance made for raising steam. The average consumption of the same type of engine, non-compound, is 31·4 lb. per mile, when doing similar work, thus showing a very considerable economy in favour of the compound system. Engine No. 503, the Dreadnought, worked the 10 a.m. Scotch Express, Euston to Carlisle, on the 19th March, a continuous run of 300¼ miles, with an average load, including engine and tender, of 207 tons; consumption of fuel, 29·2 lb. per mile; evaporation of water, 9·49 lb. of water evaporated per pound of coal. The train arrived at Rugby two minutes before time; left six minutes late; arrived at Carlisle four minutes before time; went up the Shap incline, 5½ miles, 1 in 75, in ten minutes; average speed up the incline, 33 miles per hour; average running time of the train, 44·7 miles per hour. Neither smoke-box nor ash-pan was raked out during the journey, nor was the fire cleaned. Weight of ashes in smoke-box on arrival at Carlisle, 40¼ lb.; ashes in ash-pan, 59¼ lb. Engine steamed freely throughout the journey. Engine No. 504, Thunderer, "Dreadnought" class, worked the 5.5 p.m. passenger train, Liverpool to Euston, between Liverpool and Crewe, on Friday, March 27th, with a load of eighteen vehicles—weight 227 tons 15 cwt., exclusive of engine and tender; including engine and tender, 292 tons 15 cwt. The journey from Edge Hill to Crewe was run in forty-five minutes; distance, 34¼ miles—43·4 miles per hour. The engine steamed freely throughout the journey.

Statement showing the Mileage of the various Compound Engines from the Date of commencing Regular Work to 31st March, 1885, inclusive: also the Number of Days Working and the Average Miles Run per Day.

No. of engine	Name.	Regular working. Date commenced.	Mileage.	No. of days.	Average miles per day.
66	Experiment	April 3, 1882.	174,908	616	284
300	Compound	May 2, 1883.	96,132	321	299
301	Economist	May 15, 1883.	93,875	312	301
302	Velocipede	May 25, 1883.	89,715	316	284
303	Hydra	June 1, 1883.	90,739	308	294
305	Trentham	Aug. 8, 1883.	83,512	286	292
306	Knowsley	Aug. 16, 1883.	84,104	311	270
307	Victor	Aug. 22, 1883.	85,548	313	273
310	Sarmatian	April 28, 1884.	60,594	248	244
311	R. F. Roberts.. ..	March 28, 1884.	53,016	188	282
315	Alaska	March 31, 1884.	54,603	314	174
321	Servia	April 1, 1884.	52,880	299	177
323	Britannic..	April 7, 1884	44,049	255	173
333	Germanic..	April 5, 1884.	53,026	295	179
353	Oregon	April 13, 1884.	51,590	291	177
363	Aurania	April 15, 1884.	47,225	261	181
365	America	April 21, 1884.	49,127	275	179
366	City of Chicago ..	April 23, 1884.	47,243	229	206
372	Empress	Oct. 8, 1884.	25,920	106	244
374	Emperor	Sept. 10, 1884.	29,767	152	195
503	Dreadnought	Sept. 29, 1884.	17,165	59	291
504	Thunderer	March 20, 1885.	1,350	8	168
508	Titan	Nov. 7, 1884.	19,484	63	309
519	Shooting Star ..	Aug. 29, 1883	76,504	324	236
520	Express	Aug. 29, 1883.	86,803	314	276
1102	Cyclops	July 17, 1884.	32,733	183	179
1104	Sunbeam	July 23, 1884.	36,718	157	234
1111	Messenger	Aug. 11, 1884.	31,657	174	182
1113	Hecate	Aug. 7, 1884.	32,625	164	199
1115	Snake	Aug. 14, 1884.	27,818	146	190
1116	Friar	Aug. 14, 1884.	33,625	144	234
1117	Penguin	Aug. 21, 1884.	32,212	170	189
1120	Apollo	July 10, 1884.	37,148	178	209
2063	—	May 13, 1884.	36,226	218	166
	Grand totals and	average	1,869,641	7998	234

This shows that the engines cannot have been very long in the shops for repairs.

THE METROPOLITAN RAILWAY.—We learn that Mr. J. J. Hanbury has been appointed locomotive superintendent of the Metropolitan Railway in place of Mr. Joseph Tomlinson, resigned. Mr. Hanbury has had a large experience on the Midland Railway, having been for some years district locomotive superintendent at Leeds, and for the last four years at Kentish Town.

PADDLE STEAMERS FOR THE NILE.—Towards the close of last year Messrs. Yarrow and Co. built for the Government two sternwheel steamers for the Nile expedition. These were sent out in pieces, one, the Waterlily, was put together at Alexandria; the other was sent above the second cataract and erected at Semneh; this boat was named the Lotus. In consequence of the proved suitability of this description of steamer for the Nile, the Government have entrusted Messrs. Yarrow and Co. with an order for eight more. Two of these are 120ft. in length by 23ft. beam, and draw when light 15in. only. There are three steamers of a length of 85ft., by a beam of 18ft., which will draw a little more. These five vessels will be mainly used for transport purposes for the conveyance of sick and wounded down the river and of stores up. There are also three more which are to be looked upon as the fighting boats of the expedition. They are of the same size as the smaller boats above alluded to, but will have more draught in consequence of the armament which they carry. Three of the steamers were tested under steam at Messrs. Yarrow and Co.'s works on the 18th ult. On the upper deck is provided a large saloon with sleeping accommodation. The rest of the boat will be provided with stretchers hung from the roof for the accommodation of the sick. In the forward part of the boat are provided two Nordenfelt guns and also two at the stern. On the main deck is provided a steam capstan which will be used for hauling the boat over the worst of the rapids. Above the upper deck is the pilot house, which, owing to its elevated position, enables the steersman to obtain an all-round view. A model of the Lotus and Waterlily was shown on the 18th ult., illustrating a plan, suggested by Messrs. Yarrow and Co. for indicating the draught of the river some distance ahead. This consists of employing two poles about 50ft. long, at the end of which are suspended two vertical iron rods, the bottom extremity of which comes about one foot below the level of the boat itself. One pole projects direct ahead from the port side, and the other from the starboard side. Attached to each of these vertical iron rods is a wire rope which passes in board, and is connected with the whistle on the boiler; and the gear is so arranged that immediately this indicator touches a rock or sandbank it instantly causes the steam whistle to blow. This plan in the first instance draws the pilot's attention to the fact, and also points out to him on which side of the steamer the sandbank or rock exists, so that it gives him warning in which direction to steer. The five boats just completed were only ordered at the end of February.

LETTERS TO THE EDITOR.

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

CONTINUOUS BRAKES.

SIR,—The return relating to continuous brakes in use to 31st December, 1884, has recently been published, but, unfortunately, like its predecessors, it furnishes evidence that at present there is no prospect of the adoption of one general system, and that several companies are actually continuing the absurd practice of fitting rolling stock with inefficient brakes, showing practically that they care neither for the safety of their trains nor for the waste of their shareholders' capital. It should be mentioned that the Board of Trade has considerably improved the form of the return by placing engines and vehicles which are fitted with brakes complete in different columns from those which have "apparatus for working," or through pipes or chains only; the percentage of vehicles and mileage on each railway is also valuable information; perhaps in future returns still further details will be given in the form of a summary of "failures," placing the total instances under one of the three heads to which they belong. The following tabulated statement shows the amount of rolling stock fitted and unfitted on 31st December, 1884:—

	Engines fitted with brakes.	Engines fitted with apparatus for working brakes.	Carriages, &c., fitted with brakes.	Carriages, &c., fitted with pipes, chains, &c.	Miles run.
Total amount of stock returned as fitted with brakes which appear to comply with the conditions of Board of Trade..	3066	90	19,047	4037	31,953,436
Total amount fitted with brakes which do not comply with the conditions	1111	482	13,005	3049	21,854,973
Total fitted	4749		39,138		
Not fitted with any continuous brake	1705		11,374		15,881,925
Total passenger rolling stock, therefore	6454		50,512		

The above figures show very plainly that the majority of railway companies are not making sufficient progress, for out of a total of 6454 engines, only 3066 have brakes which even appear to be efficient, and of 50,512 vehicles, only 19,047 profess to have those brakes; and it must also be remembered that, to use the words of the return, some of the brakes so returned but very imperfectly fulfil that designation. The North London Company, for instance, gives 83 engines and 560 vehicles fitted with Clark and Webb's chain brake, as fulfilling the "conditions" of the Board of Trade. It is not necessary for me to say that it does nothing of the kind. Then again the Midland and Great Western companies take credit for a large number of engines fitted with non-automatic steam brakes, and vehicles provided with that most dangerous of all appliances—the Clayton two-minute leak-off vacuum system. No person can honestly say that the "leak-off" brake is safe, and that it fulfils those well-known and excellent conditions contained in the circular of 30th August, 1877.

Having given the total amount of stock fitted, reference should now be made to the actual progress. The following table shows the total number of engines and vehicles which were fitted with each system during the half-year ending 31st December, 1877.

Name of brake.	Engines.	Vehicles.
*Westinghouse automatic	97	601
†Sanders and Bolitho automatic vacuum	64	534
Smith's automatic vacuum	87	339
Clark and Webb's chain	—	20
Smith's vacuum	46	259
Newall's	—	10
Vacuum (L. and N. W.)	7	671
Heberlein	—	3
Westinghouse pressure	6	54
All other systems	—	—
Total	307	2491

* In addition to the above, 25 goods engines on the North-Eastern Railway have been fitted with the Westinghouse brake.

† The 64 engines fitted with Sanders' brakes have non-automatic steam brakes.

From these figures it will be seen that sufficient progress was not made during the last half-year, and it must also be remembered that a large amount of stock returned as fitted in the six months is no more than a change of system. The London and North-Western Company appears to have fitted a large number of vehicles with the vacuum brake; this is not progress, as another brake, the Clark and Webb chain, is being taken off, and it is by no means certain that the new simple vacuum is a better or safer appliance than the discarded chain. The following table is obtained from a comparison of the last two returns, and shows that during the half-year under-mentioned brakes were removed.

		Engines.	Vehicles.
London and North-Western	Chain Brake	—	881
West Coast J.S.	do.	—	77
Great Eastern	Smith's Vacuum	5	70
do.	Fay's	—	3
Lancashire and Yorkshire	do.	—	28
Great Western	Smith's Vacuum	4	55
Caledonian	Steel-McInnes	1	—

The fact that in six months companies should take off such a number of inefficient brakes shows the absurdity of money having ever been thrown away upon fitting them. The most unsatisfactory part of the whole "Return" is again that portion relating to "failures," the information in many cases being either incorrect or absolutely false. The Manchester, Sheffield, and Lincolnshire Company reports an actual failure under the head simply of delay. The Midland Company reports one instance only of the failure of the "two-minute leak-off vacuum," yet it is a well-known fact that numbers of failures have taken place, causing trains to run past stations and signals. This is not hearsay evidence, as I have seen some cases, and been in the trains, therefore to these I can speak with certainty. At the congress of the Amalgamated Society of Railway Servants, held at Bath last year, it was distinctly stated that failures were not reported by the companies, and nothing can confirm the truth of that statement more than the recently-published Board of Trade Return.

CLEMENT E. STRETTON,
Hon. Mem. A.S. Ry. Servants.

40, Saxe-Coburg-street, Leicester,
May 2nd.

THE LAWS OF MOTION.

SIR,—In my letter in your journal of this week I refer to having a number of years ago published what I considered a demonstration that the forces affecting any body are always balanced. As it is eight years since I did so, perhaps you will allow me in a few sentences to summarise my argument. I showed by a number of cases that we have as good evidence of the existence of centrifugal force as we have of any other force, excepting, perhaps, that of gravity. Then, if centrifugal force exists at all, it must be equal and opposite to the force that is pulling or pushing the body into the curvilinear path. If this is so, then the direction of motion of a body may be altered while all the forces affecting it are balanced. Then, also, the velocity of a body may be altered while all the forces affecting it are balanced; for when a body is moving in a curve the alteration of direction is simply alteration of velocity at right angles to the direction of motion. But if we have to admit that the velocity of a body may be altered while all the forces affecting it are balanced, we cannot stop short of the presumption that all the forces affecting a body are always balanced. I then went on to show that we have ample evidence that resistance to alteration of velocity produces exactly similar effects to those produced by force, and such as nothing but force produces; and hence we are justified in speaking of resistance to alteration of velocity as a force.

If I am asked, how then is velocity produced?—of course I mean change of velocity—and have to answer that question, I would require to reproduce nearly the whole of my paper, and I don't apprehend that your journal exists for the purpose of reproducing old papers. I may mention that about the time I wrote the paper referred to, I believe that confusion in the language used about force and motion had about reached a climax. I can remember when Newton's definition of force as any pull, push, &c., was generally accepted and fairly understood, but even then the general confusion of language on the subject was bad enough in all conscience. Later on, force came to be used to represent momentum and work, and I don't know how many other things, which added to the confusion. Finally, Professor Tait, in 1876, capped the whole affair when he proclaimed that there was no such thing as balancing of forces, but only the balancing of velocities, so that when a body was lying on a table apparently at rest, it was doing no such thing, for it was by gravity always acquiring velocity downwards at the rate of 32·2ft. per second, and by the upward force of the table on it it was always acquiring upward velocity at the same rate. According to which, if the body had lain on the table an hour, the poor thing, which seemed to be quite unconscious that it was moving at all, was really going down at the rate of twenty-two miles per second, and upwards at the same rate.

All this absurdity is the outcome of gradually changing the meaning of the word "force," and it seems to me that it can only be rectified by going back to the original meaning of the word, that is to say, that it is a pressure or strain. The force propelling a steam engine piston is the total difference of pressure on the two sides of it, and has nothing whatever to do with the rate the piston is travelling. One fruitful source of confusion in this subject is using the word "inertia" to represent both what Professor Lodge calls "reaction," and the inherent quality of a mass by which it is capable of resisting change of velocity up to a rate proportional to the force compelling it to change its velocity. It is a property, in fact, without which it would be impossible to apply force at all to a body free to move.

One thing I think is transparent throughout this correspondence, which is that the great bulk of the difference of views arises from the habit of the careless and inappropriate use of terms. Is it too much to hope that as a result of so many men in prominent positions having taken part in the discussion—is it too much, I say, to hope that a decision may be come to that shall be binding as to the definition of a certain number of terms, the want of which is manifestly the principal source of all the discussion?

Hyde Park street, Glasgow, May 2nd. R. D. NAPIER.

SIR,—"Φ. Π.'s" difficulty is that if Newton's third law were true we could have no experience of motion, but that as we *have* experience of motion, Newton's third law cannot be true. But surely the *reaction* is seen in the *motion*, actual or molecular, communicated to one body previously at rest, by another acting upon it. Why should so simple a fact be involved in so much of verbal mystery? To take the now familiar instance of the horse and cart. "Φ. Π.'s" idea is that the pull of the horse upon the cart, and the resistant pull of the cart upon the horse, are, by Newton's third law, exactly equal, and not unreasonably he quite fails to see how it is that the cart ever moves. And yet it *does* move, as we have every day abundant proof; hence, says the bewildered "Φ. Π.," Newton's third law *must* be wrong. But *did* Newton ever say that *pull and resistance* were equal? he only says that *action and reaction* are equal. Action and reaction are far wider terms than pull and resistance, and include many more manifestations. If we begin by assuming that the strength of the horse to pull and the weight of the cart to resist are exactly balanced, it is the merest truism to say that neither will ever move. But if we assert that the power of the horse to drag is greater than that of the cart to resist, we do not therefore necessarily imply that action and reaction cannot be equal. For surely there exists some equivalent of the horse's pull in the shape of molecular motion or heat before the cart moves at all. And when the cart does begin to move what do we find? Why, that the motion of the cart, slow or rapid as the case may be, is entirely dependent upon the horse's action. The cart may be so heavy that the horse fails to move it at all, in which case Newton's axiom is illustrated differently; each remains quiescent, because their pull and resistance are equally balanced. Then we lighten the cart, and the horse is enabled to pull it at a slow rate, and so on, the motion of the cart being always in an inverse ratio to its weight—in short, the motion of the cart × its weight (or mass-acceleration as Dr. Lodge prefers learnedly to call them) form together a constant sum equalling the action of the horse. No matter in what way we look at it, we must always come to the same conclusion; for if, instead of lightening the cart, we add another horse; if, instead of lessening resistance, we increase the pull, the result is the same—we get motion. In the whole process there is nothing left unaccounted for. If the horse exert a greater pull we have an immediate equivalent in the acceleration of the cart's motion. (Couldn't it be shown that the equivalent is exact, and not merely approximate?)

One word more. If the cart's motion is *not* part of the reaction, I should like to ask *what is it?* How is it accounted for? or are we to suppose it is an effect without a cause?

A GIRTON GIRL.

SIR,—As both Dr. Lodge and "Φ. Π." have made free use of my letter of March 27th, perhaps I may be excused if I ask permission to say a word or two more on the subject.

So far, I have failed to quite understand Dr. Lodge's meaning. Perhaps before we go any further, he will favour me with a reply to the following questions.

I have a piece of clockwork mechanism so contrived that when wound up it will climb a vertical rack at a definite velocity. The rack is about 50ft. high. The clockwork, &c., weighs 13 lb. About 2ft. are passed over during the period of acceleration, so that we have, making all allowances at top and bottom, a vertical height of 40ft. traversed at a uniform velocity, and in about one minute of time. The work done by the spring driving the clockwork is 13 × 40 = 520 foot-pounds. The rack is suspended from the top, and for the present purpose I suppose it to have no weight.

While the clockwork is at rest on the rack anywhere, the pull on the hook carrying the rack is obviously 13 lb.

Now, if I understand Dr. Lodge aright as to the tug of war question, one party overcomes the other because the ground—that is to say, the earth—pushes one body of men more than it pushes the other.

Then, by parity of reasoning, my clockwork climbs the rack because the rack pulls it up more strongly than gravity pulls it down. I ask Dr. Lodge to kindly say either "yes" or "no" to this my first question.

My second question is; Supposing that the rack does pull up more strongly than gravity pulls down, then the earth must in turn push up the hook carrying the rack more strongly than gravity pulls down. Now, the pull of gravity is certainly 13 lb., and cannot be less. Therefore, the pull up must be more than 13 lb. Will Dr. Lodge say whether the strain on the hook is more than 13 lb. while the clockwork is climbing at a uniform speed?

My third question is this: During the time of uniform climb no less than 520 foot-pounds of work are being done. Is this done by the ground—that is to say, the earth—overcoming the action of gravity? Dr. Lodge will, I suspect, say it is not. Well, then, it appears to me that although the earth does all the pulling up, my clock does all the work, which is, to say the least, a remarkable division of labour.

Lastly, I ask Dr. Lodge, does he believe in resistance in the popular sense of the word, and is resistance identical with what he terms reaction? I have read what Dr. Lodge has written with great care, but I confess that I am not quite clear on this point.

May 6th. AN OLD STUDENT.

HYDRAULIC LIFTS.

SIR,—We do not expect to further encroach upon your courtesy by asking additional space, but Mr. Ellington's letter in your last issue is of such a nature as to create erroneous impressions. The points to which we wish to refer will be so obvious that to secure brevity we may proceed at once, without quoting Mr. Ellington's language. (1) Our New York house has been engaged in the manufacture of lifts about thirty years, but until six years ago the business was confined almost exclusively to steam lifts. We then began to make the Standard hydraulic lift. Since, therefore, that part of our business is only six years old, and since the machine is patented in the different countries, it is a curious fancy to call it "an antiquated type of apparatus." (2) In August last we had made 3345 lifts. Of this number there were in the City of New York alone more than 520 passenger lifts, of which only about 75 were steam, and more than 970 goods lifts. We do not know how many of these are hydraulic. Our passenger lifts in New York City alone are carrying daily more than 400,000 passengers, and our goods lifts in New York City are carrying daily more than 10,000 tons of freight, and they are doing this without interruption. When Mr. Ellington states that in the last fifteen months 80 hydraulic lifts have been adapted to the use of the power, his figures are undoubtedly correct, because no such arrangement could be effected without his knowledge. It must, however, be borne in mind that this figure does not represent the production of any one company, but is the aggregate of all the manufacturers of lifts who use the hydraulic power. It is very true that the three lifts for Warnford Court were let when the buildings were outside the area of supply, but the use of the power was strongly urged and carefully considered, and if it had been desired the power would have been brought there. Mr. Ellington correctly "imagines" that the low-pressure lifts "erected on the line of the power mains since the supply was available" do not greatly exceed these three; but his imagination does not cover the orders which have since been taken by us for lifts about to be erected. (3) There is more than one argument which will justify the use of our system, without entering into the question whether the supply given by the Power Company can be depended upon. If we admit that it can be depended upon, the question still remains as to the cost and frequency of necessary repairs, and the damage which may be caused by faults in the service at such high pressure. If, therefore, we concede the reliability of the power, there will still remain as another argument for the use of our low-pressure lifts the absence of the need or cost of frequent repairs, and the absence of interruptions. Mr. Ellington's statement, that we "acknowledge that if the Power Company reduced rates sufficiently, the system they—we—recommend must fall," is sufficiently remarkable. We seek in vain for any such acknowledgment, than which nothing could be farther from our thoughts. Every lift fixed by us is, in the quality of its service, an argument for our system. We have sought in vain for instances of an equal quality of service in other lifts, and are still asking where it can be found. It is generally admitted, and by Mr. Ellington as well as by others, that the use of lifts has been developed in the United States more than in this country, and in this country thus far those who use lifts have been satisfied with a service equal to that of their neighbours; but as the use of the Standard lift grows, and as it is found that they work without interruption, that quality will be demanded in other lifts. We think we are able to show that it cannot be found in other systems. (4) We must not pass unnoticed Mr. Ellington's remark in the first part of his letter, that the use of the Public Supply Hydraulic Power has already superseded for lifting purposes every other system previously in use in London. Certainly this is not true in regard to the Standard lift, the use of which is so rapidly growing. We have already said, and cordially repeat, that the work of the Power Company has been admirably done, and that the use of the power is wise in many cases; but all the facts go to show that passenger lifts are not among those cases, unless used in combination with our low-pressure system, and this we are always ready to do. The Standard lift has not only not been superseded or displaced, but the evidence accumulates that it will not be. (5) We see no reason for Mr. Ellington's objection to our "hypothetical case," the use of which has led to all this discussion, and reference to your issue of April 17th will show that Mr. Ellington is in error in saying that we "shifted the ground of discussion." We have furnished ample proof that a given amount of work could be done in our way and by our system with vastly better results than by any other system; and, this being proven, of what consequence is it whether the case was hypothetical or not? (6) We do not tax your space further. We have printed a pamphlet containing all the discussion on both sides, up to the issue of this last letter of Mr. Ellington, and we shall be glad to furnish it to any who may desire. Our appeal is to the facts. AMERICAN ELEVATOR CO.

38, Old Jewry, E.C., May 2nd.

BOILER EFFICIENCY.

SIR,—In THE ENGINEER of the 24th April, "Economist," in describing what he calls his improved principle of supplying oxygen to the furnace of steam boilers by means of a fan, goes far to describe what I applied to an externally-fired boiler when manager of the North Wall Ironworks, in the summer of 1865, which, with your permission, I will describe. On setting up a fan to blow several smiths' fires, it took up the speed of the engine and machinery so much that I had to think what was to be done to get more pressure. The boiler was set in a furnace without wheel flues; the direct heat of the fire played on it for about two-thirds of its surface; the chimney could not be got to bring up such a sharp heat in the fire as was seen to be necessary to produce more steam. I had to think how the difficulty was to be got over, and after seeing how a small fan could be conveniently driven, I determined to get up one—such as I had made in early life to blow, by hand, single fires for blacksmiths. A 6in. pipe was laid from this fan to right under the fire-bars, with the end of it turned up. A flat plate was laid over the bottom of the ash-pit, with a 7in. hole cast in it, to allow the wind to pass up through, and over this again was placed an oblong shutter plate, which played an important part in the mechanism. A circle, 7in. diameter, was closely perforated with ½in. holes, countersunk on the underside, to assist in spreading the wind over the underside of the bars, and at the same time to keep the ashes from falling down into the wind-pipe, and by drawing it along, we could shut the wind off altogether, or partly so only. A pair of tight fitting doors, with a sight hole nearly at the top of one of them, completed the apparatus. As to the damper being kept full open as formerly, one-fourth open was all that could be permitted after the steam was up. Ebullition seemed to get so strong that water rose with it and went over into the engine. I cannot say that the air in the ashpit kept cool, but rather got very hot, and what of it did not get up through the fire-bars at once seemed to recoil down the sides of the ashpit, and rise again with the incoming blast, as seen through the sight-hole in the door when wood shavings were put in. The engineman would have it that less fuel was consumed, but I did not pay any attention to that, seeing that he could always keep up plenty of steam.

This blowing apparatus was not over twenty minutes at work when steam was blowing off furiously at both unit and main safety valves, and the machinery all on, the damper having been left inadvertently full open. This system gave me much satisfaction for the four remaining years I was in the works.

Seville Engineering Works, Dublin, WM. ROBERTSON.
May 5th.

DEEP WATER DOCKS AT TILBURY.

SIR,—Referring to your description of the above, and to the letter of "Z." in your issues of the 3rd and 24th ult. respectively, I cannot but think that this great work, which will cost apparently some £2,000,000, hardly meets with the attention it deserves. There are so many points of exceptional engineering interest about it that I am sure it would be a boon to your readers if you could publish detail drawings showing sections of the docks, walls, &c. I visited the works last year, and was much impressed with the grave engineering difficulties that have to be overcome. These seem to arise mainly from two causes—first, the very great depths to which it is necessary to go to obtain foundations beyond what the necessities of the work require; and secondly, the very soft nature of the excavation. When I was there it seemed difficult to make this stand at any slope, and even though slopes had been flattened from the 1½ to 1, which "Z." states were originally intended down to 6 to 1, apparently it was still slipping. I could not help thinking that it would have been better to substitute walls for these slopes, especially as these latter were so flat they almost filled up the tidal dock, leaving but little more than the channel way through it. No doubt to have substituted walls for slopes would have caused great extra expense, as the foundation level—ballast level—is so deep. I was somewhat staggered to find there was as much as 30ft. to 35ft. of solid concrete under the walls and floors of the small graving docks, and this will in all probability cause the cost of the shallow graving docks to be greater than that of the deep ones; they are all founded at about the same level. I could not understand why the graving docks were not placed at the extreme north end of the wet docks, where, I believe, the foundations were some 25ft. less in depth; but probably there is some reason for this.

Your correspondent refers to the entrance works being constructed without a coffer dam. If I remember rightly, I was told the piles for the jetties jutting out into the river had to be either 70ft. or 80ft. long, in order to reach something solid. As I presume it would be necessary to use similar piles in the coffer dam, the cost of this puts it quite out of the question, even though it were practicable to construct a coffer dam with a 40ft. to 50ft. head of water against it, and with but little that was stable to strut to. It appears to me that this is pre-eminently one of those cases in which walls may advantageously be built on the monolithic system, such as Mr. Stoney has adopted in Dublin. W. X. Y.

May 5th.

FRICTION OF SLIDE VALVES.

SIR,—Is it not possible that the fact of your correspondent, "Janus," being the only one—among so many who have discussed or read the letters on this subject—to find out that my relieved slide valve was old, may not argue superior intelligence on his part but the reverse? He brings forward two instances intended to bear on the subject, neither of which, however, bear any resemblance to the conditions under which my valve works. He says the latest application of the idea was that in Halpin's compound engine; but it need hardly be pointed out that in Halpin's valve the exhaust cavity is placed as usual immediately in the line of motion. This may seem a matter of little importance to "Janus," or—in spite of his two faces!—he may have overlooked it, whereas in mine it is so far removed from the line of motion that the work required to move it would be at most 30 or 40 per cent. of that required for his. This is the main difference between Halpin's valve and mine, and if there were not a dozen others it is quite sufficient to prove the utter dissimilarity of the two ideas. I need not refer to the complicated nature of Halpin's valve both in design and manufacture, and it may hardly be wondered at that, if it had not failed otherwise, this alone would have condemned it, while the simplicity of both the relieved valve and cylinder is certainly apparent. In a former letter I said that I never expected that the valve would wear evenly, but that I did not see anything to prevent its keeping tight and reducing the strain in the gear by at least 60 or 70 per cent. If it does this I think it trivial to condemn it because its face may not wear like a straight-edge. At any rate, as a perfectly relieved slide, with one face, and "innocent of relief rings and all such vanities," it is not, as "Janus" says, an old idea; and I think it only due to me to draw attention to the fact that "Janus" has made a statement regarding it, which, if uncorrected, might do me much harm, which he does not in the least attempt to substantiate, and which, so far as is at present ascertained, is not true. EDWARD C. PECK.

Old Charlton, Kent, May 5th.

KING'S COLLEGE ENGINEERING SOCIETY.

AT the last meeting of this Society a paper was read by Mr. Smith "On the Use of Petroleum as a Fuel." Petroleum, though found all over the world, has as yet only been successfully worked in America and Russia. Last year the output of crude oil from American wells was computed at 3,000,000 tons, ranging in price from 16s. to 32s. per ton, as against 1,130,000 tons from Baku, where it was worth from 3½d. to 2s. 6d. per ton. The Pennsylvanian oil seems to be found in strata always older than the carboniferous; while that in the Aspheron peninsula soaks tertiary sandstones, both, however, being associated with metamorphism. The original source of the oil, however, is still unknown. Its use as a fuel in this country dates some twenty-three years back—a series of experiments both by private persons and at Woolwich, together with similar tests in America and France, giving most promising results, but with the effect that the price of crude oil was raised to a prohibitive figure. All this work had been done with crude oil, and it was only when it was found that the distillation, first of the lighter benzene products, then the illuminating oil, kerosine, and, finally, the separation of a valuable lubricating oil, left nearly 50 per cent. of refuse still valuable as fuel, and fuel only, that petroleum had its chance.

According to the latest research Baku oil differs from American, not only in yielding some 60 per cent. of refuse instead of 15 per cent., but chemically in that while the former is rich in paraffine which renders it useless for liquid fuel, the latter has not yet been found to contain more than ¼ per cent. Russian petroleum refuse is a black-brown liquid of high viscosity, having an average specific gravity close upon 0·9, and an average theoretical evaporative power, from and at 202 deg., of 21. The history of its use as a fuel during the last fifteen years shows that the oil was sprayed into the combustion chamber, first by an air jet in the easy burners of Bridges-Adams and Richardson, and then waste steam was added to the spray. Steam injection alone soon followed in the burners of Lentz, Karapetoff, and Hoffman, while a hollow flame supplied by a separate air injector with the oxygen necessary for the perfect combustion is the latest development, as in the burner of Anderson. The early experiments with boilers and fire-boxes designed for the comparatively moderate heat of coal soon showed by cracked plates and broken tubes the need of a fire-brick lining, and its important use as a store for heat was recognised later. First, a brick hearth, then a brick box, and finally in marine boilers a complete flue lining was the result. Siemens has lately found that this lining may be broken into rings. Nobel, both for metallurgical and boiler firing, has used a trough burner, in which the oil is consumed direct without being pulverised. Experiments last year by Mr. Urquhart on the Grazi-Tsairtsyn Railway, show in locomotive practice, and the Caspian oil fleet in marine practice, its economic advantages. In England, where the crude oil exceeds £5 per ton, we must await the completion of the proposed 560 miles of pipe from Baku to Batoum on the Black Sea, before refuse can be obtained. Drawings and diagrams of all the principal burners in use, diagrams of locomotive and marine boilers adapted to petroleum fuel, curves of cost and consumption, illustrated the lecture.

LAUNCHES AND TRIAL TRIPS.

ON the 29th ult. the ss. Courage, built by Messrs. Raylton Dixon and Co., for the Great Yarmouth Steam Carrying Company, proceeded to sea, making a successful trial trip. This is the fifth steamer of the kind built by this firm for this company, besides a fleet of ten sailing vessels, and is to be employed as carrier between the trawling fleet in the North Sea and the London Billingsgate Fish Market. Her principal dimensions are 128ft. over all, 21ft. beam, 11ft. 7in. depth of hold. She is fitted with engines of 50-horse power by Messrs. Blair and Co., Stockton, and will drive the vessel at sea an average speed of 11 knots. The engines are placed in the after part of the vessel, and the forehold is divided into two compartments, the smaller being for the stowage of broken ice which she will carry out to the fishing fleet where this is delivered to the trawlers, and in return she will receive from them the packed boxes which are stowed in the main hold of steamer. The main hold is protected from the effects of external heat by being lined throughout with timber and caulked, the space between the lining and shell being packed with non-conducting material, the same being the case under the deck. She is also fitted with a steam capstan and every convenience for trawling when not employed in fish carrying. Messrs. Dixon and Co. have also at present in hand a fleet of similar small vessels for the Baroness Burdett-Coutts.

On the 2nd inst. Messrs. Oswald, Mordaunt, and Co., Southampton, launched the Woolton, a fine iron sailing ship of 2100 tons net register, and of the following dimensions:—Length, 274ft. 7in.; breadth, 40ft. 3in.; depth of hold, 24ft. 2in. The vessel has been built for Messrs. R. W. Leyland and Co., Liverpool, and exceeds the highest requirements of both Lloyd's and Liverpool Underwriters' Registry. She is full rigged and fitted with a topsail on main mast. She is fitted with Emerson and Walker's patent combined capstan windlass for working anchors and chains. During construction the vessel has been under the supervision of Captain Semple.

On the 2nd inst. the ss. Donegal, 125ft. by 22ft. by 10ft. 6in., built by Messrs. Craig, Taylor, and Co., of Stockton-on-Tees, Liverpool owners, made her trial trip. She is fitted with engines of 50 nominal horse-power; cylinders, 18in. and 36in. by 24in., the working pressure being 85 lb. They are made by Messrs. Westgarth, English, and Co., of Middlesbrough, and indicated 281-horse power when the speed was 9½ knots.

On Saturday the screw steamer Sitonia, built and engined by Messrs. Wigham Richardson and Co., proceeded to sea for her trial trip. She is a vessel of 950 tons dead weight carrying capacity, built to the order of Messrs. De la Condamine and Johnston, of London, for Messrs. William Thorburn and Sons, of Uddevalla, Sweden, and is intended principally to trade between Uddevalla and London with general cargoes and passengers, handsome accommodation for a limited number of the latter being provided amidships. The engines are compound surface-condensing of 750 indicated horse-power. The boilers are of steel and work at 80 lb. pressure. All the latest improvements both in machinery and fittings are provided, and on the trial trip were found to work to the very great satisfaction of everyone interested. The vessel was taken for a series of runs over the measured mile off Whitley, and a mean speed of eleven knots was obtained.

On Wednesday, the 6th inst., Messrs. Earle's Shipbuilding and Engineering Company, Hull, launched the Flamingo, an iron steam fishing cutter, built for the Great Grimsby Ice Company. The vessel, which is classed 100 A1 at Lloyd's, is for carrying fish from the Grimsby fishing fleet. Her dimensions are as follows:—Length, p.p., 137ft.; breadth, 21ft. 6in.; depth of hold, 11ft. She has a raised quarter deck aft, extending from the engine and boiler space and forecastle forward, and is designed with good shear so as to make her a fast and at the same time a seaworthy ship. She is ketch rigged, with a large spread of canvas, and is fitted with a powerful steam winch and trawling gear arrangements. This boat will not only carry fish, but will also be employed for trawling. She will be fitted by the builders with their triple compound engines of 80 nominal horse-power. This is the tenth steam vessel built by Earle's Company for Grimsby fishing companies.

THE IRON AND STEEL INSTITUTE.

THE annual general spring meeting of the Iron and Steel Institute commenced on Wednesday at the Institution of Civil Engineers, when the report of the Council for the year 1884 was presented and accepted. The Bessemer gold medal for 1885 was presented to Professor Akerman, of Stockholm, and Dr. Percy, F.R.S., took the place of the retiring president—Mr. B. Samuelson—and delivered his inaugural address. As would be expected from Dr. Percy, the address contained much original, characteristic, and valuable information and suggestive thought. We are, however, owing to great pressure on our space this week, forced to postpone our account of the meeting and of the papers read.

EXPRESS LOCOMOTIVE, MIDLAND RAILWAY.

WE publish this week, as a supplement, a working drawing—No. 125 of THE ENGINEER portfolio of working drawings—of one of the new express engines designed by Mr. Samuel Johnson, for the fast passenger service of the Midland Railway. We gave a perspective view of this engine, with full description, in our impression for February 6th, and a cross section on February 27th. The drawing being fully dimensioned, it is unnecessary to give further particulars here.

A GREAT SHAPING MACHINE.—We omitted to state in our description of Messrs. J. Archdale and Co.'s great shaping machine, illustrated in our last impression, that it was specially constructed for Chatham Dockyard, where it will be employed in shaping armour-plates.

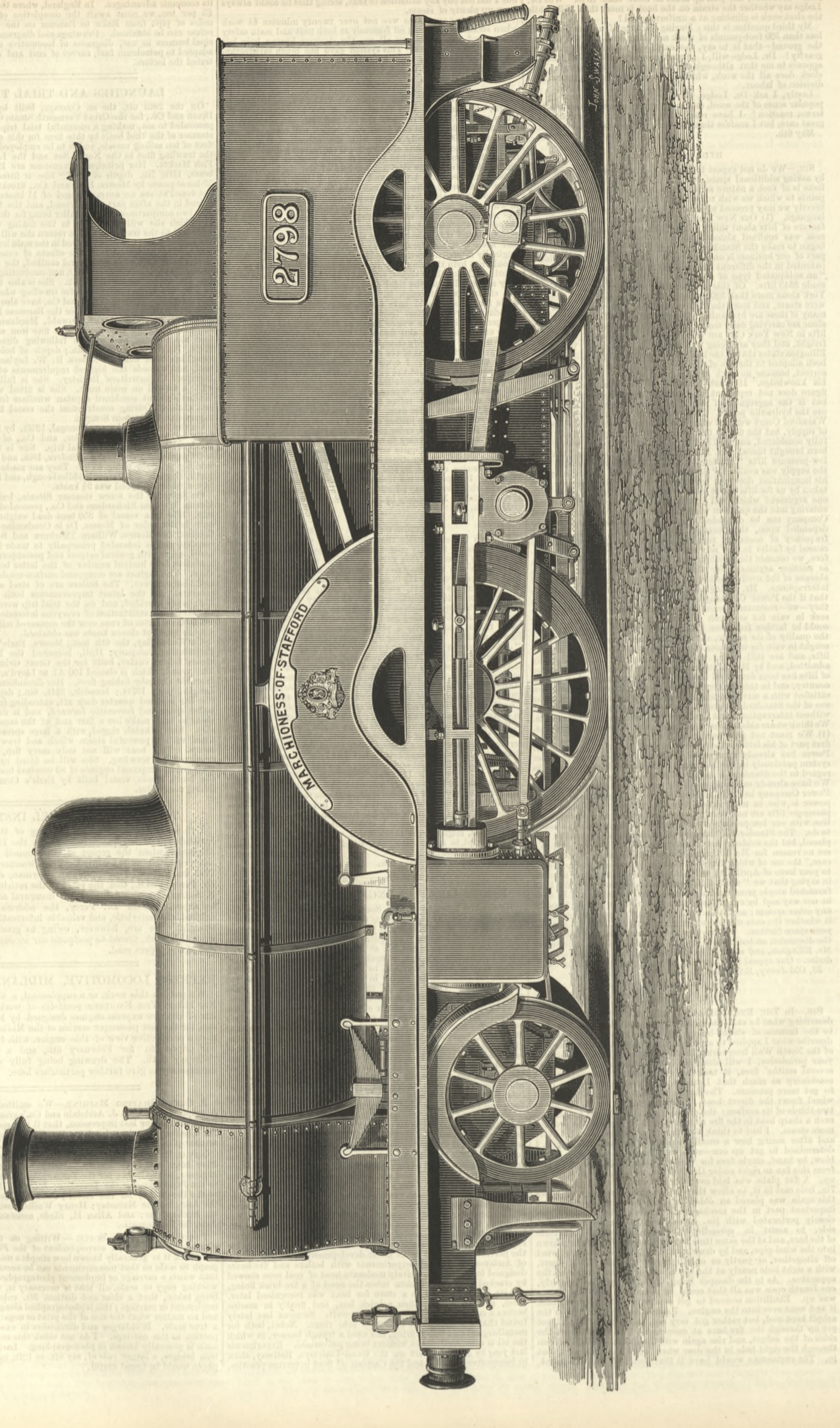
NAVAL ENGINEER APPOINTMENTS.—The following appointments have been made at the Admiralty:—Robert Burridge, chief engineer, to the Indus, for the Tamar; James D. Chuter, engineer, to the Pembroke, for the Traveller; John W. Henwood, engineer, to the Pembroke, for the Rover; John G. Stevens, engineer, to the Asia, for the Mainstay; Henry Wallis, assistant engineer, to the Enchantress; and Allan H. Slade, assistant engineer, to the Asia, for the Surprise.

PHOTOGRAPHING TO SCALE.—Writing on the production of photographs to scale, a correspondent of the *Field* says:—"I do not think it is generally known how simple a matter it is to photograph to scale so that measurements can be accurately taken. If a man wants a carriage or implement photographed so as to make a working copy to scale, all that is necessary is, when the photo is being taken, that a clear and distinct 3ft. rule be placed on the implement or carriage; this is photographed along with the carriage, and no matter what the size of the print or negative, will always be a true scale. It enlarges and diminishes in exactly the same proportion as the carriage. I do not think this simple and accurate scale is generally known in photographing. Larger works, such as iron bridges, a larger rule of, say 6ft. or 12ft. introduced into the photo would be found useful."

THE INVENTIONS EXHIBITION. COMPOUND ENGINE, LONDON AND NORTH-WESTERN RAILWAY.

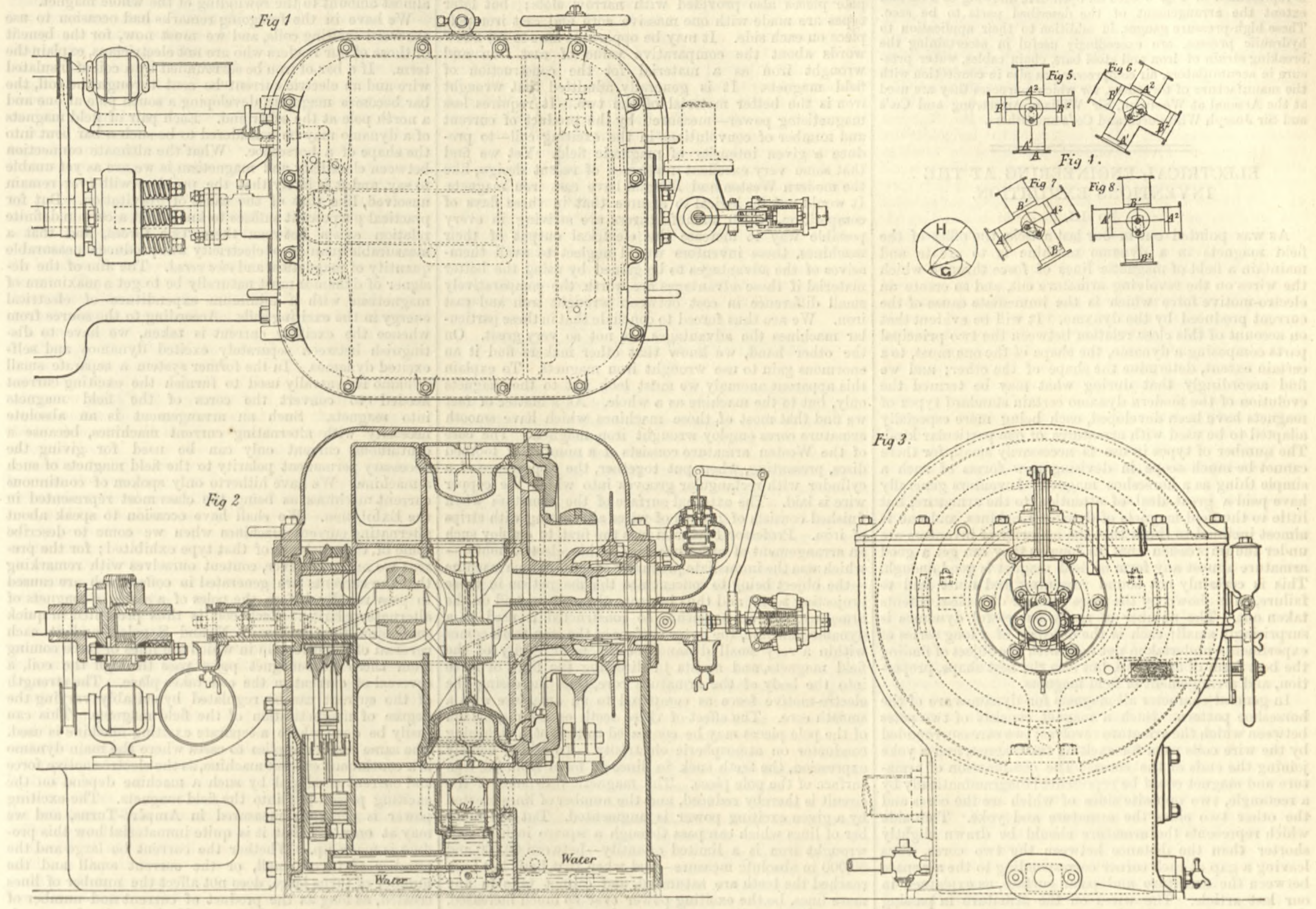
MR. F. W. WEBB, M.I.C.E., CREWE, ENGINEER

(For description see page 349.)

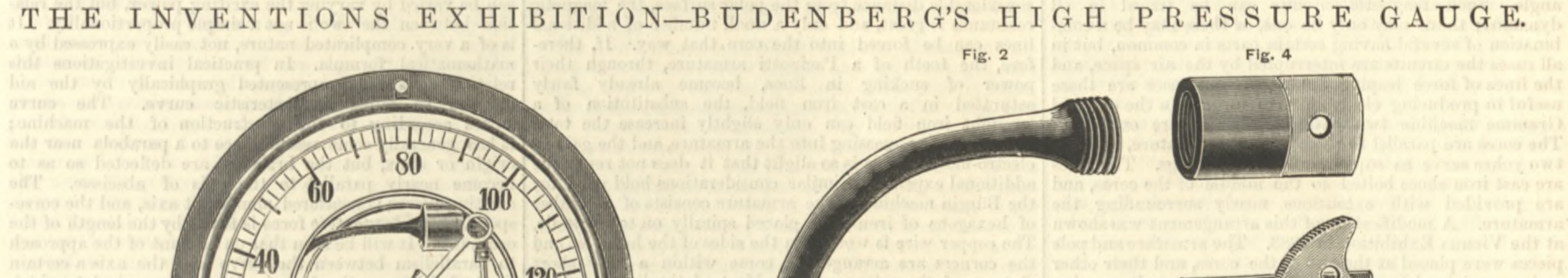


THE INVENTIONS EXHIBITION—PARSONS' PATENT HIGH SPEED ENGINE.

MESSRS. KITSON AND CO., LEEDS, ENGINEERS.



THE INVENTIONS EXHIBITION—BUDENBERG'S HIGH PRESSURE GAUGE.



THE accompanying engravings illustrate a gauge for pressures up to as much as 10 tons per sq. in., made by Mr. A. Budenberg. None of the ordinary steam pressure and vacuum gauges can be applied for indicating constantly such high pressures as 300 lb. per square inch, and still less so pressures very much higher which are needed for high-pressure tubing, hydraulic presses, &c. Messrs. Schäffer and Budenberg have, they claim, succeeded in constructing gauges which have overcome these difficulties. In manufacturing tube springs, steel rods of the highest quality attainable are cut to the proper length of the springs required; they are bored out, and turned off outside, except the ends, on which a suitable thread is screwed. Fig. 1. After having been submitted to the required heat, they are bent, in which operation they are at the same time flattened and conveniently shaped. Fig. 2. They undergo a process of tempering, and thereafter the one end is screwed into the stem or principal part of the gauge—Fig. 3—through which the pressure is carried on from the generator, and upon the other end is screwed a solid piece of metal—Fig. 4—to which the rod is fixed transmitting the movements of the steel spring by suitable gearing —Fig. 5—to the pointer and dial of the gauge. The springs for gauges to indicate the very highest pressures are prepared in a similar manner, the lower pressures requiring the larger tubes. This solid steel tube spring is exceedingly durable, retaining perfect elasticity, and has the great advantage that all soldering is avoided, which is requisite in the Bourdon and other constructions in which the spring consists of a tube. These gauges were originally only intended for hydraulic purposes, but the principle has been so far modified as to allow of its being applied to gauges for all ordinary steam pressures, and it is claimed that they register the lower pressures with as great accuracy as the higher, and are now very extensively used, and their superiority recognised by leading engineers and steam users. The solid steel tube gauge, arranged for steam pressure, is represented in Fig. 6 with an open dial, allowing to a certain extent the arrangement of the described parts to be seen. These high-pressure gauges, in addition to their application to hydraulic presses, are exceedingly useful in ascertaining the breaking strain of iron and steel bars, chain cables, water pressure in accumulators, air compressors, as also in connection with the manufacture of torpedoes, for which purposes they are used at the Arsenal at Woolwich, Sir William Armstrong and Co.'s and Sir Joseph Whitworth and Co.'s and others.

ELECTRICAL ENGINEERING AT THE INVENTIONS EXHIBITION.

No III.

As was pointed out in our last article, the office of the field magnets in a dynamo machine is to create and maintain a field of magnetic lines of force through which the wires on the revolving armature cut, and so create an electro-motive force which is the immediate cause of the current produced by the dynamo. It will be evident that on account of this close relation between the two principal parts composing a dynamo, the shape of the one must, to a certain extent, determine the shape of the other; and we find accordingly that during what may be termed the evolution of the modern dynamo certain standard types of magnets have been developed, each being more especially adapted to be used with armatures of one particular kind. The number of types in use is necessarily small, for there cannot be much scope in devising new forms of such a simple thing as a horseshoe magnet. Inventors generally have paid a great deal of attention to the armature, but little to the field magnets of dynamo machines, and one is almost inclined to think that the majority of inventors are under the impression that as long as they can get a good armature almost any form of field magnet is good enough. This is certainly not sound reasoning, and must lead to failure, as is shown by the large number of useless patents taken out. The number of really successful dynamos is surprisingly small; each is the outcome of a long series of experiments undertaken not only with the object of finding the best form of armature, but also the best shape, proportion, and arrangement of field magnets.

In general character all magnets for dynamos are of the horseshoe pattern. Such a magnet consists of two poles between which the armature revolves; two cores surrounded by the wire coils used for exciting the magnet, and a yoke joining the ends of the cores. The combination of armature and magnet could be represented diagrammatically by a rectangle, two opposite sides of which are the cores and the other two sides the armature and yoke. That side which represents the armature should be drawn slightly shorter than the distance between the two cores, thus leaving a gap at each corner corresponding to the air space between the armature and polar surface, as explained in our last article. The wires on the armature in passing these gaps must cut the lines of force which run round the magnetic circuit, represented diagramatically by the rectangle. Such magnetic circuits can be traced in all dynamos; there may only be one, or there may be a combination of several having certain parts in common, but in all cases the circuits are interrupted by the air space, and the lines of force leaping across this air space are those useful in producing electro-motive force. In the original Gramme machine two pairs of magnets are employed. The cores are parallel to the axis of the armature, and the two yokes serve as supports for its bearings. The poles are cast iron shoes bolted to the middle of the cores, and are provided with extensions nearly surrounding the armature. A modification of this arrangement was shown at the Vienna Exhibition in 1883. The armature and pole pieces were placed at the end of the cores, and their other ends were joined by one common yoke, the spindle passing through a bearing supported by this yoke. Similar machines, but of more recent design, are to be exhibited this year.

In the Schuckert-Mordey, Gülcher, Brush, and other machines having disc armatures, another modification of the original Gramme magnets is used. The active portion of the wire on the armature is not only that on the outer periphery, but also that on the sides of the disc; and in order to bring that portion well within the lines of force, the cores are arranged to either side of the disc, the whole or the greater part of the active surface of the poles being a plane at right angles to the axis. It may be mentioned that on theoretical grounds these disc armatures give a maximum of electro-motive force with a given length of wire, because, with the exception of that small portion of the winding which crosses the ring on the internal periphery, the whole of the wire is active; but there are some practical difficulties in attaching the core of the armature to the spindle, and some space on the inner periphery must be sacrificed for this purpose. There is a yoke on each side of the machine joining the outer ends of the cores and supporting the bearings, as in Gramme's original design. In the larger types of Schuckert-Mordey and Gülcher machines a double set of magnets is employed, producing four poles around the disc. In this way the output in current from these machines has been doubled.

Another type of field magnets, first employed, we believe, by Siemens, is particularly applicable to cylindrical armatures. The cores are placed at right angles to the axis of the armature, and are arched in the middle, so as to form polar cavities surrounding a little over a third of the armature on each side. Yokes are placed at each end of the cores, so that two complete magnetic circuits are formed with poles common to both. In the original Siemens machine the cores are not made in one solid piece, but consist of a number of bars separated from each other by small air spaces. This is done partly for convenience of manufacture and partly to avoid eddy currents in the body of the magnets, and to facilitate the ventilation of the armature. The magnets of the Maxim dynamo are constructed similarly, but those of the Bürgin, Crompton, and Lumley machines have solid magnet cores. The original Weston dynamo had a set of three or more cylindrical cores on each side of the armature, and cast iron pole pieces also provided with narrow slots; but later types are made with one massive core and cast iron pole piece on each side. It may be opportune here to say a few words about the comparative value of cast iron and wrought iron as a material for the construction of field magnets. It is generally admitted that wrought iron is the better material of the two. It requires less magnetising power—measured by the product of current and number of convolutions in the exciting coil—to produce a given intensity of magnetic field. Yet we find that some very excellent machines of recent design, like the modern Weston and Bürgin, have cast iron magnets. It would not be logical to assume that in these days of competition, when manufacturers are striving in every possible way to increase the electrical output of their machines, these inventors would neglect to avail themselves of the advantages to be gained by using the better material if these advantages are worth the comparatively small difference in cost between wrought iron and cast iron. We are thus forced to conclude that in these particular machines the advantages are not so very great. On the other hand, we know that other makers find it an enormous gain to use wrought iron magnets. To explain this apparent anomaly we must look not to the magnets only, but to the machine as a whole. As a matter of fact we find that most of those machines which have smooth armature cores employ wrought iron magnets. The core of the Weston armature consists of a number of toothed discs, presenting, when put together, the appearance of a cylinder with rectangular grooves into which the copper wire is laid. The external surface of the armature when finished consists of groups of wires alternating with strips of iron. Professor Pacinotti was the first to employ such an arrangement of armature core in his electric motor—which was the immediate precursor of the Gramme machine—the object being to concentrate the magnetism in these projecting teeth, and thus increase the statical pull on the armature. If an armature so constructed is used in a dynamo machine, the outer surface of the iron teeth comes within a very small distance of the polar cavity of the field magnets, and assists in directing the lines of force into the body of the armature core, thus increasing the electro-motive force as compared to an armature with a smooth core. The effect of these teeth on the magnetism of the pole pieces may be compared to that of a lightning conductor on atmospheric electricity. To use a homely expression, the teeth suck in lines of force from the iron surface of the pole piece. The magnetic resistance of the circuit is thereby reduced, and the number of lines created by a given exciting power is augmented. But the number of lines which can pass through a square inch of soft wrought iron is a limited quantity—between 60,000 and 80,000 in absolute measure—and when that limit has been reached the teeth are saturated, and cannot take in any more lines, be the exciting power ever so much increased. Any additional lines must pass into the armature core between the teeth, and as the bottom of the grooves is a considerable distance from the polar surface, the magnetic resistance is great, and only a small number of additional lines can be forced into the core that way. If, therefore, the teeth of a Pacinotti armature, through their power of sucking in lines, become already fairly saturated in a cast iron field, the substitution of a wrought iron field can only slightly increase the total number of lines passing into the armature, and the gain in electro-motive force is so slight that it does not repay the additional expense. Similar considerations hold good for the Bürgin machine. The armature consists of a number of hexagons of iron wire placed spirally on to a spindle. The copper wire is wound on the sides of the hexagon, and the corners are arranged to come within a very short distance of the polar surface. Most of the lines of force enter the core at these corners, which correspond to the teeth in the Weston armature. Experiments made by the writer have shown that the increase of electro-motive force obtainable by the substitution of wrought iron for cast iron magnets in a Bürgin machine is only slight.

An ingenious form of field magnets which will be shown by Messrs. Mather and Platt may be described as a horseshoe, with the exciting coil placed over the yoke. To revert to our geometrical illustration, that side of the rectangle which is parallel to the line representing the armature is the core surrounded by a magnetising coil, and the two other sides are merely prolonged poles. A similar arrangement was some years ago used by M. Gramme, and shown at the Paris Exhibition in 1881; but the design worked out by Messrs. Mather and Platt is more massive, and shows a due appreciation of the necessity of having a magnetic circuit of as low a resistance as possible. We shall in a future article illustrate and describe in detail this dynamo, as also the very compact driving gear and diagonal engine used with it. Perhaps the most simple form of field magnets is that used in the Edison dynamo. It is a vertical horseshoe, the armature being at the bottom and a heavy yoke at the top. In the original American machines the pole pieces and yoke were joined by a number of long cylindrical cores on which the exciting coils were placed. The modern Edison-Hopkinson machines of English make have only one massive and shorter core on each side. The resistance of the magnetic circuit has thereby been considerably decreased, and the output of the machines has been nearly doubled.

With the above descriptions we have not exhausted the list of field magnets that are employed. We merely give a general review of those types or modifications of types that are mostly used, and reserve description of particular forms to future occasions, when we shall give a more detailed account of some of the more important machines exhibited.

Formerly some makers used to wind the exciting coils direct on the magnet cores, but now almost every maker winds the coils on separate formers, which are slipped on to the core. The advantage of this method of construction is evident. In the first place the weight and size of modern machines would make the direct winding of the coils on to the magnet cores very inconvenient; and in the second place, the exchange of a damaged coil would almost amount to the rewinding of the whole magnet.

We have in the foregoing remarks had occasion to use the word exciting coils, and we must now, for the benefit of those of our readers who are not electricians, explain the term. If a bar of iron be surrounded by a coil of insulated wire and an electric current be sent through the coil, the bar becomes magnetic, developing a south pole at one and a north pole at the other end. Each pair of field magnets of a dynamo may be considered to be such a bar bent into the shape of a horseshoe. What the ultimate connection between electricity and magnetism is we are as yet unable to say, and it is likely that the problem will ever remain unsolved, like that of the cause of gravitation. But for practical purposes it suffices to know that a certain definite relation exists between these two forces, and that a measurable quantity of electricity will produce a measurable quantity of magnetism and *vice versâ*. The aim of the designer of dynamos must naturally be to get a maximum of magnetism with a minimum expenditure of electrical energy in the exciting coils. According to the source from whence the exciting current is taken, we have to distinguish between separately excited dynamos and self-excited dynamos. In the former system a separate small dynamo is generally used to furnish the exciting current needed to convert the cores of the field magnets into magnets. Such an arrangement is an absolute necessity with alternating current machines, because a continuous current only can be used for giving the necessary permanent polarity to the field magnets of such a machine. We have hitherto only spoken of continuous current machines as being the class most represented in the Exhibition. We shall have occasion to speak about alternating current machines when we come to describe some of the machines of that type exhibited; for the present we must, however, content ourselves with remarking that the currents are generated in coils which are caused to pass rapidly before the poles of a series of magnets of alternate polarity. Each coil is thus presented in quick succession to a series of N and S poles, and at each reversal of the direction in which the lines of force coming from these field-magnet poles pass through the coil, a reversal of current in the coil takes place. The strength of the current can be regulated by suitably varying the degree of magnetisation of the field magnets. This can easily be done where a separate exciting machine is used. The same remark applies to cases where the main dynamo is a continuous current machine, as the electro-motive force and current produced by such a machine depend on the exciting power put into the field magnets. The exciting power is generally measured in Ampère-Turns, and we may at once say that it is quite immaterial how this product is made up. Whether the current be large and the number of turns small, or the current small and the number of turns large, does not affect the number of lines created, as long as the product of current and number of convolutions remain constant. If the main dynamo is kept running at a constant speed, the electro-motive force can be varied by varying the exciting power, but the relation between the two is not a simple proportionality. It is of a very complicated nature, not easily expressed by a mathematical formula. In practical investigations this relation is always represented graphically by the aid of the so-called characteristic curve. The curve varies according to the construction of the machine; it has generally some resemblance to a parabola near the origin or apex, but the branches are deflected so as to become nearly parallel to the axis of abscissæ. The exciting power is measured along that axis, and the corresponding electro-motive force is found by the length of the ordinates. It will be seen that on account of the approach to parallelism between the curve and the axis a certain limit of electro-motive force is ultimately reached, to which a very large exciting power corresponds. This condition is expressed by the term saturation of field magnets, and an increase of exciting power beyond this point cannot sensibly increase the electro-motive force. In practice machines are generally worked somewhat below saturation point, partly for economy in exciting power and partly to leave a certain margin for the purpose of regulating the electro-motive force.

As regards self-exciting dynamos, there are three principal types in use—series, shunt, and compound wound machines. In the series machine the current generated in the armature is first led through the exciting coils on the field magnets before being allowed to flow into the outer circuit. The principle of mutual accumulation between the armature and field magnets is so well and generally known that we need only make a passing allusion to it. According to this principle, if the resistance of the outer circuit is sufficiently low, the slight trace of magnetism existing in the iron of the field magnets—as it exists in any piece of iron within the magnetic influence of the earth—induces a correspondingly slight current in the armature, which being led through the exciting coils, tends to increase the original magnetism. This again reacts on the armature, the current is increased, and further intensifies the field until a point near saturation is reached. The machine is then in full work. Since the electro-motive force is dependent on the current, it is evident that the machine cannot produce any electro-motive force when working on open circuit or on a circuit of so high a resistance that the principle of mutual accumulation cannot come into action. Series machines are therefore only applicable in cases where the resistance of the outer circuit cannot be increased beyond a certain limit, as in the case of an electric light installation containing a fixed minimum number of incandescent lamps in parallel connection, or where the resistance of the outer circuit is low to begin with and increases as the current increases. As an example, we may cite the case of a number of arc lamps placed in series. Before the machine is set in motion all the carbons are in contact, offering very little resistance to a current passing through the series of lamps. If the machine be started, the incipient current finds a path of low resistance open, and thus the principle of mutual accumulation can come into action. Another example is the transmission of motive-power by means of two series dynamos. Whilst the receiving dynamo, which is acting as motor, is at rest, there is only its resistance and that of the line to be overcome by the generating dynamo, and a current is quickly started. Afterwards there is the opposing electro-motive force of the motor added to its resistance, but the field of the generator being already established the latter is able to maintain the current.

It will be seen that series machines are not suitable for incandescent light installations where the number of lamps burning at a time varies between wide limits. For such a purpose shunt-wound dynamos are somewhat better, but by no means quite so satisfactory as compound-wound machines. We shall decribe the former first. The exciting coils consist of a large number of turns of fine wire having a considerable resistance, and they are connected direct to the brushes of the armature without reference to the outer circuit. The current which magnetises the field circulates through the exciting coils and armature, and as far as this current alone is concerned, the machine can be considered as a series-wound dynamo working on short circuit—that is, through an external circuit of no resistance. The principle of mutual accumulation will therefore come into action, and the field magnets will become excited to nearly saturation point. In consequence of this there will be an electro-motive force maintained between the terminals of the machine, even if the same be disconnected from any external circuit. It is therefore possible on making the connection to light one single incandescent lamp and to increase the number as required. Each successive lamp switched on forms an additional path for the electric current, and the total current given out by the armature is nearly proportional to the number of lamps burning. But as the current increases the loss of electro-motive force, in consequence of the resistance offered by the wires on the armature, also increases, and the exciting current circulating round the field magnets is thereby somewhat decreased. This lessens to a certain extent the magnetism in the field, and again reacts on the electro-motive force, tending further to lower the exciting current. In fact, the converse of mutual accumulation takes place between the armature and field magnets until a point is reached at which the electro-motive force is just sufficient to maintain an exciting power corresponding to the intensity of the field to which the electro-motive force is due. To represent this graphically, the machine is now working at a lower point of its characteristic curve, and each lamp fed by it will burn somewhat less brilliantly than before. In some machines, as for example the Edison and Weston, the resistance of the armature is so extremely low that this difference in brilliancy between a small and a large number of lamps on at a time is scarcely noticeable. In other machines the difference is very marked, and by far too great to allow the use of shunt machines pure and simple for incandescent lighting, unless some sort of electrical governor is provided which will cause the speed of the machine to increase as the number of lamps burning at a time is increased.

Another way of overcoming the difficulty is by the employment of a combination of the series and shunt systems of winding the field magnets. This is generally known under the name of compound winding, and is now almost universally used by the makers of dynamos for incandescent lighting. After what was said above about the two systems if employed simply, our non-electrical readers will have no difficulty in seeing how the combination acts. The office of the shunt coils is to maintain the electro-motive force between the terminals of the dynamo when the outer circuit is open. If, now, one lamp after another be switched on, additional exciting power is applied to the magnet through the series coils which carry the current to the outer circuit; and this additional exciting power should just suffice to raise the electro-motive force by an amount corresponding to the loss due to the resistance of armature, series coils, and main leads. In this way the difference of potential between the positive and negative lead at the lamps is maintained nearly con stant, whatever may be the number of lamps switched on at a time.

A point of great practical importance is the efficiency of dynamo machines. As mentioned above, the aim in designing the field magnets should be to produce a maximum number of useful lines of force with a minimum expenditure of electrical energy. This can be obtained partly by so shaping the magnets as to offer the least possible magnetic resistance, and thus to require only a small exciting power, and partly by using a large amount of copper in the exciting coils. It must be evident that the thicker the exciting wire in a series machine, the less resistance will the exciting coils offer to the current, and the smaller will be that portion of the total electro-motive force which must be sacrificed to drive the current through them. Similarly, the greater the length of wire coiled on the magnets of a shunt machine the greater will be the resistance of these coils, and the smaller the amount of current which can pass through them. In this case the exciting power is nearly independent of the number of turns, because current and number of turns are nearly inversely proportional. We need not go at length into these matters, as we have in a recent article—February 27th—treated the question of the different losses of power taking place in a dynamo machine. Suffice it to say that the quicker a dynamo is driven the more efficient will it be. The electro-motive force produced in the armature is proportional to the strength of the field, the number of turns of wire, and the speed. The smaller the number of turns coiled on a given armature the larger can be the cross-sectional area of the wire, and the smaller will be its resistance. In this case the resistance of the armature is about inversely proportional to the square of the number of turns. By doubling the speed of the armature we shall, therefore, quarter the loss of electro-motive force due to its resistance. But since very high speeds are for practical reasons inconvenient, there is a limit beyond which increase of efficiency should not be attempted by the simple device of increased speed. There are also cases where it is absolutely necessary to keep the speed below a certain limit, especially where the dynamo is coupled direct to the engine, and then economy must be sought in other ways than by increasing the speed. This can be done by an increase in the size of the armature, and by employing a very powerful field. After what we have said, it will be seen that it would evidently be unfair to compare the efficiency of different dynamos irrespectively of their speed. To obtain a just basis of comparison between two machines of equal electrical output but different speeds, the loss of electrical energy in the armature should in both cases be multiplied by the square of the speed, and the figures thus obtained should be used for comparison.

It is interesting to note that recent improvements in dynamos have generally been in the direction of a decrease in speed, whilst the makers of steam engines have striven to increase their speeds. A point has thus been reached where the two meet, as is shown by the comparatively large number of direct-driven dynamos exhibited.

THE NEW ORLEANS EXHIBITION.
No. IV.

AMONG the most successful of the manufactories in America are those which have been established by Englishmen, who, finding that their products as made at home are shut out by the heavy import duties, bring capital, experience, and workmen here and endeavour to carry on their accustomed trades. As an example, the manufacture of sewing cotton, or, as it is called here, spool cotton, is exhibited by two of the largest firms in the world—Clark, of Glasgow, and the American Willimantic Company. The former has a very large factory in America, and exhibit a complete set of machinery showing the treatment of the cotton from its raw condition as purchased from the plantation to the finished reel or bobbin as sold to the consumer. The reeling machinery is one of the most extraordinary series of automatic processes ever witnessed, and in its completeness and compactness quite outshines the less efficient appliances of the American firm, who, however, in all the preparatory stages, are on an equal footing. It is interesting to note how in the subdivisions of manufacture machines have been brought together from the two countries. Thus on the different machines of the Willimantic Company may be seen the names of Curtis, Son, and Co., of Manchester; J. T. Boyd, of Glasgow; the Lowell Machine Company, of Massachusetts; the Machine Company of Providence, Rhode Island, and others.

The introduction of old-established trades from a foreign country is not always successful, for it is not easy to transplant industries which grow up in districts, affording subsidiary trades of all kinds; and a single factory in a new country is often hampered for want of the preliminary or secondary processes which are best performed as separate enterprises, and which are abundant only in places where manufactories congregate. Such a trade as lace-making, for instance, which at present is carried on mainly at Nottingham, Calais, and certain German towns, is not doing very well here.

The Government and State exhibits alluded to in a previous article are so complete and well arranged, and display so plainly the vast resources of the country, especially of the parts hitherto least known to the world, that they alone, by the information they afford, justify the trouble and expense of the Exhibition, and make amends for the many minor defects in the undertaking. It was at first intended to make this official display in the main building, but so great were the demands for space in the latter by private persons, that it proved insufficient even for them alone, and it was decided to construct a separate building for the official exhibits. This building, already alluded to, is about 900ft. long by 600ft. wide, and of the 540,000 square feet of space thus available, the Government takes about 100,000, and the forty-six States and territories the remainder, Texas heading the list with 18,000ft., and all being represented except Utah. Besides these purely Government displays, two of the principal railway companies interested in the development of the South, namely the line from Cincinnati to New Orleans, known as the Queen and Crescent route, and the Richmond and Danville system, which embraces lines south and south-west from Washington through Virginia, also take 10,000 and 12,000 square feet respectively, to show the agricultural, mineral, and other products of the lands they traverse.

The last-named company affords a curious example of railroad development in this country. The original line from Richmond to Danville measures only 140 miles, and now the company owns or controls more than 2000 miles, of which the Virginia Midland is probably the most important, connecting, as it does, to Baltimore and Washington on the north, with a subsidiary steamship line to New York; while south there are running powers and leased lines into both Carolinas and to Georgia. The tendency to bigness in this country is specially seen in the nomenclature of the railroads, and a small line seeks greatness by adopting the name of a State or district some thousands of miles distant. Thus it is with the Georgia-Pacific, which is controlled by the Richmond and Danville Extension Company, but which, except in its name, will reach the western ocean only in some remote future.

In the centre of the building devoted to the Government and State display are the national exhibits, classed according to the branch of service they represent. Thus the War Department shows rifled ordnance, but is most conspicuous in the medical branch, which shows models of railway ambulances, which are ingenious adaptations of the usual American cars for conveying wounded soldiers, while surgical instruments and appliances of all kinds are conveniently arranged for inspection. Naval hospital ships are also exhibited by models, but war ships are not at present conspicuous in this country, and do not claim much attention here. The postal authorities show their sorting cars, which differ in many respects from those used in England, and fitted with apparatus for taking up and throwing off mail bags while running of a kind much simpler than those on English railways. Specimen sets of postage stamps are exhibited, and with these also are shown a complete assortment of bank notes, the pictures and other portions of the design which are peculiar to the paper money of the country affording exquisite specimens of fine-line engraving.

The Government Surveyor's Department has a very fine display of maps, some of them in relief, which give amongst other information the results of the latest mineralogical investigations. The Smithsonian Institute exhibits an interesting collection from its museum and library. The Patent-office has a department of its own, with conveniently arranged books of reference and other information generally accessible only at Washington. In the galleries of the buildings are shown the methods and appliances adopted in the common schools of the different States, including in these some most interesting information concerning rudimentary technical schools which have been recently established in various districts. Specimens of artisans' work from the New York trade schools are shown. Typical engineering structures on a small scale as suitable for instructional purposes are exhibited, amongst them being a useful and effective display of models of American bridges and roof trusses. In this department foreign as well as home exhibits are admitted. There is a school workshop from Sweden, and France sends a very complete display of drawings, tools, and appliances from the Rouen primary technical schools. Probably the old connection of New Orleans with France induced the authorities to take the great trouble this exhibit must have involved.

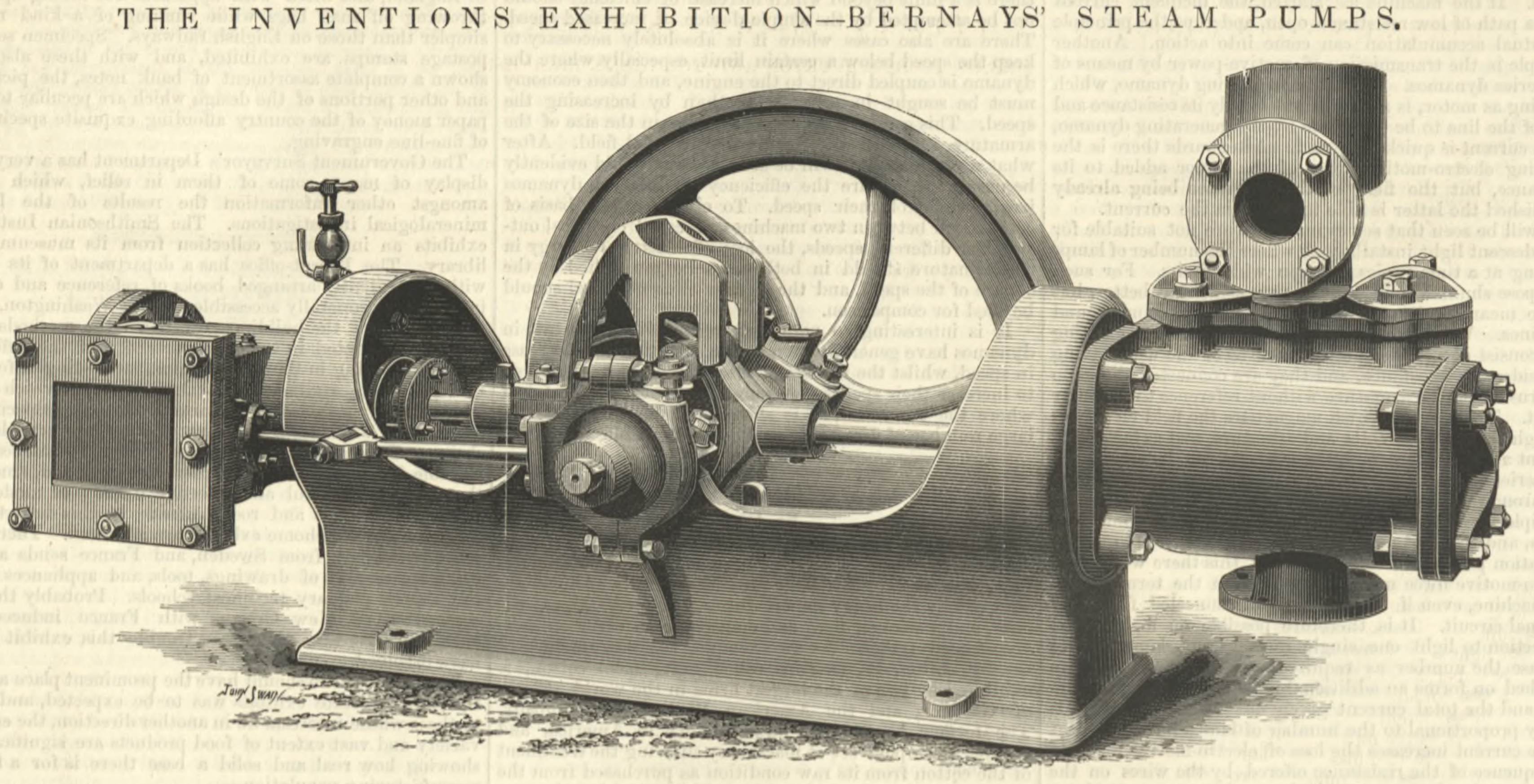
That agriculture should have the prominent place among the separate State exhibits was to be expected, and even to those whose interests lie in another direction, the endless variety and vast extent of food products are significant as showing how real and solid a base there is for a future manufacturing population.

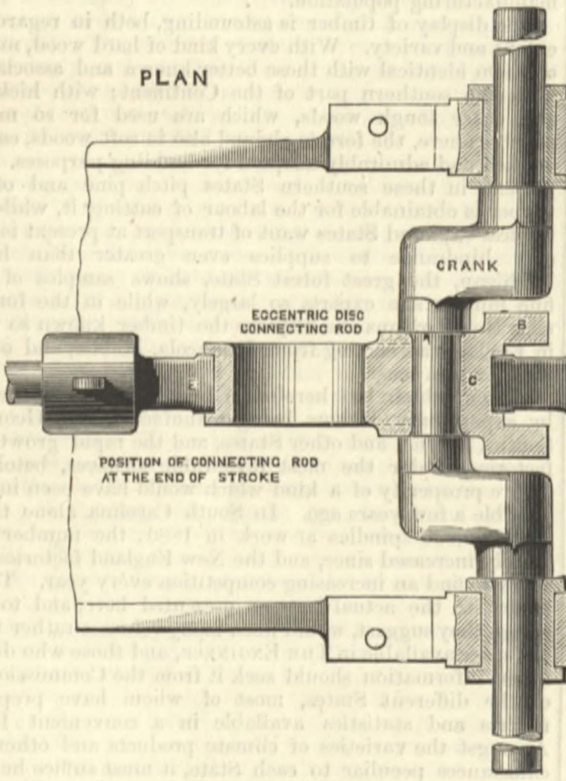
The display of timber is astounding, both in regard to extent and variety. With every kind of hard wood, many of them identical with those better known and associated with the southern part of the Continent; with hickory and other tough woods, which are used for so many purposes here, the forests abound also in soft woods, easily worked and admirably adapted for building purposes. At present in these southern States pitch pine and other timber is obtainable for the labour of cutting it, while in the less-explored States want of transport at present is the only hindrance to supplies even greater than here. Michigan, the great forest State, shows samples of the fine lumber she exports so largely, while in the forests near New Orleans one may see the timber known so well in England as coming from Pensacola, Mobile, and other ports on this coast.

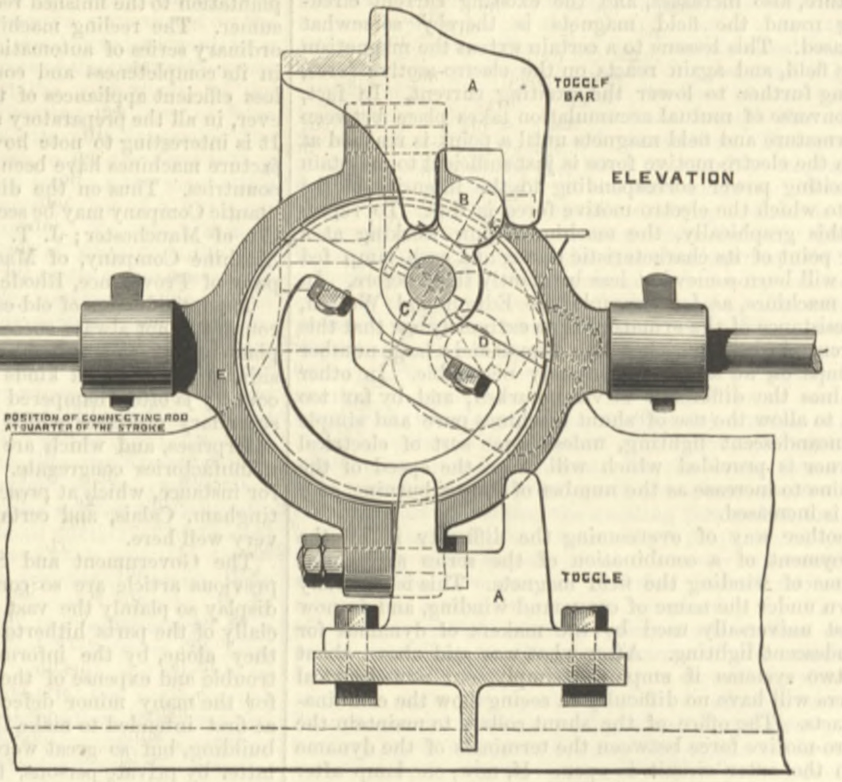
Cotton, which has heretofore been a source of wealth by export only, is now being manufactured in Georgia, South Carolina, and other States, and the rapid growth of factories, under the most favourable auspices, betokens future prosperity of a kind which would have been inconceivable a few years ago. In South Carolina alone there were 100,000 spindles at work in 1880; the number has greatly increased since, and the New England factories are likely to find an increasing competition every year. To do justice to the actual facts as presented here, and to the future they suggest, would need many volumes rather than the space available in THE ENGINEER, and those who desire fuller information should seek it from the Commissioners of the different States, most of whom have prepared reports and statistics available in a convenient form. Amongst the varieties of climate products and other circumstances peculiar to each State, it must suffice here to describe what appears most interesting to metallurgists and engineers in the present condition and rapidly approaching development of the Southern States, particularly Alabama and Georgia. Under one of the galleries of the main building are exhibited the products of the Birmingham Rolling Mills, Alabama. There is nothing very grand or imposing in the display, and if it were shown in Pittsburgh, or Philadelphia, or in Birmingham, England, it would suggest nothing more than the samples of an enterprising firm who manufactured rolled iron in rather more variety than is usual in any one establishment. But coming from where it does, it betokens an approaching revolution in the iron industries of the United States, and even of the world. It can hardly be supposed that the significance of this exhibit was unknown to the authorities here, and it can only be laid to their hospitality in this capital of the South that they gave it so unobtrusive a place and left the conspicuous spaces in the building to exhibitors from the North. But to an impartial observer from Europe, who has no bias either for North or South, it would have appeared more appropriate if Mr. Pullman, with his model train and sumptuous cars, had been moved aside from the central site they occupy to make room for the bars and plates and sheets of the new iron city. A visit to this new Birmingham is, however, necessary to a proper description of it, and this we shall give at another time.

TILBURY DOCKS.—In the recently tried action by Messrs. Kirk and Randall against the *Bullionist* for a libel, in which the defendants had said that the Tilbury Dock works were taken out of the contractors' hands in consequence of Messrs. Kirk and Randall's "failure," the following facts were stated by Mr. Webster, Q.C. :—The original contract was for about £700,000, and under it work had been carried on up to June, 1884. So different, however, had the soil proved to be from what was anticipated, that upon the plant, which originally had been estimated at some £50,000, Messrs. Kirk and Randall had expended upwards of £200,000. Upon this the East and West India Dock Company had paid Messrs. Kirk and Randall only £120,000, leaving a balance of £80,000. Moreover there were retentions amounting to £35,000 upon work certified for up to the end of May, and further there was the value of the work done during June. Thus there were assets amounting to nearly £200,000, quite apart from the larger claims against the Dock Company, which were the subject of an arbitration now taking place.

THE INVENTIONS EXHIBITION—BERNAYS' STEAM PUMPS.







We illustrate above a novel steam pump, the invention of Mr. Joseph Bernays, M.I.C.E., of London, a name that will be well known to our readers as that of the inventor of Bernay's centrifugal pump. The pump now under notice is a decided novelty. The patentee claims for his invention that the new patent pump combines the advantages of direct-acting pumps with those of the fly-wheel type. It admits of the long stroke and simple construction of the former, whilst retaining the steadiness and certainty of action, economy of steam, and accessibility of working parts, of the latter. The novelty consists in making the connecting rod C B of the same length only as the crank, and by the use of two toggles A A to lead the rod to change its position during each stroke from—in the vertical type—above the crank at one end, to below the crank at the other end. The rod thus adds its own length to the stroke at each end, and in that way causes the piston to move through four times the length of the crank, instead of twice only. A simple contrivance keeps all the working parts in their proper relative positions during the stroke, and at the same time relieves the piston-rod from side strain, in consequence of which crosshead guides are dispensed with, and the wearing of the glands avoided. The engraving above shows one arrangement, in which an excentric is combined with the crank and connecting rod. The piston moves accurately in accordance with the true law of the versed sine, both on the in and out stroke; it therefore reaches the cylinder ends at greatly reduced speed, and the slide valve can be set alike for both ends. It is by no means easy to make the action of this gear clear, even with drawings, although it is exceedingly simple, and can be grasped in a moment when the pump is seen at work. It will, however, we think, be understood. If the reader regards the connecting rod end B in the sketch above as a simple cog taking at each stroke into a tooth space A in the toggles, it will be seen that once the end of the connecting rod gets into this space, it is impossible for the piston to continue to make its stroke without causing the crank to revolve. To put what takes place in a very crude form, the crank is "kicked over the dead points" at each stroke by the toggles. The pumps take up very little space, and can be fixed in places where other fly-wheel pumps would be impossible. They are made in all sizes, and can be adapted for any purpose.

We have inspected two of the pumps exhibited. The smaller of the two is a ram pump having a steam cylinder $2\frac{5}{8}$in. in diameter. The ram is $1\frac{1}{2}$in. diameter, with a stroke of 3in., and delivering at 160 revolutions per minute about 180 gallons per hour. The other is a double-acting pump with steam cylinder 6in. diameter, water cylinder $4\frac{1}{2}$in. diameter, and stroke 9in.; the cylinder is lined with gun-metal, and the glands bushed with the same metal. This pump will deliver at an average speed 4800 gallons per hour. Mr. Bernays has granted an exclusive licence for the making of his patent pump to Messrs. T. Larmuth and Co., engineers, of Salford, Manchester, and the various details of construction have been very carefully considered. The firm have several in hand, amongst others specially arranged pumps, available for all general purposes, boiler feeding, &c., and of sufficient power for use as fire pumps in cases of necessity.

THE ROYAL AGRICULTURAL SOCIETY.

Few persons whose duty it becomes to make anything like a detailed examination of the contents of the many rows of shedding to be found in the Implement Department of the Royal Agricultural Show will be at all sorry to learn that this section of the Preston Exhibition, to be held next July, will not be on quite so extensive a scale as its immediate predecessors. The appended figures will enable the reader to compare the facts for himself, so far as regards the total length of shedding allotted at Preston and the preceding five shows:—

Description of Shedding.	Preston.	Shrewsbury.	York.	Reading.	Derby.	Carlisle.
	1885.	1884.	1883.	1882.	1881.	1880.
Ordinary	8,417	9,315	9,569	9,326	9,136	6,662
Machinery-in-motion .	2,063	2,035	1,949	2,289	2,012	2,060
Side sheds	1,520	1,554	1,618	1,402	1,511	1,059
Total	12,000	12,904	13,136	13,017	12,751	9,781

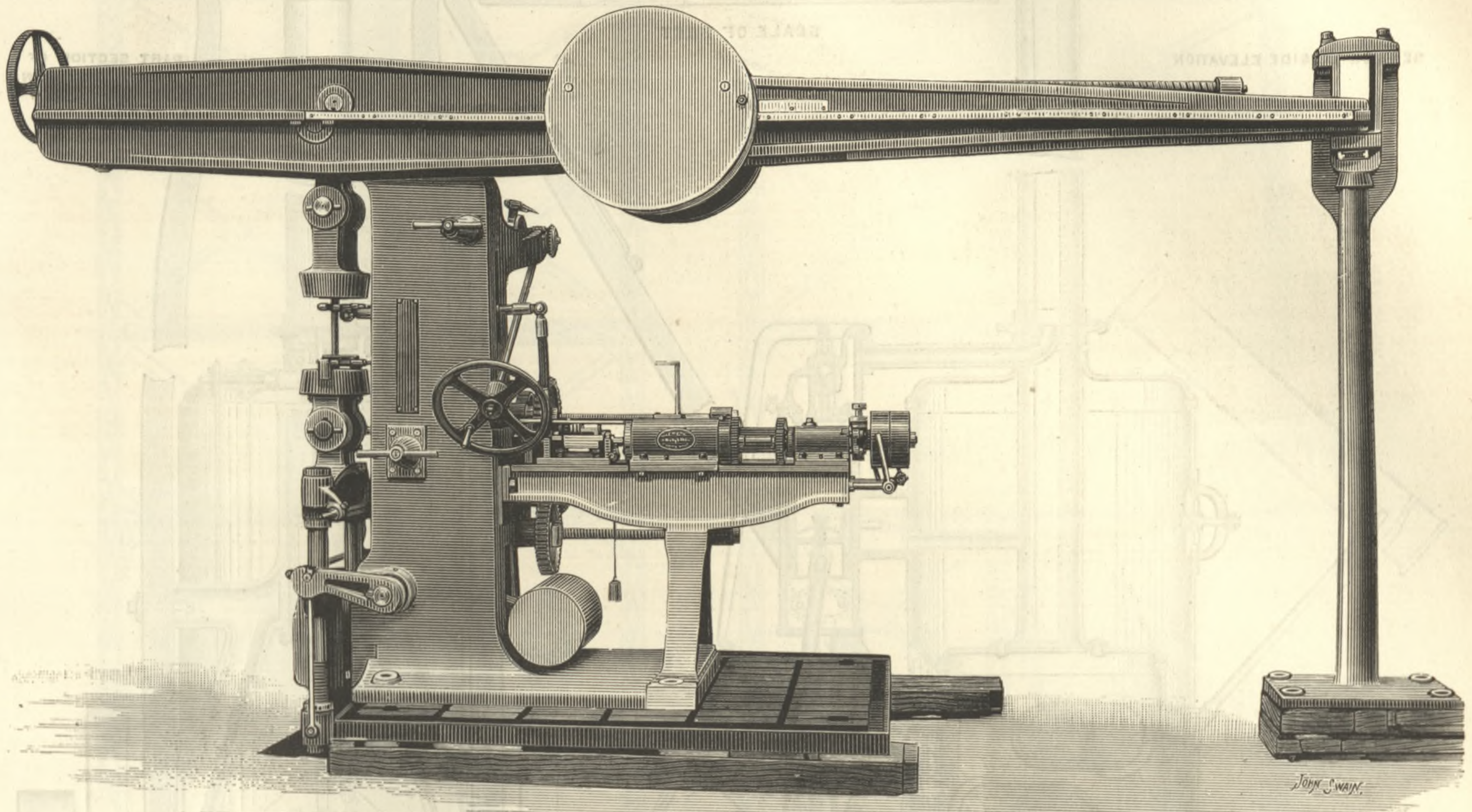
How far the reduced dimensions of the forthcoming show may be attributed to the depressed condition of trade it would be hard to determine. This perhaps has had some sort of influence; but, on the other hand, it may be certainly assumed that the most powerful cause is to be found in the fact that this year there are to be no trials of new implements worth mentioning. The trials, in fact, relate only to harness, whippletrees, and butter packages. Beyond these prizes there is, of course, the stereotyped offer of ten silver medals, which may be awarded in cases of sufficient merit in new implements; and, in addition, the customary power is given to the judges to make special awards of medals for efficient modes of guarding or shielding machinery.

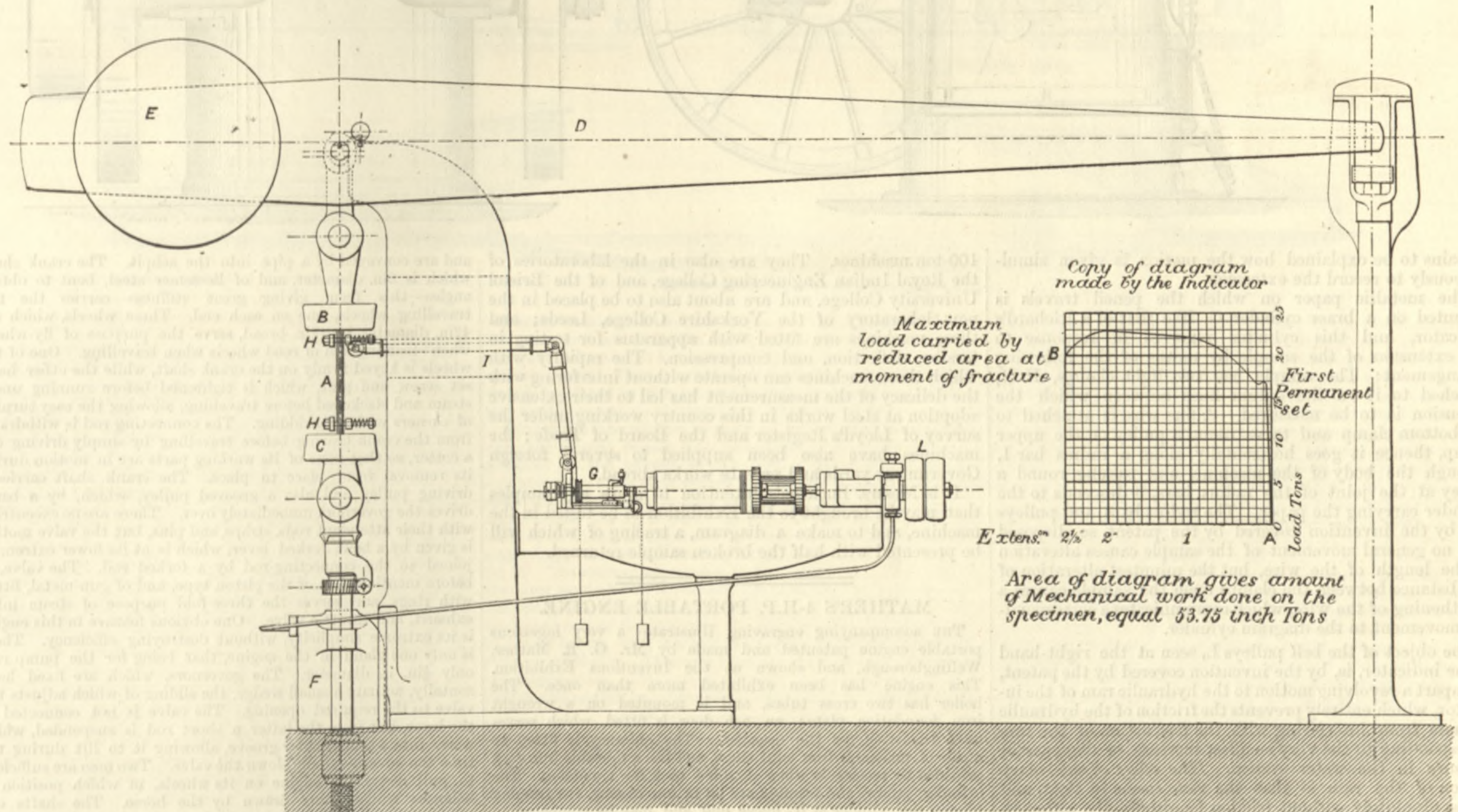
Last week the official statement of accounts relating to the show held last summer at Shrewsbury was made public. The total expenditure connected with the meeting amounted to £14,557 10s. 9d., and the receipts to £16,858 3s. 5d., leaving a balance of £2300 12s. 8d. to be added to the funded capital of the Royal Agricultural Society. The actual outlay for showyard works was £9521 14s. 8d., from which, however, must be deducted the sum of £4971 7s. 9d., proceeds of the sale of materials used, and the charges for work executed for exhibitors and refreshment purveyors, thus bringing the net cost of the showyard works down to £4550 6s. 11d. The latter amount was more than met by the fees charged to exhibitors of implements, the payments for shedding reaching a total of £4225 15s. 6d., and entry fees from non-members amounting to £190. We note, too, that a fine of £25 was enforced for non-exhibition of one of the sheaf-binders entered for trial. The trials themselves appear to have been conducted with much greater regard for economy than on some previous occasions.

Old War Vessels.—The Admiralty are fast clearing the national harbours of the obsolete hulks. In addition to the Caledonia, Hastings, Magpie, Dapper, and Cromer, at Devonport, the Admiralty are offering for sale the Royal Oak, Zealous, Favourite, Netley, and Plover at Portsmouth. It will thus be seen that the fleet of old wooden armour-clads promises soon to be nothing more than a naval tradition. The Caledonia, 6832 tons and 4538-horse power, was launched at Woolwich in October, 1862, and was paid off at Devonport in March, 1875. Her total cost, including engines by Maudslay, was £264,658. The Royal Oak, 6366 tons and 3704-horse power, was launched at Chatham in September, 1862, and was last paid off at Portsmouth in January, 1872, when it was ascertained that it would require about £60,000 to make her good for commission. Her original cost was £234,691, inclusive of £45,310 for machinery by Maudslay. The Favourite, 3232 tons and 1773-horse power, was launched at Deptford in July, 1864, and was finally paid off at Portsmouth in December, 1876, after having in 1869-70 been refitted at a cost for hull and machinery of £6815. Her first cost was £122,423 for hull and £24,016 for engines by Maudslay, Humphrys and Tennant. The Zealous, 6096 tons and 3448-horse power, was launched at Pembroke in March, 1864, at a total cost of £220,079, inclusive of £53,168 for engines by Maudslay. She was paid off at Portsmouth in June, 1875, when, as in the case of the Royal Oak, though two years younger, it was found that £60,000 would be required to prepare her for another commission. Of the entire fleet of fourteen wooden armour-clads only two, the Lord Warden and the Repulse, are in commission.

THE INVENTIONS EXHIBITION—WICKSTEED'S TESTING MACHINE.

MESSRS. JOSHUA BUCKTON AND CO., LEEDS, ENGINEERS.



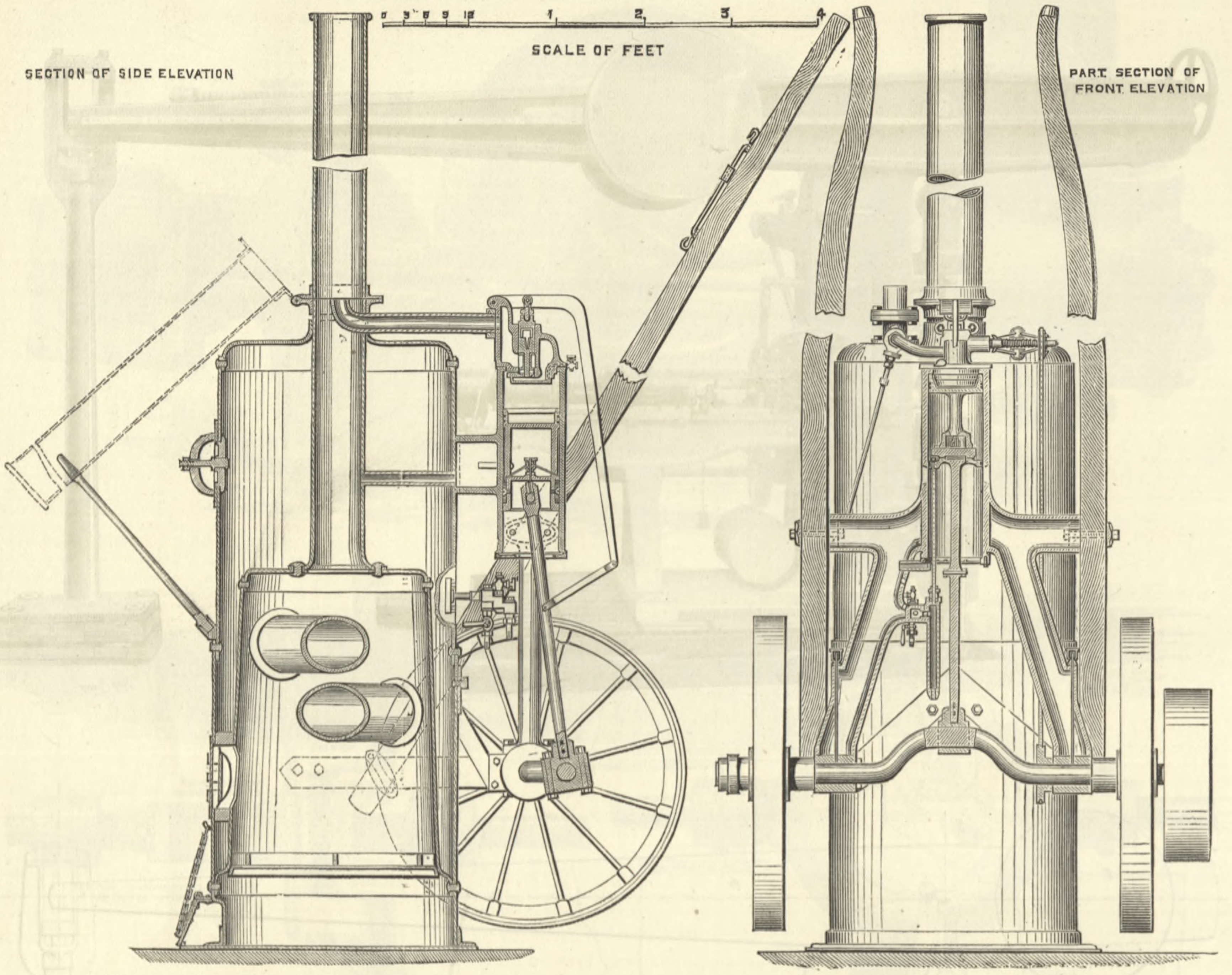


WICKSTEED'S TESTING MACHINE.

THE testing machine shown at the Inventions Exhibition by Messrs. Joshua Buckton and Co., Leeds, presents features of very special interest to all who are concerned with the testing of iron and steel. For the first time almost, Mr. Wicksteed has enabled the material under test to record its own behaviour, and this by a method involving the use of exquisite mechanical devices, depending on the discovery of a new principle. The well-known single-lever testing machine of the firm is fitted with a new patent autographic indicator. This traces a line upon metallic paper, showing exactly the extension of the sample as the load upon it increases. A reduced copy of one of the diagrams is shown in our engraving. The height of the figure represents the load in tons, and the length of it the extension in inches. The line indicating the behaviour of the test pieces begins at A and ends at B. It will be seen that the line rises to 17 tons with very little lateral movement to show extension. At that point it records a sudden extension of the sample without any additional load. This is the first permanent set of the material. After about ¼in. of this lateral movement the line makes an ascending curve, showing a rapidly increasing extension in proportion to the added load, until it reaches a height indicative of 23 tons of load with 2·1in. of extension. At this point the descending line begins to show a diminution of the load carried, while the extension of the sample continues till it breaks at B. This reduction of load takes place owing to the rapidly decreasing area of the sample before it breaks. This rapid decrease begins when the extension leaves off, being general throughout the length of the sample, but becoming rapidly localised in that part of the sample where it is going to break. The indicator is extremely sensitive, and records the smallest alteration of load upon the sample, together with the accompanying extension due to that load.

A general explanation of the action of the whole system of testing may be given as follows:—The sample A is held between an upper gripping box B and a lower gripping box C. The upper box is suspended from the back centre of a steelyard D, which weighs by the adjustment of its poise weight E whatever pull is put upon the sample. The lower box is connected with an hydraulic ram F, which puts the pull upon the sample and extends it until it breaks. Thus, while the hydraulic system is doing the mechanical work of breaking the sample, the steelyard system is accurately measuring the load it is sustaining. The object of the indicator is simultaneously to record the amount of load and the extension due to that load, and the area of the diagram gives the amount of mechanical work done in breaking the sample, which may be conveniently expressed in the equivalent of tons lifted 1in. high. To get this simultaneous record, the ram of the indicator which carries the pencil is in fluid connection with the hydraulic system that puts the load upon the sample, and the indicator therefore partakes of that load; and as the load is measured by the steelyard, so the reading from the steelyard determines the scale of the diagram. Thus in the indicator the water system imparts the movement to the pencil, but the steelyard system assigns the value to that movement. It

THE INVENTIONS EXHIBITION—MATHER'S PORTABLE ENGINE.



remains to be explained how the motion is given simultaneously to record the extension.

The metallic paper on which the pencil travels is mounted on a brass cylinder G, like that of a Richard's indicator, and this cylinder revolves in response to the extension of the sample by means of the following arrangement: The sample has two light clamps, H H, attached to it on the datum lines between which the extension is to be measured. A fine wire is attached to the bottom clamp and turns round a pulley on the upper clamp, thence it goes horizontally along a radius bar I, through the body of the machine, and passing round a pulley at the joint of the radius bars, it descends to the cylinder carrying the paper. The radius bars and pulleys are, by the invention covered by the patent, so disposed that no general movement of the sample causes alteration in the length of the wire, but the minutest alteration of the distance between the clamps upon the sample causes a lengthening of the wire, which communicates a corresponding movement to the diagram cylinder.

The object of the belt pulleys L, seen at the right-hand of the indicator, is, by the invention covered by the patent, to impart a revolving motion to the hydraulic ram of the indicator, which entirely prevents the friction of the hydraulic leathers from interfering with the free action of the ram in responding to the very smallest increase or decrease of pressure in the water system. The effect of the rotary motion of the ram is that the ram seems to float, and moves absolutely without friction longitudinally, although very considerable power is needed to cause its rotation, a 4in. strap being required to rotate it at about 120 revolutions per minute. The delicacy of this response is shown by the behaviour of the pencil at that part of the diagram where the permanent set takes place, and again by the drooping curve after the power of the sample to carry the maximum load is passed. It will be seen that this system of testing is almost equivalent to loading the sample with actual weights, seeing that the load sustained by the sample is a dead weight of one ton acting through a single lever of the first order, this lever having for its fulcrum a long knife-edge which vibrates without appreciable friction, even when supporting a load of fifty tons. The purely horizontal movement of the poise-weight imparts no unrecorded strains to the sample, and the water pressure is brought to bear without impact. The whole machinery may be worked so quickly as to break twenty pieces in an hour, and this without introducing any errors from unrecorded strains.

The accuracy of these single lever dead weight testing machines has led to their adoption by Professor Unwin at the new laboratory of the City and Guilds Institute for Technical Instruction adjoining the Exhibition building, where he has just put down one of Messrs. Buckton's 100-ton machines. They are also in the laboratories of the Royal Indian Engineering College, and of the Bristol University College, and are about also to be placed in the new laboratory of the Yorkshire College, Leeds; and these machines are fitted with apparatus for testing in torsion, deflection, and compression. The rapidity with which these machines can operate without interfering with the delicacy of the measurement has led to their extensive adoption at steel works in this country working under the survey of Lloyd's Register and the Board of Trade; the machines have also been supplied to several foreign Government yards and private works abroad.

It is Messrs. Buckton's intention to allow any samples that may be brought to the Exhibition to be tested in the machine, and to make a diagram, a tracing of which will be presented with half the broken sample returned.

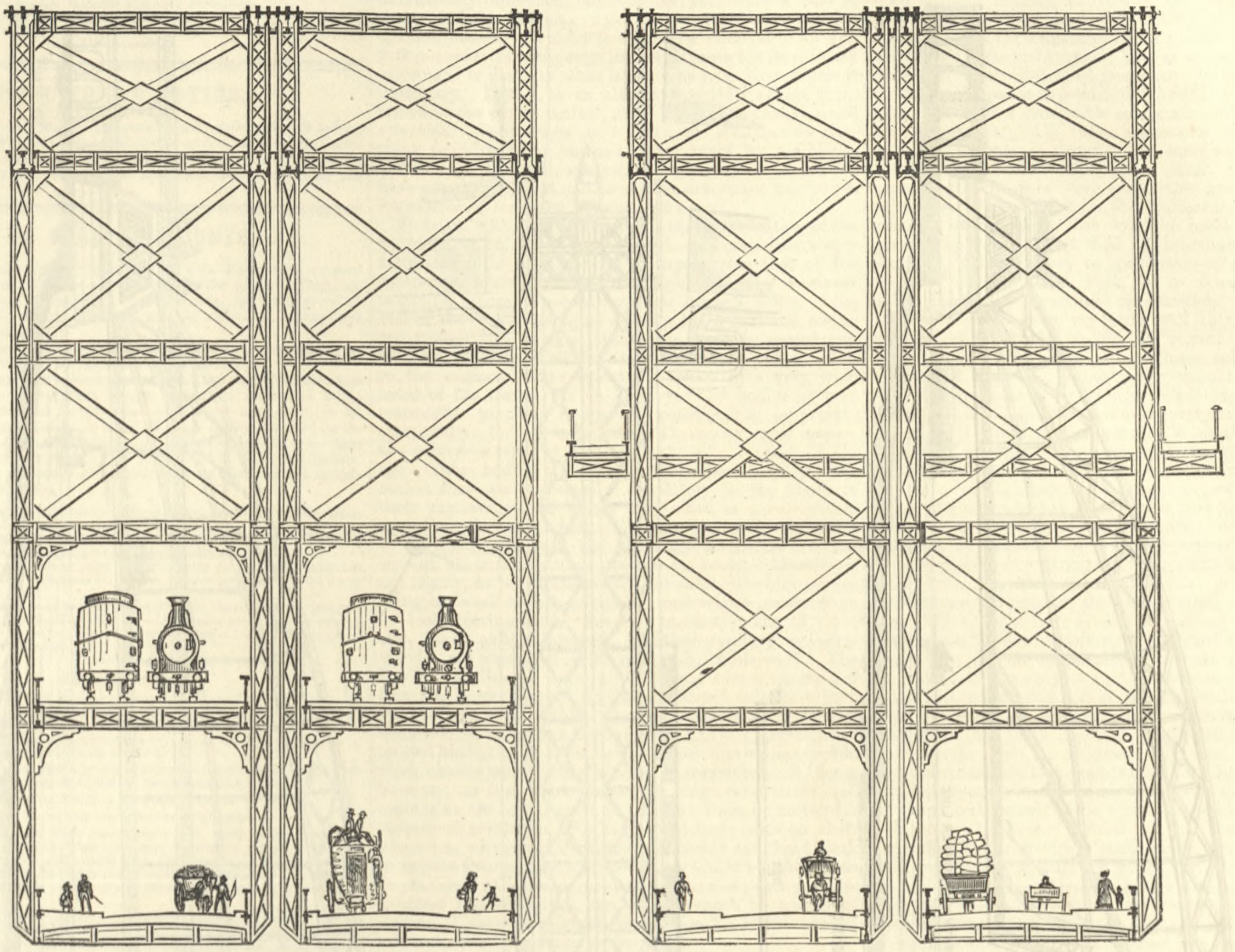
MATHER'S 4-H.P. PORTABLE ENGINE.

THE accompanying engraving illustrates a very ingenious portable engine patented and made by Mr. G. R. Mather, Wellingborough, and shown at the Inventions Exhibition. This engine has been exhibited more than once. The boiler has two cross tubes, and is mounted on a wrought iron foundation plate; an ash door is fitted, which serves as a regulator for the draught. The chimney is fitted to a pair of malleable iron joint rings, and has a movable iron fork provided to receive it when doubled back for travelling. The cylinder, guides, and framing are all in one casting, the framing joining the cylinder at its lower end, and may be compared to arms and legs, all of which are cast hollow and are of great strength. To the arms and horizontal side stays, afterwards mentioned, are clipped the wood horse shafts; to the legs are bolted massive adjustable bearings, and to these bearings are bolted four wrought iron stays, the ends of which are bolted to the boiler; two running to the side horizontally and two to the centre obliquely.

On the back of the cylinder is cast a bracket of the same radius as the boiler, to which it is secured by bolts. On the left leg is formed a hollow bracket, to which the feed pump barrel is bolted by two bolts; the joints, which are faced, being made with paper for easy removal. To the back of the bracket is attached the treble valve-box, the upper end of which joins the boiler. The cylinder cover or head contains the steam and exhaust openings and piston valve, and also carries the governors. The piston and crosshead are in one casting; the upper end is dished, and fitted with two rings, and the lower end is fitted with one ring immediately under the slide plates, which are adjustable. A lubricator is fitted to the crosshead, having three outlets, one central, oiling the upper end of the connecting rod, and the other two conveying oil to the slide plates. The pump plunger is screwed into the crosshead flange. The lower end of the cylinder is covered by a drip pan, provided with a central slot, through which the connecting-rod works. The drippings are conveyed by a tube into the hollow leg frame, and join any leakage that may arise from the pump plunger, and are conveyed by a pipe into the ashpit. The crank shaft, which is 3in. diameter, and of Bessemer steel, bent to obtuse angles—this form giving great stiffness—carries the two travelling wheels, one on each end. These wheels, which are 42in. diameter by 4½in. broad, serve the purpose of fly-wheels when steaming and of road wheels when travelling. One of the wheels is keyed firmly on the crank shaft, while the other has a set screw and glut, which is tightened before running under steam and slackened before travelling, allowing the easy turning of corners without skidding. The connecting-rod is withdrawn from the crank bearing before travelling by simply driving out a cotter, so that none of its working parts are in motion during its removal from place to place. The crank shaft carries a driving pulley and also a grooved pulley, which, by a band, drives the governors immediately over. There are no excentrics, with their attendant rods, straps, and pins, but the valve motion is given by a bent forked lever, which is at its lower extremity joined to the connecting-rod by a forked rod. The valve, as before mentioned, is of the piston type, and of gun-metal, fitted with rings, and serves the three-fold purpose of steam inlet, exhaust, and throttle valve. One obvious feature in this engine is its extreme simplicity, without destroying efficiency. There is only one gland in the engine, that being for the pump-rod, only ⅝in. in diameter. The governors, which are fixed horizontally, actuate a small wedge, the sliding of which adjusts the valve to the required opening. The valve is not connected to the lever, but from the latter a short rod is suspended, which works into a semicircular groove, allowing it to lift during the time the governors hold down the valve. Two men are sufficient to pull down the engine on its wheels, in which position it balances whilst being drawn by the horse. The shafts can before running, if desired, be withdrawn by slackening the clip nuts, or they can be retained in position. The piston and valve may be taken out and replaced in a few minutes, without breaking and joints and without the usual tools. There is a pipe fitted from the exhaust to heat the feed-water before passing into the boiler. There being two fly-wheels and also a pulley, a strap can be led from each of the wheels, thereby, in many cases, saving the necessity of a main shaft. Another good feature in this engine is that the cylinder is open at its lower extremity, whereby any serious leakage past the piston rings may be detected and remedied, thereby preventing waste of fuel. A tube is fitted from the cylinder bracket through the boiler into chimney flue, carrying off any slight leakage, thereby preventing inconvenience. These engines have now been two and a-half years under test, and give, we understand, satisfaction. They are at present made in two sizes—2½ and 4-horse power. As the working parts are all in compression, they seldom necessitate adjustment, as no knocking would be heard even under considerable wear.

SOUTH KENSINGTON MUSEUM.—Visitors during the week ending May 2nd, 1885:—On Monday, Tuesday, and Saturday, free, from 10 a.m. to 10 p.m., Museum, 12,308; mercantile marine, Indian section, and other collections, 4385. On Wednesday, Thursday, and Friday, admission 6d., from 10 a.m. to 6 p.m., Museum, 2152; mercantile marine, Indian section, and other collections, 245. Total, 19,090. Average of corresponding week in former years, 17,037. Total from the opening of the Museum, 23,965,100.

CROSS SECTIONS OF PROPOSED LOW-LEVEL TOWER BRIDGE.



WITHOUT OPENING SPAN — WITH OPENING SPAN

DIAGRAM SHOWING STAGING AND LAUNCHING ARRANGEMENT

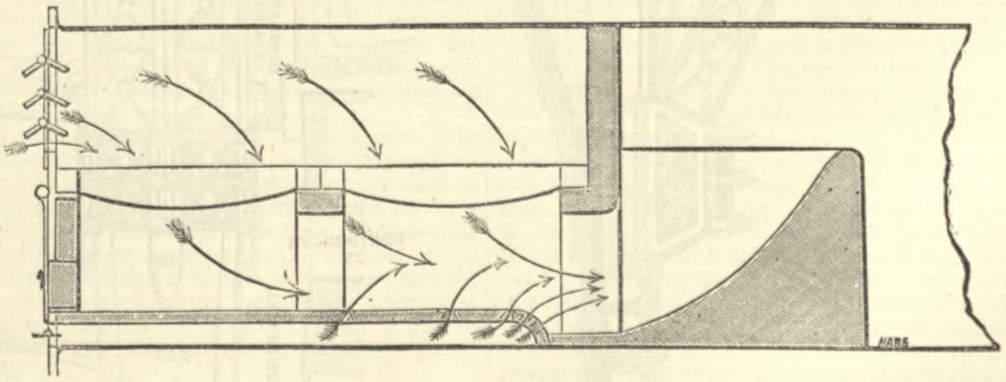
DESIGN FOR THE TOWER BRIDGE.

On another page we express our views as to the scheme of the Corporation now before Parliament, and the following is a description of the design proposed by Mr. R. M. Ordish and Mr. Ewing Matheson, as illustrated above and on page 460:—The bridge is in one span of 850ft., with four main ribs or arches of wrought iron or steel. The thrust of the arches would be taken on masonry abutments built on concrete foundations on the London clay, which is well suited to sustain such a load. The roadway is suspended from the arched ribs by vertical members strongly braced together, and in the centre a portion of the roadway is movable and made to hinge upwards as a bascule bridge, leaving an opening 120ft. wide and 120ft. high for vessels to pass through. The arched form of the bridge, its width, and its great weight, not only afford sufficient stiffness and stability against wind pressure and the strains caused by the traffic, but in regard also to the possible collision of vessels passing through the bridge, the structure would have ample strength. Even at high water the bridge would be clear above the hulls of the largest steamers navigating this part of the river. The one clear opening of 120ft. in an unobstructed tide-way, as here proposed, would afford as great facility for navigation as the wider opening proposed in the Corporation design, where the channel is obstructed by large piers in the centre of the river. If, however, it were deemed important to provide a wider opening than here proposed, the design would admit of an opening of 150ft., or even 200ft. This is, however, deemed unnecessary and inexpedient. In regard to the future addition of a railway, which is contemplated, if the time should arrive when the movable part of the bridge was no longer opened, it is proposed to carry the four lines of rails above the road traffic, as shown in the cross section above, namely, two lines above each roadway, this higher level being as necessary for the railways as the low level is for the street traffic. The bridge would be erected as follows, as shown in the engraving on this page:—On either shore of the river suitable staging would be erected to carry a half-span of one pair of ribs, and during the building of these ribs the road traffic below could be arranged to pass through openings in the staging. By means of a sufficient counterweight at the shore end balancing the overhanging weight of the rib, the staging could be removed, and the half arch propelled forward over the river on a suitable cradle resting on the approaches till it met the corresponding half arch in the middle of the stream, and the two halves would then be united. The second pair of ribs could then be erected in the same way, and then braced to the first pair. From the arch ribs the platform of the bridge would then be suspended and braced, leaving open in the centre of the bridge a gap 120ft. wide for the movable part. This gap would be filled by a bridge in two halves, each hinged, and with a counterpoise so arranged as to afford at all positions while moving in the segment of the circle, the altering weight necessary for a balance. Only a moderate force would, therefore, be required, and this could be conveniently obtained from the mains of the Hydraulic Power Company now laid along the banks of the river, and constantly charged with water at a pressure of 700 lb. per inch, or by other motive power. The counterbalance weights and mechanism would be placed in the spaces available inside the arched ribs, and would present no obstruction to the road traffic.

During the interruption to the road traffic while the bridge is open for masted vessels, foot passengers could cross by stairs attached to the outside of the main ribs, as shown in the engravings. If the time arrives for the closing of the opening span, it would be easy to alter the moving part of the bridge to make it like the fixed part. If then or thereafter a railway were to be added, an upper floor could be placed, as shown in the engravings, some of the bracing being removed to make room for it. The railway approaches to the bridge on either side of the river would be on a viaduct, which would be made in convenient spans, so as not to impede the road traffic below. The estimated cost of the bridge in the first instance—that is to say, as a road bridge, with mechanical opening and without the railway—is £820,000. This sum does not include the cost of land or compensation. The cost of altering the structure to a closed bridge and adding four lines of railway would be about £20,000.

WELFORD'S PATENT FURNACE.

This patent furnace, illustrated by the accompanying cut, and patented by Messrs. R. and W. Welford, of Sunderland, has been designed more especially for the complete combustion of bituminous coal, but with every kind of coal it will, it is claimed, give most economical and smokeless combustion, and with any boiler it may be used to replace the ordinary furnace. The annexed sketch shows a longitudinal section of the furnace in a Cornish boiler. The apparatus consists of an open fire-door in which are fixed shutters, a fire-brick fire-grate, closed hanging bridge, closed ashpit lined throughout with fire-brick, a bottom air flue underneath the ashpit, and a fire-brick flame bed or regenerator. The shutters or venetians in the fire-doors are so arranged as to prevent the air from striking the top of the flue, and at the same time prevent the radiation of heat into the stokehole. The closed hanging bridge causes a down draught through the grate, which renders it necessary that the ashpit should be closed at its front end. The bottom air flue has perforations for the admission of a fixed quantity of fresh, pure air. The flame bed is so arranged as to throw the heated products of combustion against the top of the flue to be utilised—at first here—for the generation of steam. The fuel is fed on to the grate in the usual manner, and the draught is regulated by the venetians. The major portion of the air to effect combustion comes through the fire-door, the solid fuel being distilled into the ashpit as gaseous fuel, having passed through the layers of red-hot coal in full combustion. The gaseous fuel and flame are maintained at a high temperature by the practically non-absorbent surfaces of fire-brick in the ashpit, and being met by currents of fresh, pure air from the air flue underneath, final combination takes place, and the gases are completely burnt. It may be stated that the air in the flue below the ashpit is necessarily heated, which, of course, effects the combustion more readily; also, that without the lining of fire-bricks in the flame chamber, the degree of heat would not be sufficient for the decomposition of the hydrocarbon compounds. It is claimed that the intimate mixture of the gases with the air causes a very small excess of air to be used, and produces that complete and smokeless combustion which is not possible with any other arrangement. The system



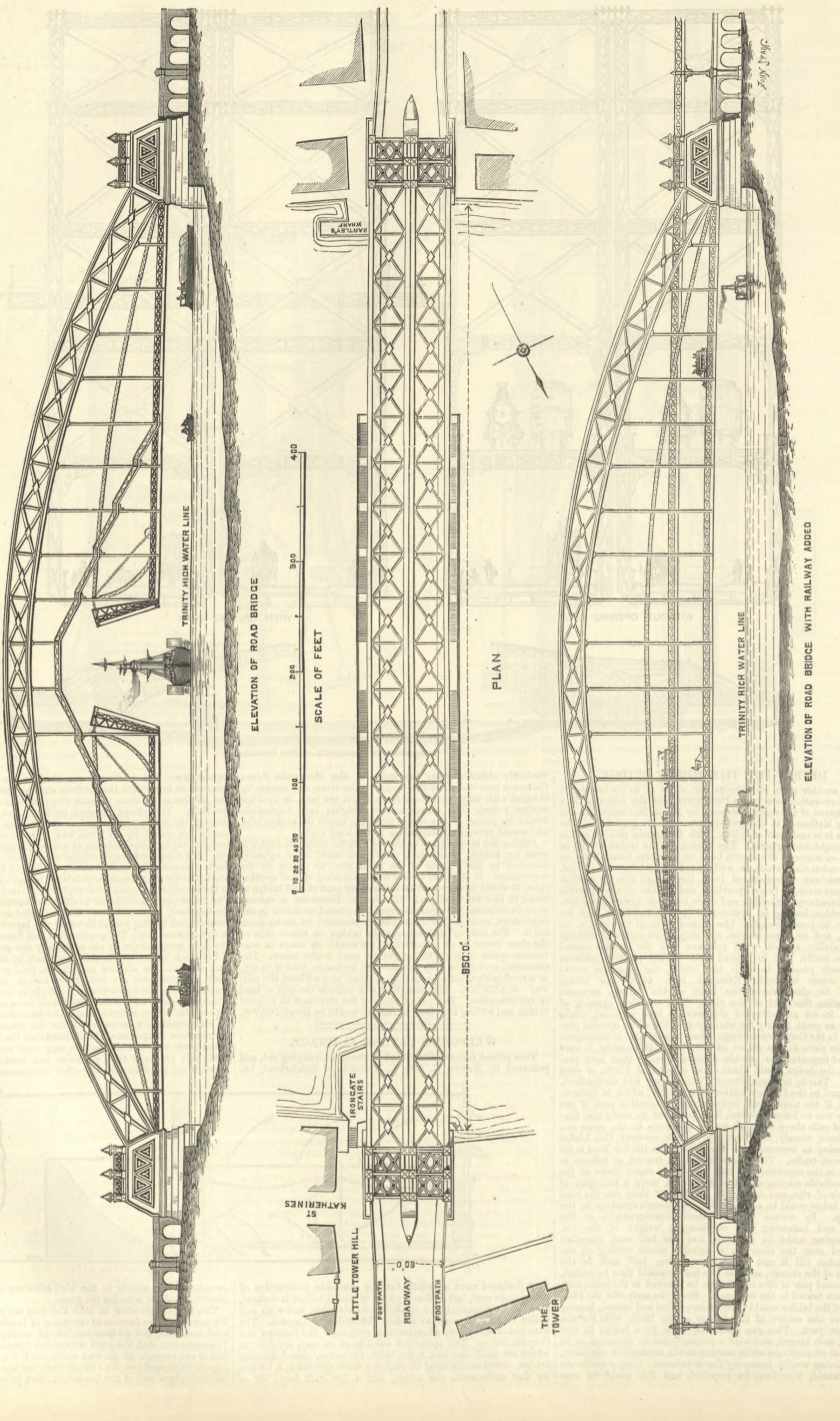
owes its success mainly to the high efficiency of the refractory material used for forming the grate.

This grate is peculiar in that the bars are made of fire-clay. We have seen the furnace in operation in London, and found it work very well, but we have carried out no experiments with it. The mere fact that the gases are carried downward through the fuel is not enough to prevent smoke, and the efficiency of the apparatus depends on the arrangement for the admission of air below the bars and of the fire-bricks there provided.

PROPOSED LOW LEVEL TOWER BRIDGE.

MESSRS. R. M. ORDISH AND EWING MATHESON, ENGINEERS.

(For description see page 359.)



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J. D.—*You are using carbons too small for the current. For 17 to 18 ampères less than No. 12 is too small.*

L. S. (Portsmouth).—*The odontograph was invented by Professor Willis, of Cambridge, and is sold by Messrs. Holtzappfel, Charing-cross.*

E. H.—*The water you use is so pure that it attacks the iron in a way well understood, and the rust causes its colour. There is no cure but the use of a galvanised iron boiler.*

P. F. (Loughborough).—*As you have more draught than you want, you will gain an advantage by putting thick ferrules into the tubes which appear to you to draw most steam into them. This will cause a better distribution of the products of combustion.*

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MEETING NEXT WEEK.

ASSOCIATION OF MUNICIPAL AND SANITARY ENGINEERS AND SURVEYORS.—Midland Counties District Meeting at Nottingham, Saturday, May 16th. Business: At 11 o'clock, to elect district secretary. The following papers to be read:—"Results and Advantages of the Meter System in Domestic Consumption," by Geo. Winship, Borough Surveyor, Abingdon. "Five Years' Municipal Work in Nottingham," by A. Brown, Borough Engineer, Nottingham. At 12.30, visit to Sir J. Oldknow's Lace Manufactory; Work and Ways Depôts, Stables, &c.; Health Depôt—Destructor and Pail Closet System; London Road Paving Works; Trent Bridge; Nottingham Castle Museum; and, if time allow, other objects of interest. The members will then return to the Council Chamber and discuss the papers, &c.

THE ENGINEER.

MAY 8, 1885.

ENGINEERS AND CONTRACTORS.

WE have more than once commented on the business relations existing between engineers and their contractors during the performance of any given work, and it is with some regret that we find occasion to return to the subject. At present, contractors as a body have, or believe they have, certain grievances in connection with the terms of specifications, the mode of letting contracts, and the conditions insisted upon by engineers under which the work is to be carried out. The list of these alleged grievances may be put concisely as follows:—(1) That engineers do not certify for the full value of the work done, some men certifying for only 90 per cent., others for 80, a few as low as 75. (2) The security demanded, complaint being made that not alone is 15 or 20 per cent. of the value of the work retained or kept back, and the whole of the tools and plant constituted a legal pledge—not being deemed the property of the contractor till the work is completed and passed—but in addition the contractor is called upon to provide two substantial securities or bailsmen to join him in a bond equal to one-fourth of the amount of the contract. (3) The stipulation that the contractor shall take out his own quantities. (4) The clause constituting the engineer absolute and final judge in all matters of dispute arising during the progress of or before the work is finally accepted. That ground of dissension should exist between engineers and contractors is a great evil; that either party should fancy it has a grievance against the other is almost equally bad; and the sooner such ground, whether real or imaginary, is removed, the better, not only for the parties immediately concerned, but also for their clients, who in many, probably the majority of cases, are public, corporate, or other bodies. In order to effect the removal of an evil it is necessary first to gauge its extent; seek out its primary cause; and to dissever what is genuine from that which is imaginary. In this, as in all other worldly affairs, there are two sides to the matter, and both must receive equal attention. Contractors as a body are sensitive to anything touching their business—over much so, we think, sometimes. We will analyse the grievances which we have enumerated, and endeavour to determine how much foundation of fact they have to rest upon.

To begin with, the circumstance that the position of the engineer, in reference to the work in hand, differs very materially in its social or moral aspect from that of the contractor, must never be lost sight of. The engineer works for others; the contractor for himself alone. Like Hal of the Wynd, he fights only for his own hand, owing responsibility to no one. Once his work is passed and paid for, his responsibilities are to all intents ended. Not so the engineer. He works for others in a very wide sense of the term. He is employed by bodies of men responsible to their ratepaying constituents, or private shareholders, for the outlay of public money, trust money, the private savings of a lifetime, the sole support of old age. These bodies seldom number experts among their ranks; they are necessarily absolutely in the hands of their engineer, whose advice they must, as a rule, either accept or reject as a whole. The engineer's responsibilities by no means end with the discharge of his duty to his council, his building committee, or his board. Morally, if not legally, he is responsible for the safety of every person using the work he has originated, and whose construction he has superintended. From a business point of view, also, great public interests, whether sanitary or commercial, are concerned in the soundness of his work. The Tay Bridge disaster was a painfully accentuated example of this; and however much Sir Thomas Bouch must have been sympathised with, still his share of responsibility for that affair seemed more than he could bear, and it is possible accelerated his death. The contractor's association with any given work usually ends when the work is completed. So long, however, as that work exists, its engineer's name and reputation are bound up in it. Can it, then, be matter for surprise if gentlemen who have spent large sums on their education, who have given years of study and hard work to acquire their special knowledge, should, when they come to practise that knowledge, attended, as the practice is, by so great responsibilities, can it, we repeat, be matter of wonder if they take every precaution to guard against mishaps, either structural or financial?

Contractors aver that certain conditions bear hardly upon them, and at a time when competition already presses them sore. But to begin with, from a generic point of view, the conditions complained of have nothing to do with competition. If they bear hardly at all, their incidence is not on individuals, but on contractors as a body. Competition does not affect this. Passing from this to detail, and examining each of the items of complaint in the order we have enumerated, then the first is that a full certificate is not given. In reference to this, contractors will scarcely dispute the fact that the entire conduct of their business involves investment. Why, then, should their voluntarily made agreement to invest a percentage of their payment in the work during its progress—to become, as it were, mortgagees of it—be a hardship, bearing in mind that their business foresight induces them to charge good interest by allowing for it, or taking count of it when sending in their tender? One man may perhaps say, "Competition is too keen to admit of my doing so;" but this is no more an argument than if he were to say, "I dare not charge more than such or such a percentage for profit on the job." Besides this, if the engineer will not give the money, a banker will, and at a percentage probably less than the mortgage interest charged by the contractor himself. The holding of the tools and plant in pledge during the progress of the work cannot be in any sense upheld as a grievance. Until the work is complete it is useless to the contractor, or, at all events, unavailable to him for anything else. A certain advantage to him, too, exists in this same lien held on it. The lien is equivalent to a protection order; and even if the contractor get into difficulties, his plant at the works is safe from his creditors—an immense advantage, as preventing a forced sale of it at perhaps a ruinous loss. The system of bails or bondsmen is not universally pursued; some very eminent engineers dispense with it, deeming it in most cases more trouble than value. The third grievance is that the contractor should have to take out his own quantities. This grievance is generally more imaginary than real. In works of moderate size an old hand at contracting can very rapidly and accurately estimate the quantities; while if the work is extensive the profits margin will certainly, either by direct computation or incidentally, defray the cost of a quantity clerk's time. Besides, we can hardly imagine any better system than that where the engineer, on behalf of his employers, estimates the cost of his work, which is subsequently checked by the contractor. "Out of the mouths of two or three witnesses" begins an adage applicable here. Suppose the engineer takes the responsibility of the correctness of the bill of quantities, and, being human, is therefore fallible, and an error is discovered during the progress of the work, what a field for dissension, friction, and delay is opened up! How much better that such things should be found at the outset.

The fourth item of contractors' complaint has long formed a burning subject, and we have commented ourselves upon it in our columns. The arguments we have advanced above in reference to the difference between the engineer's position and that of the contractor applies in an eminent degree here also. Besides this the engineer may fairly say, "I must be the best judge of what sort of thing I want." He may, and usually does, follow precedent—too much so very often—when drawing a specification; but he by no means binds himself to do so, and it is a habit for the contractor instinctively to assume that he does so bind himself, and hence the trouble. When a dispute arises, either as to the quality of material or of workmanship, the contractor takes up the standpoint that the thing is reasonably good; that is to say, he appeals at once to a vague, ill-defined precedent; he implies that the work or material is as good as that usually put in like work, and that it is a reasonable compliance with the terms of his agreement. All these arguments we have heard advanced in times of dispute. To some extent engineers are to blame about this more than contractors, for some engineers draw very formidable specifications certainly, but do not insist on the fulfilment thereof. This practice unfortunately has wrought much mischief, and given rise to a great deal of heartburning and dissension. The true way to get good—to get the best—class of materials or work is to draw a moderate and thoroughly practical specification and to print thereon a notice that its terms will be rigidly exacted, and to stick firmly to it. In regard to the terms of the clause constituting the engineer sole judge in all matters of dispute, the contractor should bear in mind that the engineer is not judge in his own cause; in no sense is he so. A great deal of misapprehension exists in the contractorial mind on this point. Were the engineer his own client even, all the same he has a perfect right to insist on getting that which he described and is willing to pay for; just as much right to get a girder, a pier, or a steam engine, as he has to get a coat that fits him, or a pair of gloves of such fashion as pleases him. At the same time, inasmuch as too many engineers have, may we venture to say, in times past, been ordering one thing and accepting another, it is a little excusable if contractors as they glance over—they seldom, we fear, read or thoroughly study—a specification say: "H'm! a lot more is asked here than will be actually insisted on." We ourselves have heard it said: "These things are put in specifications, but are never exacted." It is excusable, we say, if contractors reckon on this when framing a tender, and it is of the highest importance that, where possible, the engineer should refer those invited to tender for his work to some particular example of it done in the style he requires. In case the contractor visits and inspects this example, he then begins operations with his eyes open. If he neglects to do so, he has no one to thank but himself if he comes to trouble afterwards.

We have felt it our painful duty to thus far give our judgment in the growing controversy between engineers and contractors against the latter, but *Fiat justitia, ruat cœlum;* and the contractors allege a grievance which, if they can substantiate it, is very vexatious. We refer to their statement that an undue delay exists in the making public a notification that a contract has been let, and the return of the caution money lodged by each firm applying for the papers of an advertised job. Contractors allege cases where the caution money has been £5, which is lodged in the engineer's clerk's bank to his own account; that no receipt or acknowledgment is given to the payer of the money; that a cheque, which would form at least a constructive receipt, will not be taken, and that the money is not returned except at the clerk's own convenience. All this, if substantiated, ought to be reformed. In nothing can an engineer more fully display genuine ability than in the smoothness which characterises the execution of his contracts.

THE TOWER BRIDGE.

THE very severe inconvenience which has been felt by the great trading communities of East London seems more likely now than at any time to be speedily ended. Our readers are already well acquainted through our columns with what has been proposed by the City Architect to meet the decision of the Corporation to adopt a low-level opening bridge at the Tower. The Bill of the City of London Corporation seeking powers to construct a bridge of this character, and in accordance with the outline idea of Colonel Heywood, as illustrated in THE ENGINEER, 31st October, 1884, has been read a second time before the House of Commons, and is this week before a Committee of that House. The design and construction of a bridge across the Thames at Tower-hill is, however, a matter of much importance, and the result to be obtained is one which may have either inestimably beneficial advantages, or be attended with almost disastrously undesirable effects, so that the mode of procedure adopted in obtaining a design ought to be free from any of the defects which are so very likely to accrue from the hasty adoption of plans which could not afterwards be said to represent the best bridge-designing talent of the day. By the mode of procedure now adopted, the design of one engineer, confirmed as to feasibility by a second engineer, and hurried into consideration by a Committee without any alternative designs, is not at all satisfactory. There is no opportunity for independent views to gain a hearing in the Committee, and it therefore becomes a duty to draw attention to the dangers involved.

We have always, as is well known, advocated the construction of a low-level bridge, and are glad to recognise in the design now presented to Parliament a fair effort to secure for East London a bridge of the character most suited to the requirements, but at the same time we must say that the design is so far faulty that it is to be sincerely hoped that it will not be sanctioned by law. When the Board of Works' Bill for a tunnel was thrown out by the Committee of last year, it was recommended that a low-level bridge with mechanical openings should be constructed, and that the work should be done by the Corporation of the City of London; but so far as the project has yet proceeded, the Corporation has failed to make the most of a grand opportunity for benefitting London by a public work which might also be a great public ornament to the metropolis. There are, as the lapse of time in the discussion of the subject proves, some difficulties connected with the construction of a bridge east of Rennie's bridge, which are of no mean order. These are not, however, of an engineering character, but are the outcome of opposing interests, many of which are of a curiously mistaken class, and result from a failure to recognise the real character of the work to be done, and its effect.

Generally, it would have been supposed that the desire of the Corporation would have been to erect the best bridge that could have been designed; and that for this purpose all available aid from the designers of bridges in this country and abroad would have been enlisted, so that no essential ideas should be lost. This plan was adopted by the Government in obtaining the designs for the Law Courts, and more recently for the War-office and Admiralty buildings; it must be admitted, however, with doubtful success. The City Corporation seemed to think that one able man could represent all necessary talent, and thus instructed the City Architect to design a bridge, just as they would instruct him to design a market or a Council chamber, apparently oblivious of the fact that to design a large bridge to meet special requirements is a work which few men can do well, and which few men, even amongst the very ablest of those of the highest reputation as bridge designers, would attempt unaided. The result of their instructions to their architect is before the public. The one leading idea in his design is the construction of a river crossing which will allow ships or boats with masts to pass; and even to arrive at an opinion as to a means of effecting this comparatively minor part of the work, he sent a travelling committee far and wide to look at swing and other kinds of movable bridges. On the much larger question of the general form of structure and the best methods of protecting the wharf and river interests, which until this year seemed to be the chief consideration of the Corporation, he seems to have very easily satisfied himself that collected experience and ability should give way to his personal opinion as an architect. His scheme as now put forward provides a low-level bridge, with a central movable span of 200ft. supported on two lofty towers, each of no less than 70ft. in width, placed in the middle of the tide-way, these towers being supposed to be, as an architect would naturally think, necessary to the stability of the bridge when the roadway was opened for the passage of ships. These towers may be very handsome, but no one can suppose that the navigable channel of the Thames is the place in which to put them, if they are not essential to the bridge; and the obstruction they present to navigation is obvious. That they are not necessary may be seen from the design we give this week for a bridge in one span without any piers whatever; and if in this one design something better is to be found than what the City Architect offers, what might not have been obtained if free scope had been given to bridge designers everywhere to contribute their ideas? The minimising of obstruction during the building of the bridge seems also to have been ignored, and the usual impediments of cofferdams and staging may be expected if the City design is carried out. It will be seen from the project described on page 359 that these impediments are wholly unnecessary.

Long as London has waited for a bridge at this site, even now the authorities do not seem to grasp the importance of the whole question; and this is apparent in the financial aspect of the case, as put forward. The estimated cost of the Corporation design is £750,000, and it is announced that this sum, and no more, is available, and that, if the principle of compensation for damaged interests is to be conceded, the Bill will be withdrawn, as there are no funds available to pay such claims. Now, though we by no means desire to see money applied unnecessarily to compensations for doubtful losses, yet we protest strongly against such a scheme being made to depend on a few hundreds or thousands more or less. London could afford to pay for her main drainage, for the Thames Embankment, and for buying up the toll bridges, and, if a bridge at the Tower be once authorised, can afford to pay for a good one; and a broad, statesmanlike view should be taken of the matter. The opening span is not likely to be used long. As we have often pointed out, the trade of the river tends downwards; St. Katherine's Dock will probably soon be closed; Billingsgate cannot survive many years longer, and then, as population and street traffic grows, the Tower Bridge will have more and more thrown upon it. As pointed out in the scheme of Mr. Ordish and Mr. Matheson, the railways will want to cross, and it would be but prudent foresight to provide for this contingency, and so not only save the trouble and disputes which the claim for a new railway crossing would cause, but obtain from the railways a valuable contribution to the expenses now incurred.

If the Corporation are content to make only a bridge sufficient for the present day—if they plead poverty as a reason for doing anything but the best—then it is evident they do not realise the situation. The time is not, so far as they are concerned, ripe, and they had better withdraw and leave the matter to other hands. Unfortunately, the views we advance are not likely to be listened to in a Parliamentary Committee, for those who have a *locus standi*, and have petitioned against the Bill, are opposed to a bridge at all, and are not interested in showing that a good bridge can be built. As, therefore, neither the Metropolitan Board of Works nor the Corporation will give a hearing to outside views, a Royal Commission should be appointed to gather independent testimony.

NON-CONDUCTING COATINGS FOR BOILERS.

THERE are at present many patented compositions in the market, each claiming to be the best that can be used for keeping steam pipes and boilers warm. We have not the smallest intention of pronouncing an opinion concerning the relative merits of these materials; our purpose is to say a few words which may serve as a general guide to the steam user who has to select one. In other words, there are certain qualifications which a non-conducting boiler coating should possess; what these are we propose to state here. It goes without saying that the coating should be a good non-conductor, but this is by no means all that is demanded; it ought to admit of being easily put on; it should not be expensive, and it should not be heavy. The weight of some compositions is a drawback to their use under certain circumstances, as, for example, in yachts, where a ton of boiler coating may mean a ton less coal carried, or a reduction in speed. The coating ought to be waterproof, in the sense that it will not suffer water to get to the boiler from outside, and yet it ought to show in a few minutes a leaking rivet or seam. It ought not to act injuriously on the material of the boiler, and it ought to admit of being nicely finished. Lastly, it is highly important that it should be a bad radiator of heat, and in this respect many coatings are very deficient, although otherwise good. To explain what we mean, we may suppose the case of two boilers—one coated with one material and the other with a different composition. The first one rises, we shall say, to a temperature of 150 deg. as marked by a thermometer in contact with it; the second rises to 180 deg. or 200 deg. Yet the latter may be really the more satisfactory material of the two, because, radiating less freely, the boiler-room will be cooler. Thermometer tests made by contact are indeed of very little value; the radiation test is that on which most reliance should be placed. The thermometer should be held at a distance of 3in. from the surface of the coating and its temperature noted; but great care is necessary in such cases to prevent the influence of currents of air being felt.

A great many experimental investigations have been made from time to time to ascertain the comparative value of different materials used as clothing for steam boilers and steam pipes. The system of testing adopted is nearly always the same. Steam is admitted into a pipe of given dimensions, with a closed or blind end, and clothed with the material whose value as a non-conductor of heat is to be ascertained. The quantity of steam condensed in a given time with two or more competitive materials is taken as an exponent of their merits. At first sight this seems fair, trustworthy, and accurate; but it is quite possible to admit no small errors. Professor J. M. Ordway recently sent a paper on this subject to be read before the American Society of Mechanical Engineers. He therein gives some particulars of experiments he has carried out. He used a number of blind pipes of various lengths, and supplied with steam through pipes very carefully pocketted and trapped, to get rid of water, so that only dry steam might be supplied to the blind pipes, which were coated with the material whose value was being investigated. Arrangements were so made that the water could be withdrawn, and measured, from the pockets and traps; but Professor Ordway states that "the condensation in the transmitting pipes has been found anomalous, and by no means proportionate to the lengths. I have been much puzzled to account for the strange behaviour of these pipes, and have even gone so far as to change the arrangement of them; but the irregularity still continues. It is evident that the water formed does not all find its way into the proper pockets, and that moving steam must carry forward a little." Professor Ordway very properly points out that if water is entrained with the steam the results of the test must be deceptive. To make this quite clear it is sufficient to say that the test consists simply in finding out how much water is discharged from a steam pipe cooled with the composition being tested in an hour or two hours, or any other period fixed on by the experimenter; but the worst material may be easily made to appear the best if dry steam be supplied to it and wet steam to its rivals. Professor Ordway asserts, and we agree with him, that the steam should invariably be tested for its hygrometric quality, and he states that since he adopted the calorimetric method of testing he has found that in many trials the steam was dry while in others it was wet, the percentage of moisture varying between 3 and 42 per cent. of the whole. "This priming," he says, "comes suddenly, and may last but a short time; but even a short continuance is sufficient to vitiate any determination of lost heat, based on the latent heat of the condensed steam. As there is no instrument which, like the thermometer, renders variations visible, changes may come and go unsuspected and unknown." Another source of inaccuracy is that the condensed water being drawn off frequently, is at a higher temperature than 212, and the moment the cock is opened a considerable portion flashes into steam and is lost as water. It is very difficult to obviate this, and at the same time retain the simplicity of the apparatus.

As to the value of different materials tested by Professor Ordway after he had adopted the calorimeter method of testing—that is to say, after he took care to ascertain what percentage of water the steam really contained—he gives some particulars which are interesting. The best coating he employed was made of cork strips put on and cemented together with water glass. Whether the water glass would or would not make the cork incombustible we are unable to say; but we remember some years ago that certain works were burned to the ground in consequence of the ignition of the coating of a boiler and steam pipe, into the composition of which coating cork entered largely. Professor Ordway carried out a number of very interesting experiments by constructing on the upper end of a vertical steam pipe 7½in. in diameter a species of cell which could be filled with any material whose non-conducting power was to be tested. A brass vessel containing water, and 6in. in diameter, could be arranged at any required distance from the cap of the steam pipe, so that it rested on the material in the cell. The elevation of the temperature in the calorimeter in a given period measured the conducting power of the material placed in the cell to be tested. Professor Ordway gives a table of the results he has obtained in kilogram Centigrade heat units transmitted per hour through a thickness of 25 mm., or, say, 1in. From this table it appears that wool was by far the best non-conductor of twenty-nine materials tested, its coefficient being 4. That of compressed cotton was 4·5; of compressed fossil meal, 7·7; of the loose meal, 7·2. This meal is Kieselguhr—the same material used to absorb nitroglycerine when dynamite is being made. Fine washed sand has a coefficient of 30·7; fibrous asbestos, 24·2; pumice-stone flour, 15·4, while air alone gives 23·7. Professor Ordway calls attention to the interesting fact that air at such a temperature as 311 deg., corresponding to a steam pressure of about 80 lb., is of little or no value as a non-conductor. Something is wanted to prevent the air from moving. It is well known that the principal value of clothing of all kinds as non-conducting material, whether for boilers or human beings, depends on the air entangled in the interstices of the stuffs. It appears, therefore, that the air spaces sometimes left round cylinders ought always to be filled up with a material which will play the part of entangler. We believe that Professor Ordway's conclusions on this point are novel, for most engineers hold that an air space is as good a non-conductor as it is possible to employ.

THE MILEAGE OF SCREW SHAFTS.

NOTWITHSTANDING the complaints made from time to time against engineers about the failures of screw shafts at sea, the work to be done by any given shaft is not easily expressed, at all events from the lecture-room point of view. In engines of the highest class and best design the twisting moments are far from uniform, as may be seen by an examination of stress diagrams, the prominences and depressions representing the varying efforts communicated to the screw propeller. Now all shafting, where work is taken on at one end and given off at the other, is more or less in the condition of a torsion balance, and doubtless has its period of vibration. This period may synchronise with the irregularities of the engine effort, either at the normal speed of revolution or at the higher rate of revolution, as when racing. The longer the line of shafting the greater the amount of torsional deflection is—of course other things being equal. Again, the varying immersion of the screw propeller blades is the cause of severe straining in heavy weather. Other and probably more serious causes of trouble may be found in the changes of form to which the ship may be subject, due to the different conditions of loading or to the violence of the sea. In case of the vessel sagging—as when water-borne at the ends—the shafting will generally have sufficient elasticity to fall into its position in the pedestal blocks by gravity, and probably in the opposite condition of the vessel, as when hogging takes place, the deflection may be well within the elastic limit transversely. Yet, as has been pointed out before in this journal for March 26th, 1869, a severe demand is made on the endurance of a large shaft when its rotation is accompanied by a transverse deflection. Any change of the vessel's form due to wringing necessarily increases the evils due to hogging or sagging, as in bad weather it may occur with either of the latter. The least yielding portion of the screw shafting, by reason of its surroundings, is the stern shaft, which, although larger in diameter than the rest, is often known to break. How far this may be due to deflection and gripping in the stern tube must be an open question.

With the increasing size of screw shafting, and the fast-growing favour with which hollow steel shafts are received, come increased stiffness and a corresponding resistance to flexure, which must impose heavy local strains, especially when the unsupported portion of the stern shaft is made stiff by an increase of diameter, as noticed in a paper read at the Institution of Naval Architects this session, as being recent Admiralty practice. The occasional breakage of coupling bolts is clear evidence of the severe and irregular strains on shafts at sea, for in a perfect arrangement these bolts should be subject to shearing only when going ahead. The combination of stiff shafts with a yielding ship is sure to cause local strains and trouble, but these will probably be less felt in vessels of H.M. Navy, as they usually are possessed of a large amount of longitudinal strength to meet the requirements of armour and armament. A shaft of the size alluded to in Mr. Linnington's paper, about 45ft. between the bearings, and of an enlarged diameter to provide stiffness, would probably prove a great source of trouble if used in a merchant vessel of ordinary scantlings. The substitution of steel for iron shafts is as important a step almost as in the case of steel and iron rails, but it must be borne in mind that the endurance of steel has its limit; and although transverse deflection is said to impose an additional duty on a revolving shaft doing work, yet by going to the other extreme and making propeller shafts unduly rigid, severe local and occasional stresses may be set up which, if they do not cause fracture in the shafts themselves, may cause trouble in the neighbourhood of stern pipes, bearers, or engine bearings.

The provision of a certain small amount of elasticity is generally said to encourage durability in the webs of locomotive crank axles, and in the case of screw shafting flexibility seems to be necessary in order that the axis may accommodate itself to the changes of form in the vessel which, although slight, cannot be utterly ignored. With greater experience of a material of more uniform strength, such as steel will shortly become, the lifetime of a marine crank or screw shaft may in time perhaps be predicted without any serious error. A steam vessel doing, say, 12½ knots per hour with sixty revolutions, makes about 288 revolutions per nautical or 250 per statute mile. This number of revolutions also is the amount that a 6ft. 6in. driving wheel makes per mile. Taking 120,000 miles as the life of an iron axle in locomotive work, the life in terms of revolutions is 120,000 × 250 = 30,000,000. A screw shaft will in this number of revolutions have driven the ship 104,000 knots, or about eighteen trips to New York and back. If a month is allowed for each trip, eighteen months is the lifetime on the same terms as those of the locomotive crank axle; as, however, shafts usually last much longer than this, it seems that the conditions under which they are used are more favourable than those which decide the longevity of railway axles. No doubt this is the case because the screw shaft is spared the jarring concussions to which a locomotive crank shaft is submitted. It is not pretended that the cases are capable of close comparison, the only object of the preceding figures being to show that some allowance should be made for mileage or its equivalent when marine engineers are condemned for broken screw shafts. It is, we shall add, highly desirable that Lloyd's should collect and publish some data on the mileage of screw shafts, with the size of each shaft, the number of bearings, and the power transmitted through it. This is of all others the kind of information most wanted just now by marine engine builders. Data of the kind exist in abundance, for broken screw shafts are abundant, but they are not made public as they ought to be.

STEAMSHIPS AND WAR RISKS IN MUTUAL OFFICES.

THE uncertainty that has prevailed politically of late has brought to the front a question of great interest that can scarcely be said to have ever been within the range of practical politics before; it is that of the war risks on steamships insured in mutual assurance associations. In these the risk is nominally undertaken by the clubs; it is one that is included in the risks assured against, but practically it is one that has not been contemplated, for since the organisation of these clubs for steamships we have had no war with any great Power. It is now seen that the inclusion of these risks does subject the vessels to differential treatment without a differential rate. If two vessels insured in these clubs are taken as an example, one of which accepts freights that are near peril, that is to say, for instance, accepts a high rate of freight to a port in a country that may be an enemy's before the work is completed, and if the other accepts safer freights at much less rates, the one obtains a greater protection than the other, but the charge to both is at the same percentage. It is now seen that this involves in times like the present a practical injustice. One of the vessels may have taken a moderate freight, say, to an American port, and the other a very high rate to the Azoff, but though the danger is much greater in the latter case than in the former, yet both are assessed to contribute at the same rate to the assurance association. The risk to the latter in case of seizure is very great, and the question has in the last week or so been much discussed as to whether it is desirable to equalise the matter by increasing the charge to the vessels which take the great risk, and receive correspondingly high rates of freight, or whether it is expedient to prohibit the trade to ports that may be called perilous in periods such as that of the past and present month. It is a question that needs to be carefully thought out in the interests of the shipowners themselves, and it is one that has many branches, and that may lead to very considerable improvements in the methods of assessing the contributions of steamships to the funds for meeting losses incurred in the risks that they run—risks which vary very greatly, according to the type of the vessel and the nature and locality of the work.

LITERATURE.

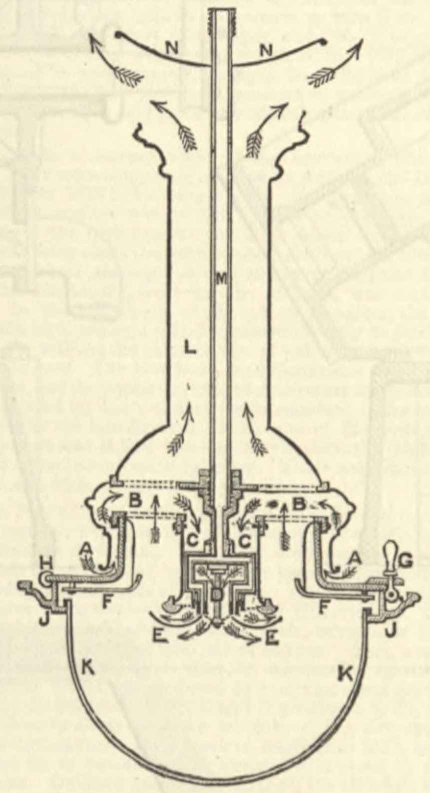
Modern Shipbuilding and the Men Engaged in it. By DAVID POLLOCK, Naval Architect. London: E. and F. N. Spon. 1884.

THE author explains in his preface that his object in producing this volume has been more to enlighten the general reader than to interest or inform the expert. Being chiefly historical, the book is also limited as to its originality. To be accurate and lucid, as well as fairly comprehensive, is the most that can be demanded; and to this extent Mr. Pollock has achieved success. The author has set before him a double task, seeing that he deals not only with ships, but also with those who build them, or who are in some way connected with them. Thus we have a series of portraits and succinct biographies scattered through the chapters treating of the various departments of marine architecture. Even the professional man may find this handy volume useful, while to those who have only an outside knowledge of the subject the several chapters will convey a vast amount of information presented in a very readable form. Although dealing exclusively with shipbuilding for the mercantile marine, Mr. Pollock has found a wealth of materials at his disposal which he might easily have extended over a much wider space. Beginning with a generous recognition of the merits of the Great Eastern—"Brunel's grand audacity"—we are shown how the colossal proportions of this extraordinary ship are being approached by recent constructions. A prediction is quoted that in the course of a few years we shall see steamers of eight hundred feet in length acting as "the ferry-boats of two oceans, with America for their central station, and Europe and Asia for their working termini." No doubt our shipbuilders only want the order, and they can produce the ship. The failure of America to compete with England in the production of ocean steamers and in the conduct of the carrying trade is, of course, due to the narrow policy under which American shipbuilders have shielded themselves from foreign competition. But the elements of marine architecture are many, and in this scientific age scarcely anything is more remarkable than the changes which relate to the construction and working of ships. Thus we have the introduction of the compound engine and engines of the triple expansion type, the use of mild steel, the adoption of the cellular system, the more extended adoption of water ballast, and other innovations. The progress of ocean steam navigation is a marvellous chapter, and we are still left to believe that the fastest possible steamship has not yet made its appearance, despite the intense competition which has animated the Transatlantic companies. The value of steamships capable of travelling at high speed has been recognised by the Admiralty, and has given rise to the scheme of the auxiliary mercantile fleet, lately applied on a large scale in anticipation of war with Russia. In connection with the Admiralty plan there comes under review the question of water-tight compartments and the safety of ships. Double bottoms belong to the same category, and mild steel also comes in aid. Progress in the science of shipbuilding furnishes the author with a fruitful topic, which he handles with much ability; and towards the close of the book there is a description of some of the more notable shipyards. Taken throughout, we have in this volume a very able review of an extensive subject, treated in a manner which is popular without being superficial. The portraits—fifteen in number—are well executed, though we hardly think Sir Edward Reed has been flattered. That which is wanting on the part of the artist is, perhaps, compensated by the statement of the biographer, that Sir Edward "has recently devised and patented a method of construction for warships which will reduce to a minimum the destructive effect of marine torpedoes, and which promises to revolutionise present structural systems." According to this, wonderful as the past has been, there is something considerable ahead.

THE WENHAM LIGHT.

AN interesting new lamp for the economical consumption of common gas has been invented by Mr. F. H. Wenham, C.E., and is in course of manufacture by the Wenham Patent Gas Lamp Company, and is shown in action at the Inventions Exhibition. The claims made by the company as to the economical advantages of the lamp are exceedingly large, namely, that it increases the illuminating power of common gas from 200 to 400 per cent., and that, too, without charging the gas with additional hydrocarbons. In the Wenham lamp the gas is burnt downwards instead of upwards, and the common air is heated before it reaches the flame; as a gas flame consumes about fifteen times as much air as gas, care is taken to heat this air as much as possible before it comes into contact with the gas. The flame of the Wenham lamp has the form of a flat, horizontal ring, resembling a quoit in shape, but not so large when the lamp is of any ordinary size. The flame has no invisible or blue part to it, but over its whole area is intensely and equably luminous, and is more painful to the eyes than a gas flame to look at for any length of time because of its brilliancy, and its being richer in the rays of the blue end of the spectrum. There is little or no flickering with the flame, or variation in its form, but it is simply a steady, luminous ring.

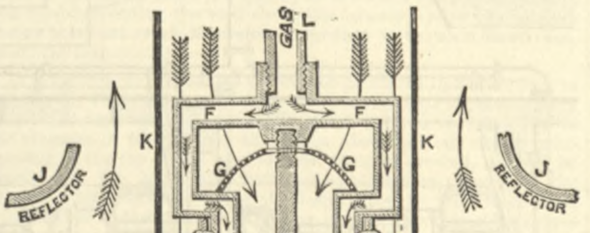
Fig. 1



The accompanying diagram, Fig. 1, represents the whole arrangement. In this cut A is the air inlet, and B the regenerator; the latter is somewhat massively made in iron, and takes up the heat from the gas-flame below to communicate it to the incoming air. A cylinder C conveys the heated air to the burner through perforated discs; D is the burner, E the flame, F the reflector, G the fastener of the ring J, which carries the lamp-glass K, and has a hinge at H. The chimney is at L, M is the gas supply pipe, and N the heat disperser.

It was necessary that the glass hemisphere K K should be light, and this was a difficulty, most of those in the market being heavy, with a very thick glass rim at the top. Some of lighter form and better quality are made in Paris. The company so far has been using bowls of thin glass cut from the ends of flower shades, and fitted with an artificial rim invented and patented by Mr. Wenham; it consists of a band made of asbestos, cemented to the glass by silicate of soda.

Fig. 2



A section of the burner is represented in Fig. 2. In this cut A is the porcelain burner, held in position by the ring B. C is a perforated disc, and D a perforated button; E the stem supporting the button, F the gas way to the burner, G a perforated dome, H a ring secured by a bayonet lock, K the external cylinder, L the gas supply pipe, and M the flame. The gas issues in a horizontal curve from a ring of holes in the burner. Mr. Wenham finds that to get the best light, the gas must issue in a series of streams rather than as a thin sheet; the air gets at it better. When the flame of this lamp is turned on so that little projections begin to appear at the outside edge of the ring of light, the arrangement is giving the maximum illumination.

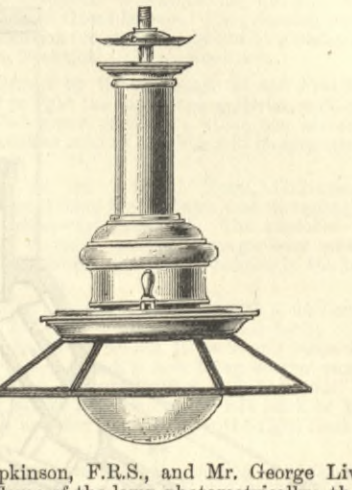
The external appearance of the simplest form of the Wenham lamp is represented in Fig. 3, but it is, of course, made of various shapes and sizes, and with more or less attention to the requirements of the luxurious.

Mr. F. W. Hartley has photometrically tested the illuminating power of the flame of the lamp at 45 deg. from the vertical, and gives the following certificate of the results:—

Lamps tested.	Gas burned per hour.	Total light obtained.	Light per Cubic foot of gas.
	Cubic feet.	Candles.	Candles.
No. 1	6·4	55·00	8·60
„ 2	12·9	122·50	9·50
„ 3	15·2	171·00	11·40

Mr. Hartley remarks about the above figures that the vertical lighting power on the average of the tests was more than 50 per cent. greater than with angular lighting. The "total light" and "light per cubic foot" mean the light of standard sperm candles, and the figures give the number of these which it would have been needful to burn at one time to produce a light equivalent to that of the Wenham lamp. The average amount of light yielded per cubic foot of gas burned from an average burner does not exceed, he says, the equivalent of 2·6 standard sperm candles.

Fig. 3



Dr. John Hopkinson, F.R.S., and Mr. George Livesey have also tested the flame of the lamp photometrically; their results, given below, agree closely with those of Mr. Hartley:—

Lamp.	Feet per hour.	Total light.	Equivalent per cubic foot.
		Candles.	Candles.
No. 1	6·4	54·1	8·5
„ 2	12·8	121·6	9·4
„ 3	15·1	173·9	11·4

In these tests, taken at 45 deg. from the vertical, reflectors were used. The same referees report that "at Mr. Wenham's express desire the experiments were made with the lamps complete with their reflectors, just as they would be used, and the light was tested both at the vertical and angularly at 45 deg." The average light directly under the lamps at the same distance from the flame was about 55 per cent. more than at 45 deg.

Some photometric tests of the economy of the Wenham light, made in comparison with an ordinary gas flame under the same conditions in each case—that is to say, both without reflectors—would be of scientific interest. At the same time the Wenham light is of unusual brilliancy, as any visitor to the Exhibition may see at a glance.

CONTRACTS OPEN.

FLEXIBLE BUFFERS AND SCREW COUPLINGS FOR CARRIAGES AND WAGONS—INDIAN STATE RAILWAYS.

THE Indian State Railways require tenders for the screw couplings and buffers illustrated on page 368. Tenders, addressed to the Secretary of State for India in Council, with the words "Tender for flexible buffers and screw couplings" on the envelope, must be delivered at the India-office, Westminster, S.W., before 2 p.m. on Tuesday, the 12th May, 1885. If delivered by hand, they are to be placed in a box provided for that purpose in the Store Department.

The work required under this specification consists of the construction, supply, and delivery in England, at one or more of the ports named in the conditions and tender, of 746 sets of flexible buffers and screw couplings, complete, with steel and india-rubber springs, and 250 hooks, with pins complete, for flexible buffers. Every part of the work included in this contract is to be constructed of wrought iron, india-rubber, or steel. The coupling hooks, coupling bolts, nuts, washers, and pins, coupling blocks, yokes, yoke pins, and washers, screws, connecting-rods, and connecting-rod pins and washers are to be forged from Lowmoor iron supplied direct from the Lowmoor Company. The yoke nuts and ferrules are to be of steel. The wrought iron used for the contract is to be of some best best brand, which is to be of a quality and made by a manufacturer approved by the Inspector-General, and equal to a tensional strain of 21 tons to the square inch, with a contraction of 10 per cent. of tested area for all plates, 22 tons tensional strain with a contraction of 15 per cent. of tested area for all channel, T, and angle irons, and 24 tons tensional strain with a contraction of 20 per cent. of tested area for all flat and round bars. The steel for the yoke nuts and ferrules is to be of such a quality as is equal to a tensional strain of not less than 27 tons, and not more than 31 tons, per square inch of sectional area, and will exhibit a contraction of area at the point of fraction of not less than 30 per cent. The steel of which the volute springs are to be made is to comply on analysis with the following conditions, namely, its carbon must not exceed ·9 or be less than ·6 per cent., and silicon, phosphorus, and sulphur must not be present in greater proportion than ·06 per cent. each. The manganese must not exceed ·6 per cent. One spring in each 300 will be selected by the company's engineer, and will be subjected to complete analysis. Should this analysis show the carbon, silicon, phosphorus, or manganese in the steel to exceed the specified maximum, or should the carbon fall short of the specified minimum, the 300 springs represented by the spring showing such defective analysis will be rejected. The india-rubber used for the work under the contract must be of the best quality and free from objectionable smell. The whole of the iron is to be well and cleanly rolled, and must be free from scales, blisters, laminations, and all defects and blemishes. No iron of foreign manufacture is to be used. When scrap iron is used, it must be cleaned in a properly constructed machine before being used for the manufacture of forgings.

The intention of this contract is that every piece of iron shall be manufactured with such accuracy that any piece may be used, without dressing of any kind, in the place for which it is designed. To ensure this every piece must be made from a carefully prepared metal template or gauge, and all holes in it must be drilled. It must further be drilled through the holes in the template, so that the corresponding parts in the different articles may without doubt be exact duplicates of each other. All templates and gauges must be provided by the contractor at his own expense, and must be of such material, and made in such a manner, and be renewed as often as the Inspector-General shall desire. The standard length of the coupling hook, measured from the centre from which the rear bearing surface of the hook pin-hole is struck to the inside of the nose at the tip, is to be 12in., and from the same centre to the bearing part—at the root—12¼in. The bend in the hook must be made so as to allow of effective contact on the proper surfaces of the hook and coupling block when the centre of one buffer head is 2in. lower or higher than the centre of the other buffer head, both buffers being placed horizontally in position for coupling. The buffer heads may be dabbed on to the jaws under a steam hammer, but great care must be taken to secure a thoroughly sound weld.

THE INVENTIONS EXHIBITION—MESSRS. GOODFELLOW AND MATTHEWS' ENGINES.

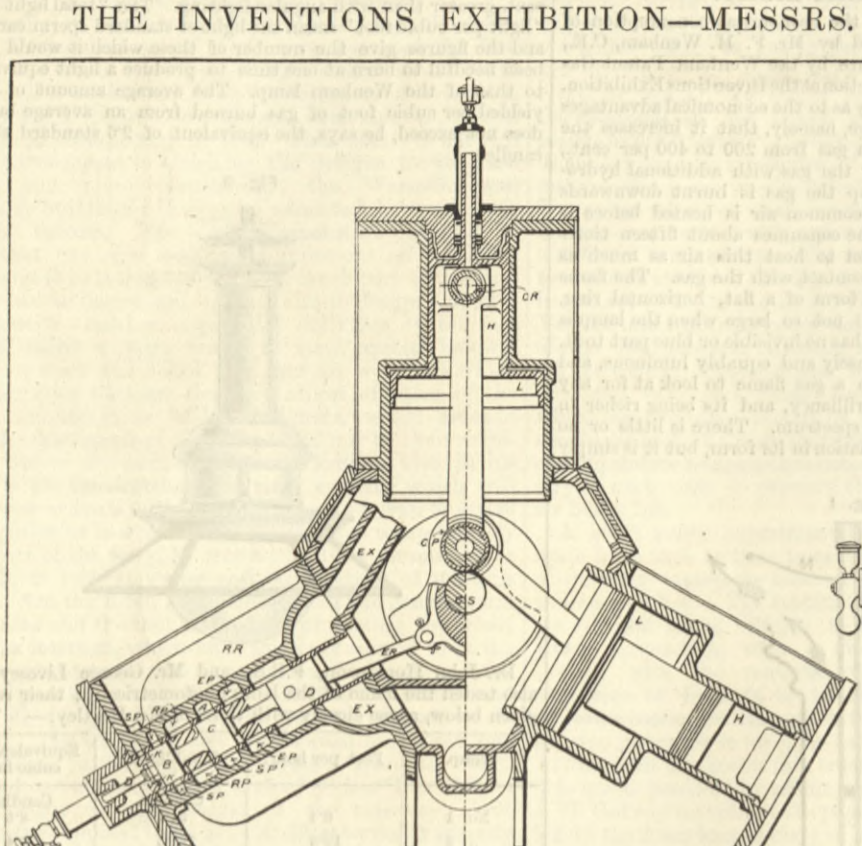


Fig. 2.

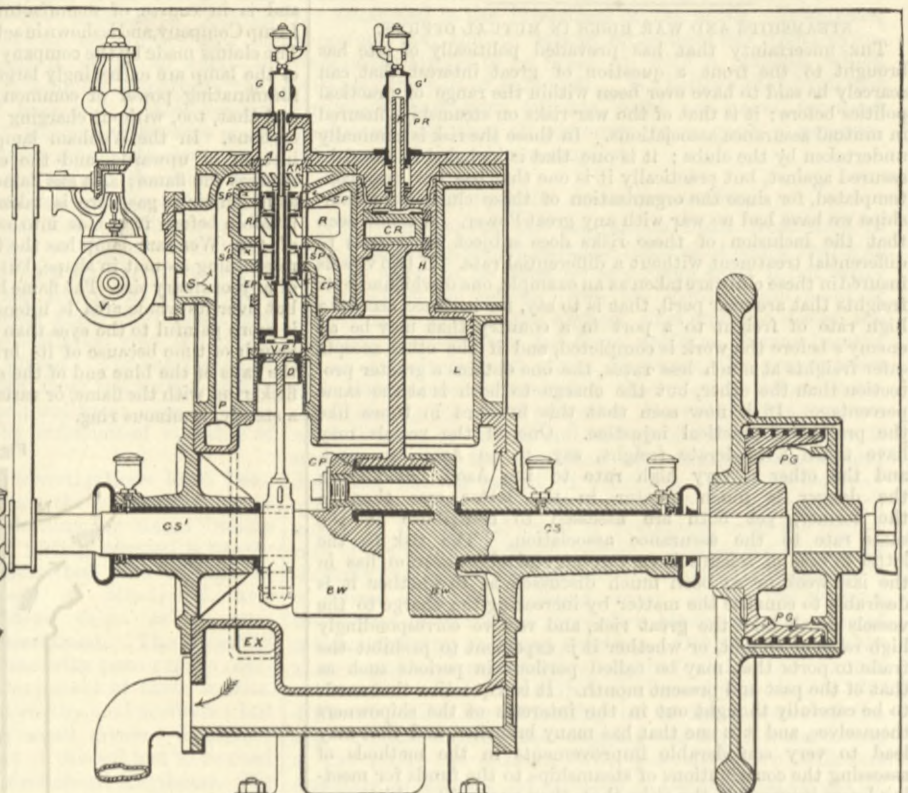


Fig. 1.

Figs. 3.

over the whole surface. The buffer faces are to be made to the shape shown on the drawing, and must be faced up all over in the lathe. The buffer shanks must be forged solid with the jaws without a weld in their length, and must be drawn down under a steam hammer true to the form shown, and the round part must be turned. The buffers must be forged from best hammered scrap iron. The yoke lever, sliding coupling block, connecting-rod and coupling screw, coupling hooks, spring sockets, and plungers must be forged out of the solid, and all the holes for the pins must be drilled, and the pins must be turned. The yoke levers, sliding coupling blocks, and connecting rods may be left black, if in the opinion of the Inspector-General they are sufficiently neat and clean forgings. All other parts must be turned, bored, or planed where tinted red on the drawing. All holes must be drilled, but the joints and pins must be an easy fit. The end of the coupling screw which fits into the sliding block must be a sufficiently easy fit to allow the screw to angle, and take up the several positions assumed by the yoke lever in passing from its extreme forward to its extreme backward position. All similar parts of the buffing gear must be interchangeable from one set to another. The spring sockets and the draw and buffer spring plates must be dressed off perfectly true to the dimensions given, and faced and turned inside. The joint channel irons are to be sent out to the dotted lines shown on the drawings, and are not to have any holes drilled in them. Great care is to be taken to cut the threads of the screw couplings accurately to the dimensions given on the drawing exhibited, and generally to finish them up in the best and most accurate manner. Whitworth's standard gauges must be used in turning all pins, boring all holes, and forging or finishing all bolt heads and nuts, and all bolts and nuts must be screwed to his standard pitch, the bolts to a length of three diameters. The bolts that pass through the india-rubber springs must be turned. Generally all surfaces tinted red on the detail drawings are to be bored or turned, and finished up smooth and bright, whether mentioned in this specification or not; and all pieces of iron not bored or turned must be cleaned up with the file, and finished off in first-class style. Generally, all workmanship must be of the very best class.

One set of buffers and couplings must be completely erected, and must be approved by the Inspector-General as a pattern before any part of the rest of the work under the contract is proceeded with. Should an examination of this pattern lead the Inspector-General to order any alterations in the designs of any of the parts, he is to be at liberty to do so, without claim on the part of the contractor for loss on any parts which he may have made prior to the approval of the sample, or for any extra payment, except in regard to weight at the schedule rates. Every set of buffers, &c., must be completely erected and coupled up as if attached to vehicles in actual work. This must be so arranged that all the

RAILWAY MATTERS.

IT is estimated that the railways in America employ, directly and indirectly, 2,000,000 men.

RAPID progress is being made with the connecting line between East and West Bournemouth, a short but expensive piece of line, involving a good deal of viaduct work, and comprising a new station at Bournemouth East.

THE Berber Railway to Otao, with a siding and an unloading platform, was completed on Monday. The contractors are anxious to go on, as they have enough rails to reach Ariab. It is said that the line will be doubled from Suakin to this place.

To secure the control of the emigrant business towards the United States, the Pennsylvania Railway Company has reduced the fare from New York to Chicago to as low as one dollar. By this means the company has obtained the bulk of the emigration traffic, the other companies having given up the contest.

A PAPER on "Cast Iron Car Wheels," recently read before the American Car Builders' Club, gives information from which it appears that the ordinary cast iron wheels on the Buffalo roads break 28 to 1 of the wrought iron and steel tires on English railways, and that the best wheels used on the New York and Lake Erie lines break 6·4 to 1 of the English tires.

THE Canadian Pacific Railway Company has completed the line between Halifax and the Rocky Mountains. It has notified the British Government that in a fortnight it will be able to carry troops by rail from Halifax to the Pacific coast, the transit taking seven days. This will be of advantage in the sending of troops and supplies to Vancouver Island and other points on the Pacific.

THE Connecticut Legislature has refused to pass a law requiring projected railways to be submitted to the railway commissioners for approval before construction. The *American Railway Review* says:—"This is disappointing. Either it or something similar should be urged before other Legislatures to a final enactment. It is better even to bear the 'parliamentary expenses' evil which has grown up in England, than to continue to suffer the blighting effects of the speculative paralleling schemes."

ON English lines, the failure of tires is about 1 in 1631. The wheels on the Pennsylvania lines are stated to have come from fifteen or twenty of the largest manufacturers; but even among these best makers the contrast is very marked. Thus, on the Erie, the best maker of all had, in 40,000 wheels, 32 in 10,000 break; the next best had, in 43,000 wheels, 46 in 10,000 break; the next best had, in 21,000 wheels, 56 in 10,000 break; the next best had, in 40,000 wheels, 110 in 10,000 break—giving the average of 63 in 10,000.

MR. WILLIAM TWEEDIE, A.M.I.C.E., has been appointed chief engineer and superintendent of the Porto Alegre Railway, in Brazil. He leaves England for Rio Grande on May 24th. Mr. Tweedie has had long experience in Brazil, and was chief engineer of the Sao Gerompno Railway, the first line opened in the province of Rio Grande do Sul. Since the opening of that line ten years ago, this large and fertile province has made rapid strides, and there are now some hundreds of miles of line in operation and in course of construction.

THESE accidents on American lines during last March are classed as to their number and causes by the *Railroad Gazette* as follows:—Collisions: Rear, 19; butting, 14; crossing, 3; total, 36. Derailments: Broken rail, 10; broken bridge, 2; spreading of rails, 5; broken wheel, 2; broken axle, 6; broken draw-head, 1; dropped brake-beam, 1; wind, 1; misplaced switch, 1; malicious obstruction, 1; unexplained, 13; total, 43. Other accidents: Broken parallel rod, 4; broken wheel, not causing derailment, 1; overhead bridge, 1; car burned while running, 1; total, 7. As usual, derailments constitute about 50 per cent. of the whole of the accidents, and about 30 per cent. of these are unexplained.

NEGLIGENCE in operating is charged with 25 per cent. of all the accidents; defects of road with 25½, and defects of equipment with 21 per cent. A division of the accidents on American lines in February according to classes of trains and accidents is given by the *Railroad Gazette* as follows, and is very instructive:—

Accidents:	Collisions.	Derailments.	Other.	Total.
To passenger trains	10	60	18	88
To a pass. and a freight ..	16	—	—	16
To freight trains	35	76	1	112
Total	61	136	19	216

Of the total number of accidents, 138 are recorded as happening in daylight and 78 at night. The number of accidents is the largest recorded for many months, and is explained by the severe weather and the many snowstorms, which made the month a more trying one to railroad men than any which they have experienced for several winters.

THE following engine-driver's story of a brakeman is given in the *Chicago Herald*:—"Several years ago I was running a fast express. One night we were three hours behind time, and if there's anything in the world I hate, it's to finish a run behind schedule. These grade crossings of one-horse roads are nuisances to the trunk lines, and we had a habit of failing to stop, merely slacking up for 'em. At one crossing I had never seen a train at that time of night, and so I rounded the curve out of the cut at full tilt. I was astonished to see that a freight train was standing right over the crossing, evidently intending to put a few cars on our switch. I gave the danger whistle, and tried to stop my train, but had seven heavy sleepers on, and we just slid down that grade, spite of everything I could do. Quicker than I can tell you, the brakesman of that freight train uncoupled a car just back of our crossing, and signalled to his engineer to go ahead, which he did sharply, but barely in time to let us through. In fact, the pilot of my engine took the buffer off the rear car. Through that little hole we slipped, and lives and property were saved. Now, that brakesman was only a common railroader, yet he saw that situation at a glance. There wasn't time to run his whole train off the crossing, nor even half of it—barely time to pull up one car length by prompt, quick work. He kept his wits about him as, I venture to say, not one man in a thousand would have done, and saved my reputation if not my life. He is now a division superintendent of one of the best roads in this country."

THE following is given by the *Chicago Herald* on "Kentucky Railroading:"—"'Do you use the block system on this road?' inquired a passenger on a train down in Kentucky. 'No, sir,' replied the conductor; 'we have no use for it.' 'Do you use the electric or pneumatic signals?' 'No, sir.' 'Have you a double track?' 'No.' 'Well, of course you have a train dispatcher, and run all trains by telegraph?' 'No.' 'I see you have no brakesman. How do you flag the rear of your train if you are stopped from any cause between stations?' 'We don't flag.' 'Great heavens! What a way to run a railroad. A man takes his life in his hands when he rides on it. This is criminally reckless.' 'See here, mister, if you don't like this railroad, you can get off and walk. I am the president of this road and its sole owner. I am also the board of directors, treasurer, secretary, general manager, superintendent, paymaster, track-master, general passenger agent, general freight agent, master mechanic, ticket agent, conductor, brakeman, and boss. This is the Great Western Railroad of Kentucky, six miles long, with termini at Harrodsburg and Harrodsburg Junction. This is the only train on the road of any kind, and ahead of us is the only engine. We never have collisions. The engineer does his own firing, and runs the repair-shop and round-house all by himself. He and I run this here railway. It keeps us pretty busy, but we've always got time to stop and eject a sassy passenger. Do you want to behave yourself and go through with us, or will you have your baggage set off here by the haystack?'"

NOTES AND MEMORANDA.

A NEW alloy known in Germany under the name of "glass composition" is said to possess good qualities for bearing surfaces. It contains a certain percentage of a vitreous substance, stated to be sufficient to impart to the alloy a durability and uniformity not hitherto reached, while even at high speeds the heating of journals is said to be avoided. Experience does not seem to point to probability in this, but it is seriously stated.

THE total number of boiler explosions in the United States in 1884 was 152, by which 254 people were killed and 261 others injured. This number falls slightly below that of the preceding year. Fifty-six of the explosions were of sawmill boilers. The percentage in 1884 was 37 per cent. of all the explosions, instead of over 40 per cent. the year before. There was a falling-off of two in the number of locomotive boiler explosions from the record of the preceding year.

IN the absence of a duly authorised and official standard of filtration regulating the volume of water to be passed through a given area of sand in a given time, it has been found during the past twelve years that when the rate of filtration does not exceed 540 gallons per square yard of filter bed each twenty-four hours the filtration is effectual; and this has been generally recognised as a tentative standard rate of filtration. The water companies all keep within this limit.

ONE thousand cubic feet of nitrogen weigh 80 lb. at a temperature of 32 deg. Fah. and a pressure of 15 lb. per square inch; oxygen weighs 90 lb.; the mixture of 770 lb. of nitrogen and 230 lb. of oxygen makes 1000 lb. of common dry air. As the oxygen is heavier, it occupies less bulk in proportion, so that if we take the air by bulk, 790 cubic feet of nitrogen and 216 of oxygen make 1000 cubic feet of air, which will weigh 82 lb. The amount of watery vapour is very variable, changes from hour to hour, and differs in localities; but the small amount of carbonic acid is less variable, and changes only from one-2500th part to about double that amount.

ACCORDING to a correspondent of the *Journal* of the Franklin Institute, there were compound engines at work on the Hudson as early as 1830 or 1832 in two steamboats—the Swiftsure and Commerce. Their engines were of the upright square form, or cross-head pattern, the high-pressure cylinder being forward and the low-pressure being abaft the paddle-wheel shaft, and both connected to it by cog-wheel gearing. About the same time the Post Boy, with similar machinery, built by Mr. Allaire, was sent to New Orleans. In the machinery of the above steamers, the exhaust steam of the high-pressure cylinder passed directly to the low-pressure cylinder without the intervention of valves or receiver between the two cylinders. The Swiftsure and Commerce were in use for several years, and the machinery of the former was subsequently taken out and replaced by the ordinary beam engines. The compound engine built by the late Erastus Smith was of the ordinary beam pattern, except that it had two steam cylinders, the high-pressure being within the low-pressure cylinder. Their respective diameters were 37in. and 80in., stroke 11ft.

HERREN MUTHEL and Lutke, of Berlin, have devised a process for oxidising rapidly, with the help of electricity, the oils employed in the manufacture of varnish. Oxidated combinations of the metalloids, which by an elevated temperature lose a part of their oxygen, are formed by the influence of electricity. Suitable for this purpose are mixtures of equivalent quantities of chlorine and vapour of water, sulphurous acid and atmospheric air, oxygen, or hyponitric acid, protoxide of nitrogen with air or oxygen. Such a mixture of gas is submitted during some time, in condensing apparatus, to a strong electric discharge, produced by a dynamo and an induction apparatus. In this manner $2HCl$ and O give birth to Cl_2 and H_2O, and S_2O_7 form by electrification a mixture of SO_2 and atmospheric air. This combination easily resolves itself into $2SO_2$ and O, &c. The linseed oil to be oxidised is warmed in a vessel to 60 deg. or 80 deg. Cent. Oxidised gas is sent through the oil while it is being agitated, and the decomposition of the glycerides is rapid. The products of decomposition are regenerated or burnt, and the clean product is washed with ammoniacal water.

CAPT. L. U. HERENDEEN, of San Francisco, communicates to *Science* the following notes on prehistoric structures in Micronesia: "A few years ago I visited Ponapé Island, in the Pacific, in east longitude 158 deg. 22 min. and north latitude 6 deg. 50 min. The island is surrounded by a reef, with a broad ship-channel between it and the island. At places in the reef there were natural breaks that served as entrances to the harbours. In these ship-channels there were a number of islands, many of which were surrounded by a wall of stone 5ft. or 6ft. high, and on these islands there stood a great many low houses, built of the same kind of stone as the walls about them. The walls are a foot or more below the water. When they were built, they were evidently above the water, and connected with the mainland. The natives on the island do not know when these works were built; they have even no tradition of the structures. Yet the works show signs of great skill, and certainly prove that whoever built them knew thoroughly how to transport and lift heavy blocks of stone. Up in the mountains of the island there is a quarry of the same kind of stone that was used in building the wall about the islands, and in that quarry to-day there are great blocks of stone that have been hewn out, ready for transportation."

IN a lecture on accidental explosions produced by non-explosive liquids, Sir F. A. Abel said: "It has been proved experimentally that if the reservoir of a burning lamp be warmed so as to favour the emission of vapour into the space above the oil, and a small opening in the top of the reservoir be then uncovered, air will be drawn into the latter and form an explosive mixture with the vapour, which, escaping from the lamp close to the wick-holder, will be fired and produce an explosion in the lamp. Another source of danger introduced in the construction of lamps which should be sufficiently obvious consists in the provision in many lamps of openings of considerable size close to the burner, apparently with the object of affording a passage for the air, or vapour, in the reservoir which may expand as the lamp becomes somewhat warm. A simple arrangement which would effect the desired object with perfect safety, and would at the same time protect the lamp wicks from deterioration by the grosser impurities sometimes contained in portions of a supply of oil, is to attach to the bottom of the burner a cylinder of wire gauze of the requisite fineness—28 meshes to the inch—which would contain the wicks, and would allow the passage of air or vapour through it towards the burner, while it would effectually prevent the transmission of fire from the lamp flame to the air space of the reservoir."

IN a paper recently read before the Chemical Society, on "Combustion in Dried Gases," by H. Brereton Baker, B.A., the author described his investigations on the question whether moisture is necessary for the combustion of carbon and phosphorus in oxygen. The phosphorus used—commercial amorphous phosphorus—had been washed with water and dried at 100 deg. in a current of carbon dioxide previously passed through two wash-bottles of sulphuric acid; it was then heated in a Sprengel vacuum at 150—160 deg. The carbon—finely powdered charcoal—had been heated to bright redness in a current of dried chlorine for three hours; the tube containing it was then transferred to an air bath and heated at 200 deg., while a current of dried air was passed through it. Portions (0·5—1 gramme) were sealed up in bent hard glass tubes along with phosphoric oxide, the tube being filled with oxygen prior to sealing; to free the glass from adhering moisture, the ends of the tubes containing the carbon or phosphorus were heated in an air-bath at 130—150 deg., the other ends being kept cool. After about eight days, the tube containing phosphorus and dried oxygen and another similar tube with phosphorus in oxygen saturated with water were supported at the same height above the flame of an Argand burner; the phosphorus in the wet gas soon took fire, but that in the dried gas slowly distilled and formed a red and yellow deposit.

MISCELLANEA.

THE Crystal Palace Company has just published its programme for the season 1885. It contains a great many special attractions besides those which are of annual recurrence.

GALVANISED iron tanks for holding drinking water are not allowed on board the French men-of-war, because zinc carbonate does not add to the potable value of the water.

THE Chilian ironclad Esmeralda, of which an account was recently given in our columns, has arrived at Panama. It is reported that a contract has been made for the transfer of this vessel to the English if war breaks out.

THE committee appointed to consider the question of forming a "Textile Institute of Great Britain" have decided in its favour, and forms of application for membership can be obtained from Mr. T. R. Ashenhurst, Technical College, Bradford.

A SYNDICATE formed by the tradesmen of the Palais Royal in Paris has decided to light the shops, the galleries, and the garden by electricity. The central station, in which the necessary works are to be commenced as soon as possible, will be arranged for 3000 incandescent lamps.

A STEAM boiler in the Tremont Hotel, Galveston, Texas, exploded on Sunday, killing four persons and wounding six, while the building was somewhat shattered. The exploded boiler was hurled to a great distance, passing through four small houses, which it partly demolished, and finally lodging in the fifth house, one hundred yards away.

THE Maine is to be made into a canal, with a uniform depth of 2·50 metres—8ft. 3in.—by means of weirs and locks. The nature of the river and its banks makes it peculiarly suitable for this treatment. In the plan which is now being carried out, there are five weirs at Frankfort, Höchst, Okriftel, Raunheim, and Kostheim. At each of these places there is on the left bank of the river a side canal with a lock for ships, and on the right bank a channel for rafts.

A NEW Act has been passed for the regulation of the bituminous coal mines of Pennsylvania. It is enacted that the Governor be authorised to appoint six competent and experienced miners and six competent and experienced coal operators, one miner and one operator from each bituminous inspection district, five members of the House of Representatives and three members of the Senate, who shall, with the six mine inspectors of the bituminous region, act as commissioners to revise the mine laws and ventilation Acts relating to the bituminous coal regions of Pennsylvania, and to report to the Legislature at its present session if possible, and if not at the next session thereof.

THE project for making Paris a seaport has once more been brought before the public, this time in a paper by M. Bouquet de la Grye. He said the subject was of importance from two points of view. The first and most important was the military one. The defence of Paris demanded imperatively the establishment of a port which would assure the victualling of the capital and its suburbs at all times. The commercial and industrial importance of the project is evident. The port should be established in the Poissy basin, and the Seine should be dredged to a mean depth of 6½ metres. M. de la Grye requires only the deepening of the bed of the river by dredging. It could be executed in four or five years. The total expense would be about 100 millions of francs.

THE official report for March says that the state of the water in the Thames at Hampton, Molesey, and Sunbury—where the intakes of the West Middlesex, Grand Junction, Southwark and Vauxhall, Lambeth, Chelsea, and East London Companies are situated—was indifferent in quality from the 1st to the 10th March, when it became good, and remained in that condition to the end of the month, with the exception of the 23rd, 24th, and 25th, when it was again indifferent. The intakes are closed as much as possible during floods, to avoid taking in turbid water. The highest flood state of the river at West Molesey during this month was 3ft. 3in. above summer level mark, and the lowest was 4in. above that mark. The rainfall at West Molesey during the month was 1·19in., the rainfall during the whole of the year 1884 having only been 15·06in. The quality of the water after filtration delivered to the metropolis during the whole of the month of March was exceptionally good for this season of the year.

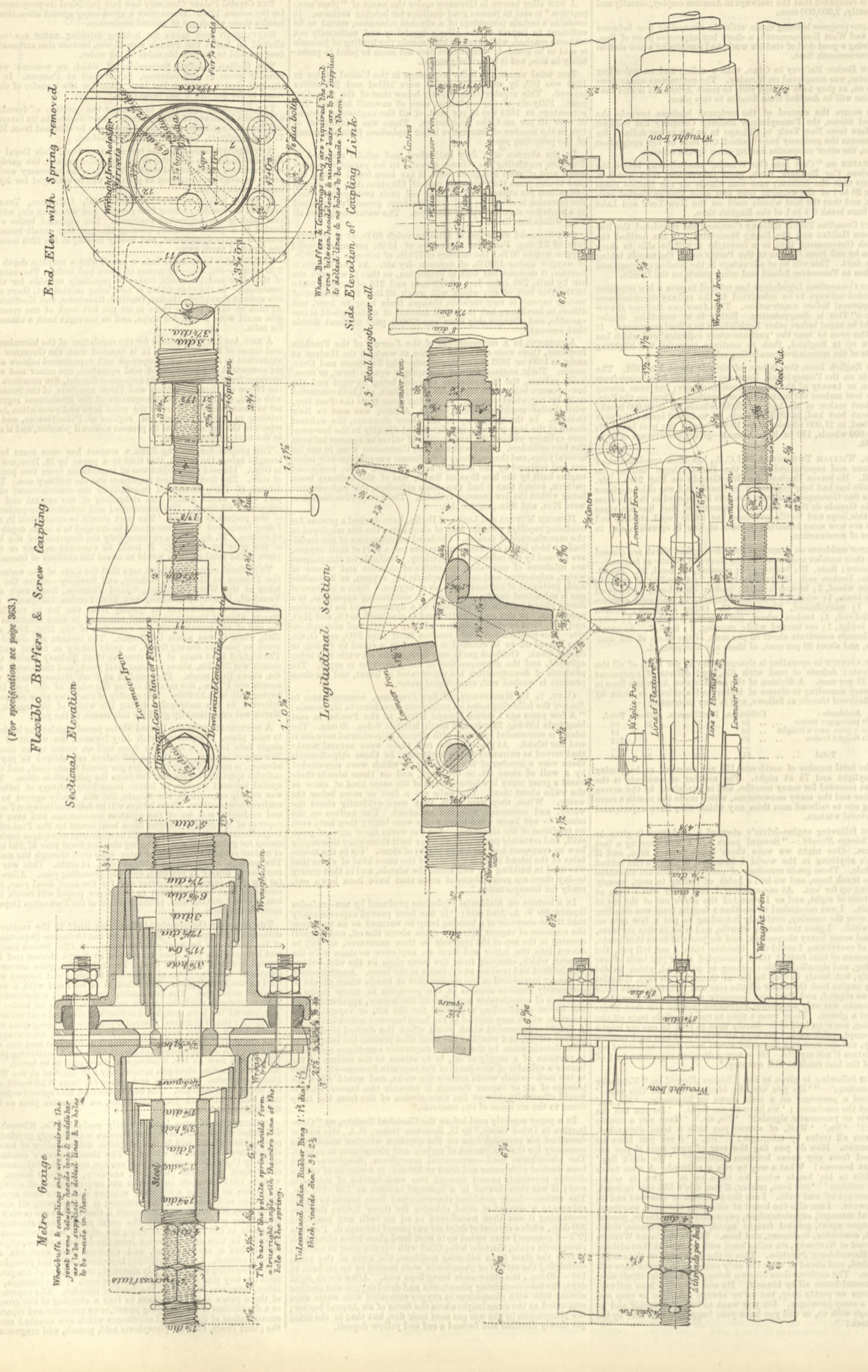
A MODIFICATION in the United States postal regulations is about to take place. Beginning with July 1st next, the weight of all single rate letters is increased from half an ounce to an ounce. Newspaper postage, which the publishers are obliged to pay in advance, is reduced from two cents per pound to one cent, and this includes specimen copies sent out from the publication office. The special ten-cent stamps, to insure immediate delivery of letters, was stoutly opposed in the Senate, but was finally agreed to in conference committee. These letters will be delivered between 7 a.m. and midnight, and be of the greatest convenience and save the expense of telegrams. Orders have been issued by the Post-office Department for the preparation of a new one-cent newspaper postage stamp for publishers' use. During the last fiscal year 47,240 tons of matter subject to newspaper rates were sent through the mails. The postage amounted to 1,899,592 dols. 14 cents. This was an increase of nearly 11 per cent. over the preceding year. Allowing for the same increase in matter sent for the next fiscal year, it is estimated that the reduction to 1 cent per pound will result in a loss of over 1,000,000 dols. to the revenues of the Post-office Department on this item.

THE American Government is bestirring itself in the matter of ordnance. The work now going on for the Ordnance Department of the army can be briefly summarised. A 12in. breech-loading cast iron gun has just been completed at South Boston and forwarded to Sandy Hook for trial. Two other 12in. guns are under construction there. One of them is to be tubed and hooped with steel on the French plan. The other is to be lined with a wire-wrapped steel tube. The first casting for this gun unfortunately went to pieces in the lathe, and a new casting is to be made. A 12in. mortar has been completed at South Boston and sent to Sandy Hook. At the Watertown Arsenal a plant for wrapping guns with wire has been put up, and two 10in. breech-loading wire-wrapped guns are to be constructed there. One is to be a cast iron gun and the other a Whitworth steel tube built upon the Woodbridge plan. This gun is now at the Washington Navy-yard to be bored. An 8in. breech-loading steel gun is now fully half-finished at the West Point Ironworks. The tube and jacket are from Whitworth and the hoops from Midvale. The department has also opened negotiations with Whitworth for a 10in. gun, on the same plan as this 8in. gun last mentioned.

INVESTIGATIONS have been recently made by Dr. Klopsch to determine whether the sewage of Breslau is sufficiently purified by passing through the soil of the irrigation fields to allow of its discharge into the surface waters. The Breslau sewers discharge annually 11,000,000 cubic metres of sewage, containing 100 grammes of nitrogen per cubic metre, or, annually, 1,100,000 kilogs. If we take 150 kilogs. per hectare as the largest amount of nitrogen which can be used as a fertiliser without waste, we have here an allowance sufficient for 7000 hectares; it is, however, all distributed upon 300 hectares. The result is that the sewage is very far from being purified, although the usual sewage farm statements are made of the labourers drinking the effluent water without ill effects. In this case the water from the drains is yellow, slightly turbid, has a musty odour, and contains both ammonia and organic matter. Of the fertilising ingredients only the phosphoric acid is anything like completely absorbed; one quarter of the potash finds its way into the drains, and 30 per cent. of the nitrogen, the latter, however, largely in the form of nitrates. The experience of three years shows no reason to fear a clogging of the ground, or a diminution of its purifying power, or an excessive and injurious accumulation of the mineral substances which are counted among the plant foods, such as phosphoric acid, potash, and magnesia.

CONTRACTS OPEN.—FLEXIBLE BUFFERS AND SCREW COUPLINGS FOR CARRIAGES AND WAGONS, INDIAN STATE RAILWAYS.

(For specification see page 363.)



THE INVENTIONS EXHIBITION—HULSE'S MACHINE TOOLS.

FIG. 1.

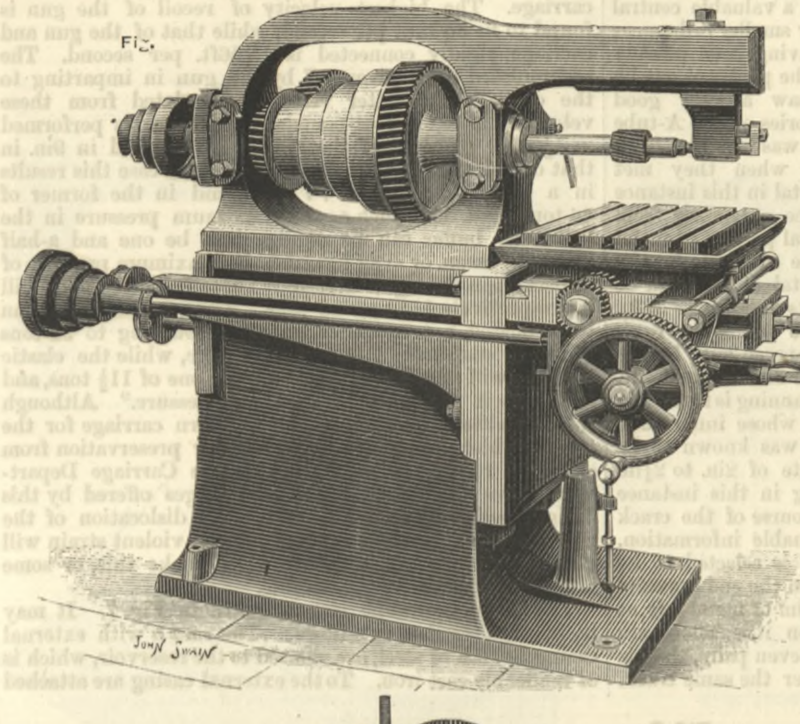


FIG. 3.

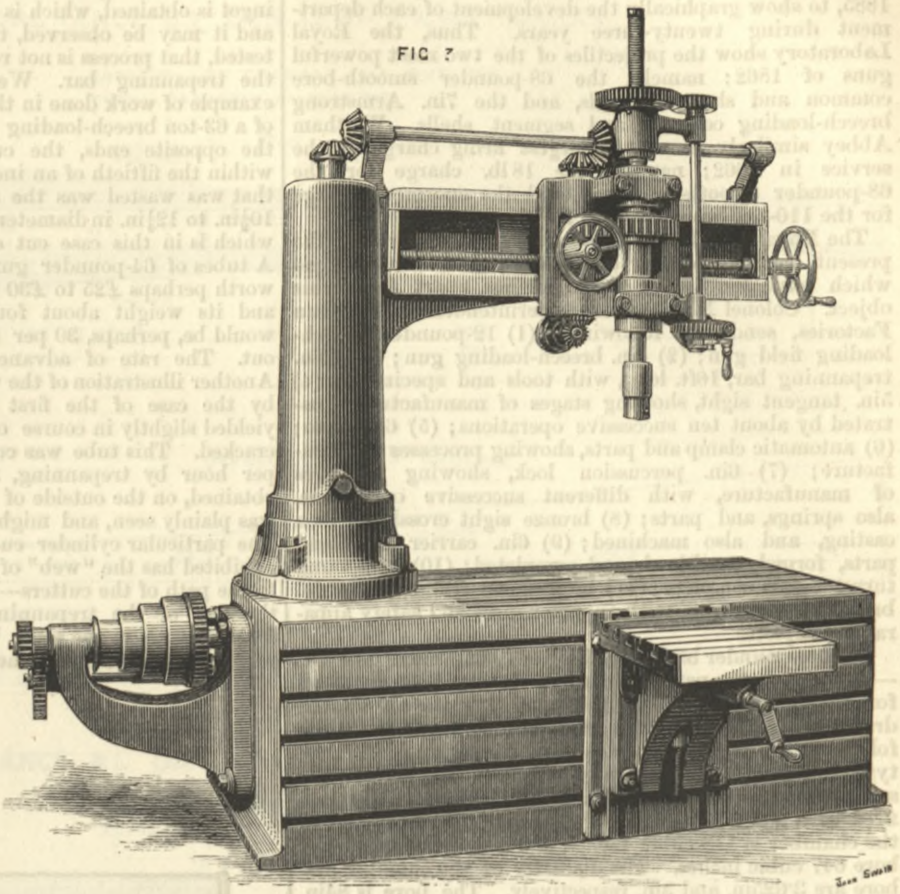


FIG. 4.

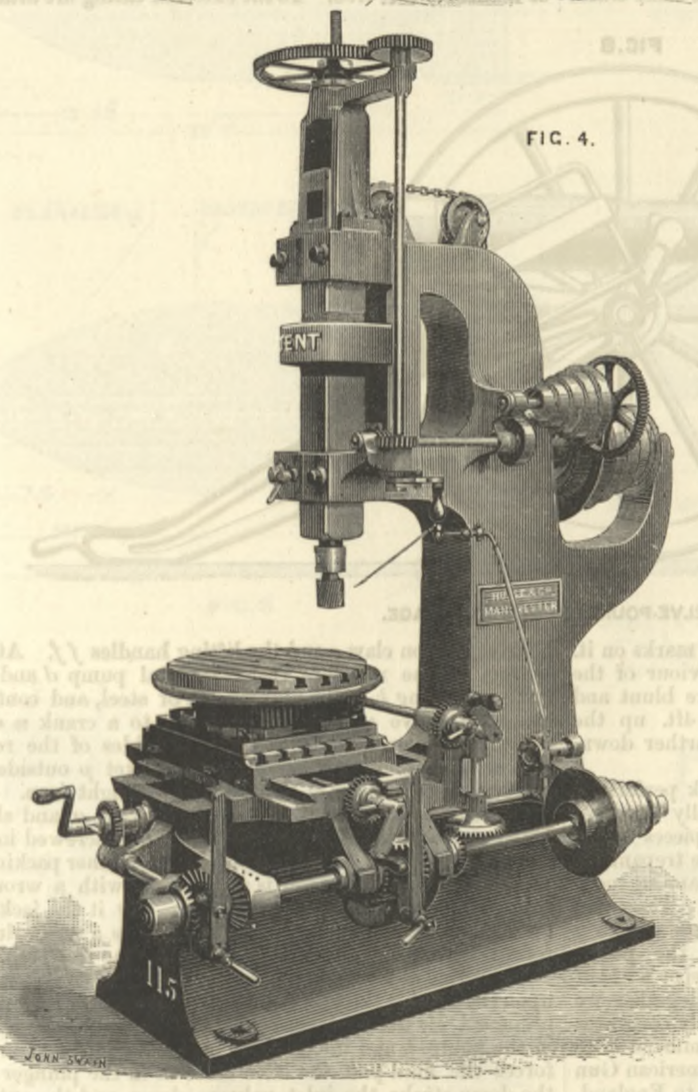
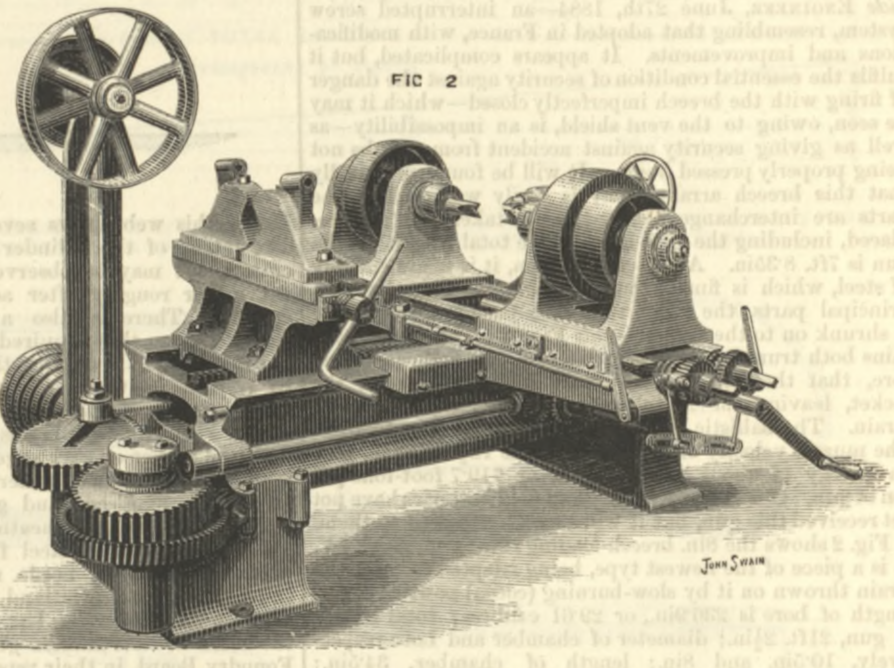


FIG. 2.



In the Western Gallery Messrs. Hulse and Co., of Salford, exhibit a representative collection of machine tools. Some of these we illustrate above. They are none of them what would be called new tools, but are examples of known types all of which have some features of novelty suggested by experience, and are of the design and workmanship which has secured to the firm its high reputation amongst tool users. The machines are of comparatively small size, in consequence of the limited space at disposal. One of the tools is a gap bed lathe for sliding, surfacing, and screw-cutting, and designed so that objects may be turned or screwed close up to the face plate whether the gap is open or closed. The guide screw is within the bed, so as to be more nearly in line with its work and to pull the rest carriage without that cross grip friction which is sometimes observable when the screw is outside the bed. It may, moreover, be extended across the gap or withdrawn without interference with the carriage or tools. Another tool is a hollow spindle lathe for turning, screwing, and finishing studs and bolts, which may be made from bars passed through the spindle and cut to length after being finished, instead of as hitherto, cutting the bar previously into short lengths and then centreing the ends. The piece or bar is quickly and firmly gripped or released by a concentric die chuck, and the screwing apparatus is readily swung into position for screwing, or outwards when not so required. A sliding saddle, carrying a capstan rest for six tools, is employed for sliding and turning work, and is brought readily into or out of action.

Another noticeable machine is a broad traverse planing machine designed to give either fine, medium, or extraordinary broad feed traverse to the cutting tools, by fine gradations, which may be readily varied whilst the machine is working. In the small machine exhibited this feed extends from $\frac{1}{32}$in. to 1in. wide. It is effected by the traverse of the table on returning each stroke after the cutting operation. The machine exhibited is strong for its size, and is provided with two tool-boxes, self-acting in all cuts and in relieving. The arrangement of the pulley and gearing for propelling the table is designed to cope with deep or broad cuts in steel.

A radial drilling and boring machine, in which the driving gear may be driven from a main shaft running either parallel with or at right angles to the machine, as desired, is also shown by Messrs. Hulse and Co., and illustrated by Fig. 3. The driving may be fixed, as shown, or at one side. A strong rectangular box bed, with grooved top and side, is provided for holding the work, to which a round column is bolted, around which the radial arm turns, and by which the drill spindle commands more than three-fourths of the circle. The self-acting feed mechanism is fitted by adjustments free from end play.

A combined vertical milling and drilling machine is also shown, and is illustrated by our engraving, Fig. 4. The revolving cutter spindle is carried within, and by a square vertical slide, so that the main bearings of the spindle are always close to the cutter, and retain a firm hold upon it in all positions of adjustment. The square slide being comparatively narrow, may, with the cutter, be got to operate in the interior of work, which, with an ordinary slide, is impracticable. The table for holding the work is grooved and surrounded by a trough for the lubricant and self-acting feed and reversing motions, and provided for the longitudinal transverse and circular slides. An improved chuck for holding the cutter firmly and truly is fixed to the end of the spindle, and a self-acting down motion for drilling is available when required. The object sought and obtained in this machine is steadiness in circular cutting, so as to get more and better work, and by steadiness of action the cutters last longer, whilst the means for holding and traversing the work rectilineally and circularly enable the machine to produce various forms of work with ease and facility. A small pump is attached to the machine for forcing the lubricant on to the cutter.

A horizontal milling machine for straight milling generally, and made of great strength and power for cutting steel or iron with rapidity, is also shown. Of this we give an engraving at Fig. 1. The table for holding the work is fitted with vertical, longitudinal, and transverse slides, the latter having a variable automatic feed and self-stopping mechanism. A small pump is attached to the machine for forcing the lubricant over the cutter.

Another machine of this class, known as a profiling milling machine, is shown, consisting of a strong slide bed and frame cast in one; a grooved table bounded on its side and ends by a trough for the lubricant, and provided with variable automatic feed and self-stopping mechanism. The profiling spindle slides easily in response to the former by hand lever or weight. Screws with disengaging nuts are also provided for the vertical and horizontal slides, so that straight milling work can be effected automatically. To this machine also a small pump is attached for forcing the lubricant on to the cutter.

A very handy horizontal slot drilling machine, Fig. 2, for drilling cutter holes, keyways, &c., in locomotive and general engineering work, is shown. The work is supported at one end by a movable headstock, and held in position by a concentric vice, or may be bolted to a removable grooved table, as is most suitable. It has two drilling headstocks, which operate in the same line, but on opposite sides of the work. These are provided with variable automatic feed and self-stopping mechanism. The sliding carriage is traversed along the bed by elliptical wheels for uniformity of traverse, and a suitable speed is provided for each inch of stroke. The carriage is actuated through the centre line of the bed, so as to avoid cross straining.

A vertical drilling and boring machine is shown which has framing of an improved form, allowing the driving belt to work at any angle which is likely to occur in practice for driving the machine. It is provided with a variable self-acting feed motion, by screw with nut adjustable endwise for taking up end play, and preventing unsteadiness in the cut. The table is grooved on the top and also one side, and to the latter; objects requiring to be drilled at their ends may be fixed and operated upon, the base-plate having an opening to allow of long objects extending below into a pit. The table is arranged to move laterally and radially for the purpose of adjusting the work to the cutter, and is raised or lowered by screws.

Messrs. Hulse and Co. also exhibit some small tools, including a pipe-screwing apparatus and some new forms of tool-holders.

THE INVENTIONS EXHIBITION—GUNS AND WAR STORES.

The Government manufacturing departments in several cases exhibit the representative designs of 1862, contrasting with them corresponding designs of the present date, 1885, to show graphically the development of each department during twenty-three years. Thus, the Royal Laboratory show the projectiles of the two most powerful guns of 1862; namely, the 68-pounder smooth-bore common and shrapnel shells, and the 7in. Armstrong breech-loading common and segment shells. Waltham Abbey similarly shows the largest firing charge in the service in 1862; namely, the 18 lb. charge for the 68-pounder smooth-bore gun, and the enormous charge for the 110-ton breech-loading rifled gun.

The Royal Gun Factories exhibits guns illustrating the present character of our equipments, as well as designs which have special individual claims apart from this object. Colonel Maitland, the superintendent of the Gun Factories, sends the following:—(1) 12-pounder breech-loading field gun; (2) 8in. breech-loading gun; (3) 20in. trepanning bar, 16ft. long, with tools and specimens; (4) 5in. tangent sight, showing stages of manufacture, illustrated by about ten successive operations; (5) 6in. ditto; (6) automatic clamp and parts, showing processes of manufacture; (7) 6in. percussion lock, showing processes of manufacture, with different successive operations, also springs, and parts; (8) bronze sight crosshead, as a casting, and also machined; (9) 6in. carrier ring and parts, forged, machined, and completed; (10) compound turret sights complete; (11) bronze end frame and model breech of 9·2in. gun, with appurtenances and safety apparatus complete.

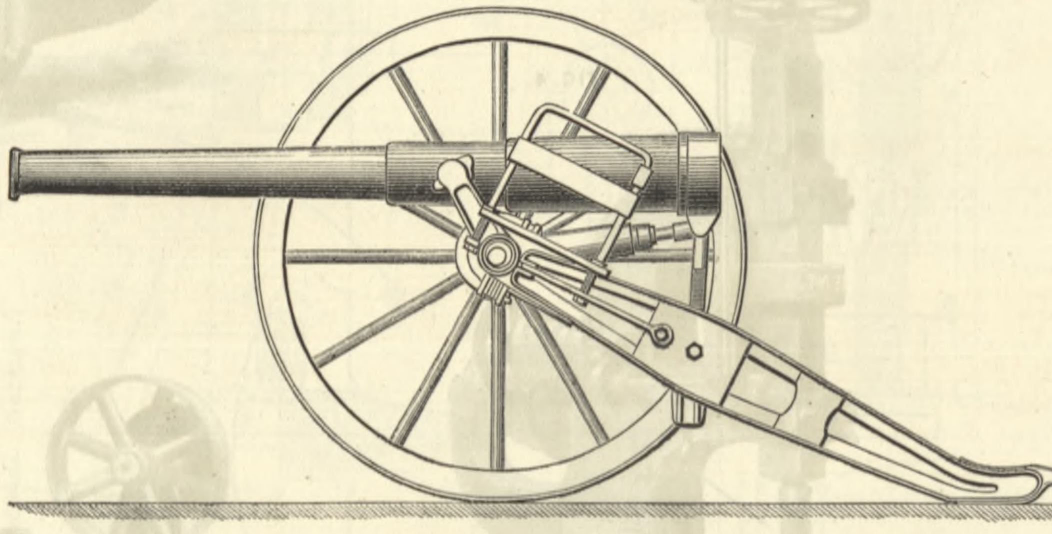
Twelve-pounder breech-loading field gun, 7 cwt. Mark I.—This gun is the pattern approved for our field batteries for future service. Its dimensions are shown on the drawing, Fig. 1. The chief characteristic features are the following:—Form and proportions: It is a gun of the new type, constructed to give a high velocity—viz., 1705ft. per second muzzle velocity—with a 12½-lb. projectile, when fired with a charge of 4 lb. "P" powder. The capacity of the chamber is 118 cubic inches, and the capacity of the bore 647 cubic inches. The diameter of the chamber and bore are 3·625in. and 3in. respectively. The bore is 84in. in length, or 28 calibres. It is rifled on the polygrooved system, the grooves being twelve in number, having increasing twists from one turn in 120 calibres at the breech to 1 in 28 calibres at 35·8in. from the breech, the remaining 35·8in. being a uniform twist of 1 in 28 calibres. The gun weighs 7 cwt. The system of breech-closing is that adopted generally in the service, viz., the system described, as adapted to larger guns, in Colonel Maitland's paper—*vide* ENGINEER, June 27th, 1884—an interrupted screw system, resembling that adopted in France, with modifications and improvements. It appears complicated, but it fulfils the essential condition of security against the danger of firing with the breech imperfectly closed—which it may be seen, owing to the vent shield, is an impossibility—as well as giving security against accident from a tube not being properly pressed home. It will be found practically that this breech arrangement is easily worked, and the parts are interchangeable, and easily taken out and replaced, including the vent itself. The total length of the gun is 7ft. 8·35in. As to construction, it is made entirely of steel, which is finally toughened in oil. There are two principal parts, the "A" tube and jacket. The latter is shrunk on to the former—*vide* Fig. 1. The jacket contains both trunnions and breech-screw. It follows, therefore, that the longitudinal strain falls entirely on the jacket, leaving the A tube free to meet the tangential strain. The ballistic qualities of this gun are as follows: The muzzle velocity of 1705ft., with the 12½ lb. shell, give an energy of about 252 foot-tons, or 719·7 foot-tons per ton of gun. Our Horse Artillery and field batteries have not yet received this gun, but it will soon be supplied to them.

Fig. 2 shows the 8in. breech-loading rifled gun, Mark IV. It is a piece of the newest type, being adapted to meet the strain thrown on it by slow-burning (cocoa) powder. The length of bore is 236·9in., or 29·61 calibres; total length of gun, 21ft. 2⅞in.; diameter of chamber and bore respectively, 10·5in. and 8in.; length of chamber, 34·5in.; capacity of chamber, 3050 cubic inches, and of bore 13,466 cubic inches. The bore is rifled on the polygrooved system, having thirty-two grooves of the form shown in Fig. 2. The twist increases from one turn in 120 calibres at the breech to one in 35 calibres at 99·7in. from breech, the remaining 99·7in. being a uniform twist of one turn in 35 calibres. The breech-closing arrangement is the same as that described in the case of the 12-pounder. The construction of the gun is shown in Fig. 2. It consists of an A tube with breech piece, a B tube and trunnion hoop, small C and four D coils. It may be seen that the breech screw is made in the breech piece, and the hooks are arranged to give the same longitudinal hold from breech and trunnion that is furnished by the jacket in the case of the 12-pounder gun, the "A" tube being left in the best condition to resist the tangential strain that falls directly on it. The B tube in this pattern extends much farther forward than in previous guns, the slow-burning and development of the force far forward in the bore having rendered this desirable.

The trepanning bar deserves special attention. Brought out in the Gun Factories, it has met with appreciation, and has been adopted elsewhere. The name suggests the character of its work. It is shown in Fig 3. By cutting out a ring of metal, leaving a core from end to end, a great saving is effected in work as well as in material. The form of head and cutters may be seen in Fig. 3, at A; B shows the end view, C details of bits, and D a section of ingot with space and solid core shown in elevation. A strong current of soap and water is forced down the inside of the bar, and it returns up grooves leading from the cutters, carrying in it the cuttings of metal as they come off. By making the work revolve, the bar is kept centred, which in very long borings would, of course, be otherwise a difficult achievement.

The application of the trepanning system saves in some cases as much as 50 per cent. in labour, besides the saving of waste in material. The most favourable cases of its application are those when a bore of large size is required to be cut in a solid steel ingot. In such cases, by cutting a circular or ring cut from end to end, a valuable central ingot is obtained, which is available for smaller ordnance; and it may be observed, the metal having been already tested, that process is not required for the piece cut out by the trepanning bar. We recently saw a very good example of work done in the Gun Factories on the A-tube of a 63-ton breech-loading gun. This was cut out from the opposite ends, the cuts agreeing when they met within the fiftieth of an inch. The metal in this instance that was wasted was the annular space extending from 10½in. to 12¼in. in diameter. The central portion of metal which is in this case cut out would be available for the A tubes of 64-pounder guns. The metal of it would be worth perhaps £25 to £30 per ton. Its length was 32ft., and its weight about four tons. The saving in work would be, perhaps, 30 per cent., as compared with boring out. The rate of advance was about 3in. in an hour. Another illustration of the value of trepanning is furnished by the case of the first 80-ton gun, whose inner tube yielded slightly in course of time, and was known to be cracked. This tube was cut out at a rate of 2in. to 2¼in. per hour by trepanning, a tube being in this instance obtained, on the outside of which the course of the crack was plainly seen, and might afford valuable information. The particular cylinder cut out which is selected to be exhibited has the "web" of metal left on the end opposite to the path of the cutters—in fact the film of metal left at the end of the trepanning-cut left on it. There are fourteen tools in the same bar, set in seven pairs, that is so as to cause two of them to go over the same track.

FIG. 8



TWELVE-POUNDER GUN CARRIAGE.

Hence this web shows seven tracks or tool marks on it. The outside of the cylinder shows the behaviour of the cutters. It may be observed that they wore blunt and cut rather roughly after advancing about 4ft. up the cylinder. There is also a lesser mark farther down, showing when they required to be sharpened.

Interesting as is the question of large work performed by trepanning, that on a small scale equally deserves attention. It is employed for cutting test pieces out of steel. Formerly a piece was cut out by a large trepanning tool, and broken off by wedges; now small trepanning tools, aptly termed "cheese tasters," are employed. These are about 1¼in. diameter, and generally cut pieces out to a length of 4¼in. The neatness of this, and the power afforded of removing steel from any desired spot without unnecessary injury, needs no comment. Altogether we think that Colonel Maitland is to be especially congratulated on the trepanning bar, and we would commend it to the notice of steel makers generally. The American Gun Foundry Board, in their report on their visit to England, briefly mention this process.

The Royal Carriage Department, under Colonel Close, R.A., exhibit the following designs:—(1) 12-pounder hydraulic carriage; (2) 20-ton hydraulic jack; (3) a modification of Baker's forge blower. The 12-pounder carriage was designed to enable the pressure of recoil, which expends itself in 1½in. of motion, to be extended or distributed over about 9in. Mr. H. J. Butter, the constructor of the Department, in describing this carriage in a paper read by him at the Institution of Civil Engineers, makes the following observations:—"Several conditions of construction in the rigid field carriage may not be greatly altered in the elastic carriage, and giving due consideration to these, and applying the elastic apparatus in various ways, different designs were worked out, one of which only, as being sufficient for the purpose, is selected for illustration. In this design—Figs. 8 and 10—a tubular steel axle is adopted, which passes through the upper ends of a pair of levers constituting the trail; two upright levers are connected with and rotate about the axle; the gun rests in the upper ends of these levers, and is connected at the breech end to the piston-rod of a hydraulic buffer, the buffer itself being fastened to the axle. The hydraulic buffer—Fig. 9—which constitutes the elastic medium, is made wholly of gun-metal, to ensure regularity of action, and is small and light, weighing only about 28 lb., which admits readily of spare buffers being carried with the battery, yet possessing ample strength to resist the pressure of recoil. The levers are so placed as to cause the centre of gravity of the gun when in the firing position to be 6in. in front of a vertical line passing through the centre of the axle, to ensure the gun, after recoil, falling of itself into the proper position for firing. Stops with india-rubber pads are provided to receive the weight of the gun in the two extreme positions. From the data furnished by the preceding investigation on the force of recoil, and the ascertained results of the same principle of carriage used with the 26-ton gun, a fair approximation may be made to the enormous reduction of strain gained by the use of the elastic principle in this carriage. The highest velocity of recoil of the gun is found to be 36·12ft. per second, while that of the gun and carriage rigidly connected is 15·56ft. per second. The accumulated work given off by the gun in imparting to the carriage the latter velocity, calculated from these velocities, is 12,935 foot-pounds. This work is performed in 1½in. in the case of the rigid carriage, and in 9in. in that of the elastic carriage. In the latter case this results in a mean pressure of 7·7 tons, and in the former of 46 tons; but inasmuch as the maximum pressure in the hydraulic buffer can be regulated to be one and a-half times the mean, or even less, and the maximum pressure of impact upon the rigid carriage is twice the mean, they will be respectively 11½ and 92 tons. Thus, as nearly as can be estimated, a pressure of impact amounting to 92 tons has to be sustained by the rigid carriage, while the elastic carriage will only be required to meet one of 11½ tons, and this more in the nature of a statical pressure." Although the committee preferred another pattern carriage for the service which depended on springs for preservation from shock of recoil, the authorities of the Carriage Department have confidence in the advantages offered by this design, believing that on service the dislocation of the parts of a field carriage exposed to such violent strain will ultimately prove so destructive as to make this, or some alternative design, very desirable.

The 20-ton hydraulic jack is shown in Fig. 7. It may be briefly described as follows:—The ram *a* with external casing *b*, both of steel, are secured to the reservoir, which is of malleable cast iron. To the external casing are attached a wrought iron claw *e* and the lifting handles *f f*. At the bottom of the ram are the gun-metal pump *d* and the leather packing *k*. The plunger *l* is of steel, and contains the inlet valve *m*. It is connected to a crank *n* on a spindle *o* supported in bearings in the sides of the reservoir *c*. The spindle *o*, of steel, has a socket *p* outside the reservoir for the lever *q*, which is of wrought iron. The ram cylinder *g*, of steel, fits over the ram *a* and slides between it and the external casing *b*. It is screwed into a malleable iron foot *h* and is fitted with a leather packing *r*. At the top of the reservoir is an air hole with a wrought iron screw plug *s* and leather washer. By it the jack can be filled or emptied. The lever handle has a screw driver formed on one end of it for use in removing the plug.

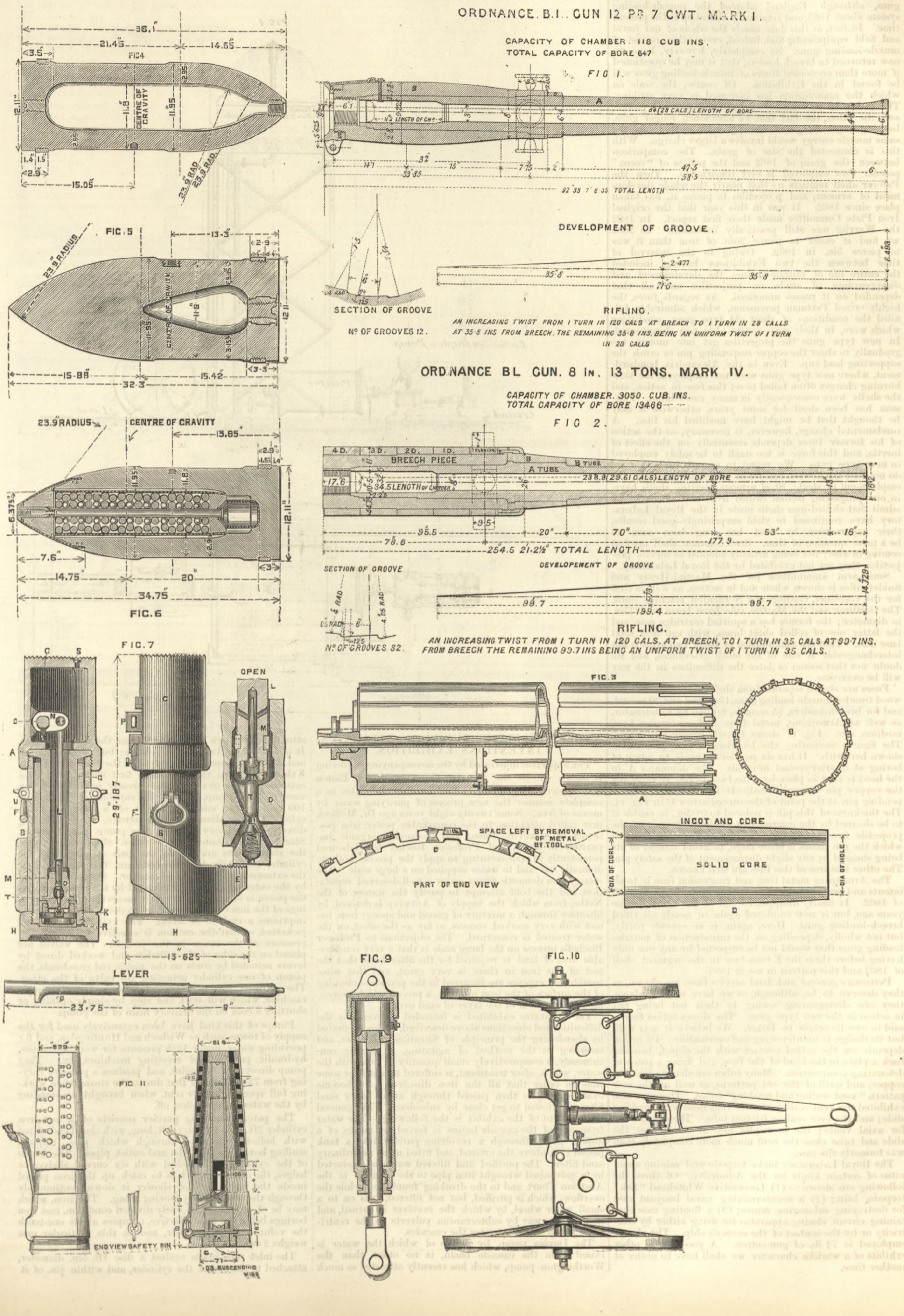
The action of the jack is as follows:—The lever *q*, acting upon the crank *n* through the spindle *o*, raises and lowers the plunger *l*. By the up stroke of the latter, a vacuum is created in the pump *d*, and the pressure of the air in the reservoir forces the fluid past the inlet valve *m* in the plunger; at the down stroke the inlet valve *m* closes, and the outlet *t* opening, the fluid is forced from the pump under the ram, thus raising it with the load. A small hole *u* limits the height of lift, by allowing the fluid to escape when the ram leather passes it. To lower: the lever is shifted in the socket *p* so as to bring its shoulder upwards, and then pressed gently downwards, until the plunger touches the valve *t*. It is then forced down to its full extent, which opens the outlet valve *t* and allows the fluid in the cylinder to escape through the space round the plunger *l* in this position back to the reservoir. The jacks are filled with methylated spirit. Water should never be used for filling them.

Baker's forge blower improved in the Royal Carriage Department offers the advantages of great speed of current generated in a small space. The screw clutch prevents back draught. It is applied to field forges for cavalry and artillery, and has been reported to be the best known. It is applicable to any small forge.

The Royal Laboratory, under the superintendent, Colonel Barlow, R.A., send the following exhibits:—(1) 68-pounder smooth-bore 18 lb. cartridge, with common shell, section filled, and fitted with Pettman's land service fuse; also the diaphragm shell for the same gun. This is the largest charge of powder used in a gun in the time of the 1862 Exhibition. (2) 7in. breech-loading Armstrong gun 14 lb. cartridge, together with common shell, section filled, and fused with an Armstrong pillar fuse; also an Armstrong segment shell, section filled, and fused with E time Armstrong fuse. This represents the ammunition of the largest rifled gun in 1862. To compare with these is exhibited (3) a 12in. breech-loading rifled gun cartridge of the present date, with common shell, section filled, and fused with a "direct-action" fuse; also shrapnel shell, section filled and fused, and Palliser shell and case-shot whole. These are intended to illustrate the progress

THE INVENTIONS EXHIBITION—GUNS AND WAR STORES.

(For description see page 370.)



in the development of this branch of artillery between 1862 and 1885. On this a few remarks may be offered.

First, it may be observed that, curiously enough, we have in both cases ammunition for rifled breech-loading guns, although England adopted the muzzle-loading system about 1865, and retained it almost up to the present time. In fact, at this date nearly the whole of our naval and field equipments, and, indeed, every other, consist of muzzle-loading guns. So completely, however, have we now returned to breech-loaders, that it may be questioned if more than occasional traces of muzzle-loading guns will be found in the Exhibition. Of course, the scale on which the ammunition has increased is very striking. This is due to two causes—one, actual increase in power; and the other, the fact that we have much longer guns, burning larger charges of slower powder, so that even the same muzzle energy would involve a larger charge. With this is connected the size of grain. The comparison between the grain of 1862 and the pellets of "cocoa" powder now employed is very remarkable. Then the Palliser shell reminds us that nearly the whole development of armour, and projectiles to pierce it, has taken place since 1862. It was in this year that the original Iron Plate Committee made their first report. In 1862 the Warrior was still practically invincible. In 1885 we find it easier to pierce 30in. of iron than it was to pierce 5in. in 1862. Owing to the interval of time between the two Exhibitions having included the entire life of muzzle-loading, the development and disappearance of studs on projectiles and all that depended on it passes unnoticed. As regards fuses, the highly-prized Pettman percussion, which admirably fulfilled the conditions of short old type guns—conditions which were, in their way, severe—has now disappeared. In new type guns the projectiles get into motion too gradually to sheer the copper suspending pin or crush the supporting lead cup. Even in the Alexandria bombardment, where new type guns were not employed, the slow burning charges often failed to set this fuse in action, and the shells were consequently in many cases blind. Pettman has been dead for some years, otherwise it may be thought that he might have modified his fuse. A fundamental change, however, is necessary, as the action of his former fuses depends essentially on the effect of inertia, and this force is too small to be safely employed in new type guns. We regret to remark here that we do not find the newest feature in projectiles—namely, the employment of steel. Steel armour piercing shells have, in our judgment, beaten chilled iron, and although we admit that chilled iron shells made in the Royal Laboratory have continued to yield surprisingly good results, their supersession by steel has long been seen to be a mere question of time. Steel common shell are fast coming in also; not being actually adopted as service projectiles, they are not exhibited by the Royal Laboratory.

Small-arm ammunition for the Martini-Henry and Snider rifles is shown whole and in section, as well as that for the Gardiner, Gatling, and Nordenfelt machine guns. The Gardiner and the Martini rifle have bores of 0·45in. in diameter; the former has a squirted cartridge case, and the latter one of rolled sheet brass, with cap and solid base disc. That the ammunition of these two arms is not interchangeable is one of the stock grievances, and we doubt not that sooner or later the difficulties in the way will be overcome.

Fuses are shown separate from shells in section. Boxer's wood time for muzzle-loading guns, 15 second and 30 second, and for breech-loaders, 15 seconds, ignited by a detonator, as well as Armstrong, metal time and concussion fuse, medium size. Fig. 11 shows Boxer's breech-loader fuse. The figures indicating the lengths are now printed, as shown herewith. It has six powder channels, to admit of boring at quarter-second intervals. The detonator A in the head is kept in place by a steel safety pin B, replacing the copper pin formerly used. It has a very light suspending pin at the point of the curved arrow C in Fig. 11. The thickness of this pin is reduced to 0·03in., to enable it to be sheared by the comparative gradual advance of the projectile fired in a new type gun. The hole through which the pin passes is made large, to avoid danger of its being sheared by any slight displacement of the safety pin. The other features of this fuse are well known.

The Armstrong metal time and concussion fuse is to all intents and purposes the same as that in the segment shell of 1862. It nearly disappeared out of the service some years ago, but is now employed again in nearly all rifled breech-loading guns. Here, again, is an episode partly, but not wholly, depending on the introduction of muzzle-loading guns that would not be suspected by any one only having before them the E time fuse in the segment shell of 1862 and this pattern in use in 1885.

Pettman's general and land service fuses are shown, as they deserve to be, although, as we have noticed above, they are disappearing owing to their not being put in action in the new type guns. The direct-action fuse is said to owe its origin to Boxer. We believe it acts well, but its design is uninteresting and unscientific. Its action depends on the actual contact with the object, bending back a plate in the head of the fuse, and firing a patch of detonating composition. Many tubes are shown; friction, copper, and quill of the old patterns, as well as the new pattern "vent sealing and masking" tubes. There are also exhibited the vent sealing electric vent head with masking slide; and the vent sealing friction tube. These tubes are for axial vents; the principles are as usual, but the slide and tube close the vent much more completely than was formerly the case.

The Royal Laboratory make torpedo and mining apparatus of certain kinds for the Admiralty. Of these the following are shown:—(1) Locomotive Whitehead "fish" torpedo, 14in.; (2) a countermining naval buoyant case for destroying submarine mines; (3) a floating case containing circuit closing apparatus for firing either by electricity or by the contact of the enemy's ship. The charge employed is 72 lb. of gun-cotton. A good many other exhibits of a warlike character we shall have to notice at another time.

INVENTIONS EXHIBITION—WATER-PURIFYING APPARATUS.

FIG. 1

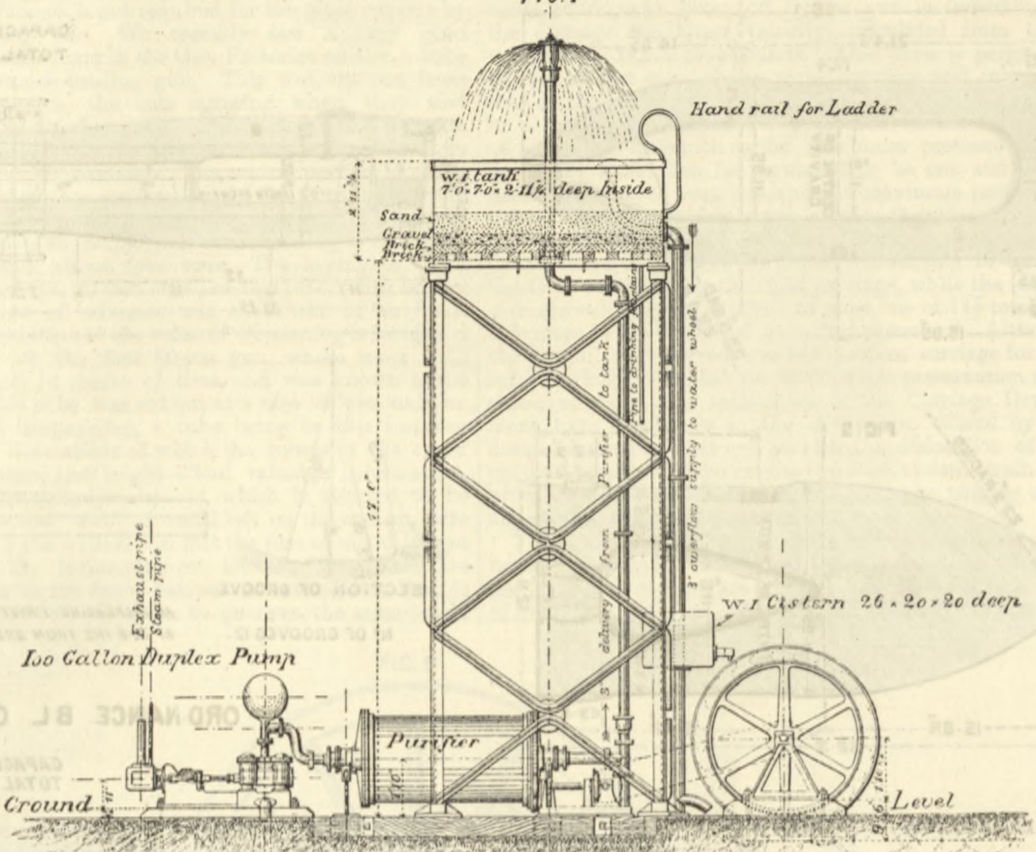
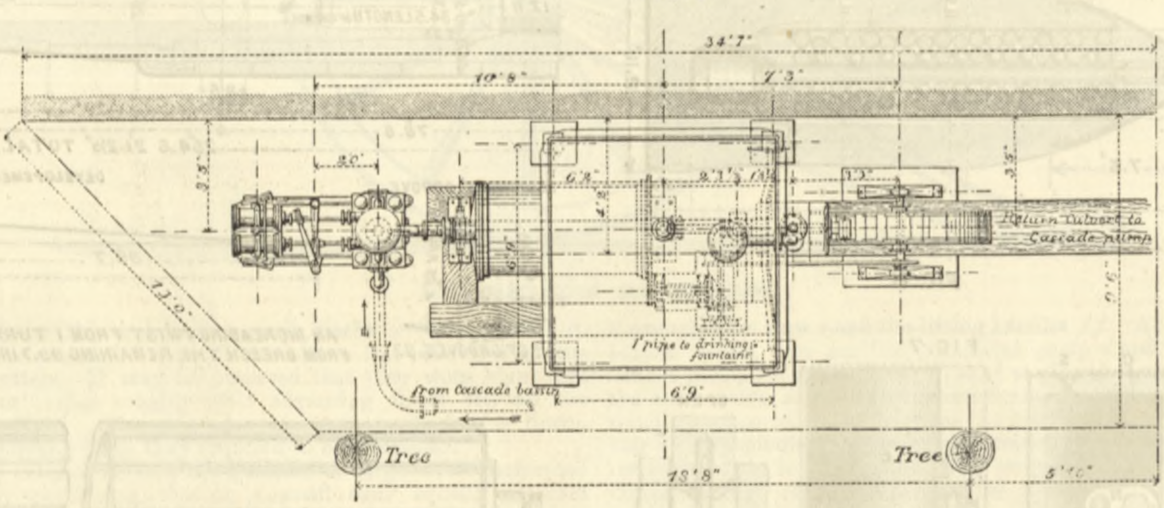


FIG. 2



ANDERSON'S WATER-PURIFYING APPARATUS: INVENTIONS EXHIBITION.

The apparatus illustrated by the accompanying engraving is shown outside the Austrian Court by Messrs. Easton and Anderson, of Erith. This exhibit illustrates in a complete manner the new process of purifying water by means of iron. Some twenty-eight years ago Dr. Medlock first called attention to the remarkable power iron possessed of removing colour and destroying organic impurities in water, and Professor Bischof has laboured persistently in endeavouring to apply the process both to domestic use and to water supplied on a large scale. The spongy iron domestic filters enjoy a well-deserved reputation, and the bold attempt to purify the waters of the Nethe, from which the supply of Antwerp is derived, by filtration through a mixture of gravel and spongy iron, has met with very marked success, so far as the effect on the water treated is concerned. The objections to Professor Bischof's process on the large scale is that a very considerable area of land is required for the filter beds, that the cost of the iron in them is very great, and that some trouble and expense are incurred in the periodical cleaning of the surface of the iron mixture, a process which necessitates the removal of the layer of sand over it.

The apparatus exhibited is intended to overcome the difficulties and objections above described. This is effected by abandoning the principle of filtration altogether, and resorting to the method of agitating, or mixing continuously, a comparatively small quantity of iron with the water, which, after treatment, is suffered to stand for some time in order that all the iron dissolved may become oxidised, and is then passed through an ordinary sand filter, or allowed to get clear by subsidence. The general arrangement of the exhibit is the following:—The water from one of the cascade basins is forced by means of a duplex pump through a revolving purifier into a tank placed 17ft. above the ground, and fitted up as an ordinary sand filter. The purified and filtered water is conducted by a galvanised wrought iron pipe to the fountain in the Austrian Court and to the drinking fountains; while the overflow, which is purified, but not filtered, falls on to a small water wheel, by which the revolver is turned, and then flows away by subterranean culverts to the centrifugal pump which operates the cascades.

The Duplex pump, by means of which the water is raised from the cascade basin, is no other than the Worthington pump, which has recently attracted so much attention as a new importation from the United States. It is, indeed, an American invention; but Messrs. Easton and Anderson acquired the patent at the time of the 1862 Exhibition, when the pump was first shown, and have manufactured large numbers of greatly improved design since. The pump, which is capable of delivering 100 gallons per minute, consists of a pair of steam cylinders 5½in. diameter, 12in. stroke, each actuating directly an ordinary double-acting pump 3½in. diameter. Steam is distributed by common slide valves; but the steam ports are double, one pair opening into the cylinder some 1⅞in. from the ends and the other pair at the extreme ends in the usual manner. Steam is admitted by the outer passages and exhausted by the inner ones, but the piston is so constructed that it passes the cylinder openings of the inner passages, and by so doing closes them and imprisons a cushion of steam. The cylinders are steam jacketted, so that the cushion is effective up to the full pressure of the steam in the jackets. The valves are placed on the sides of the cylinders and worked direct by levers actuated by studs on the piston-rod crossheads, the piston of one cylinder actuating the valve of the other. The effect of this arrangement is an extremely simple machine, which will start and stop by simply opening or shutting a cock on the delivery main of the pump.

Pumps of this kind have been extensively used for the supply of towns, such as Wisbech and Huntingdon, and for providing water under high pressure for working cranes, hydraulic presses, and rivetting machines, &c. They pump direct into the mains, and produce a pressure varying from 73 per cent. of that due to the steam when working full speed, to 94 per cent. when brought up standing by the water being all shut off.

The patent revolving purifier consists of a cast iron cylinder 2ft. 6in. diameter, 5ft. long, with closed ends fitted with hollow trunnions, through which pass, through stuffing boxes, the 3in. inlet and outlet pipes. The inside of the cylinder is furnished with six curved shelves or ledges, the office of which is to catch up the iron placed inside the cylinder, and shower it down continuously through the water slowly flowing along. The iron, which may be of any kind in a finely divided condition, cast iron borings being the most effective, occupies about one-tenth the volume of the cylinder, and in this particular case weighs 2 cwt.

The inlet pipe opens against a disc 1ft. 5in. diameter, attached to the end of the cylinder, and within ½in. of it

4 WHEELS COUPLED PASSENGER ENGINE.

MIDLAND RAILWAY.

PORTFOLIO OF WORKING DRAWINGS No. 125
SUPPLEMENT TO THE ENGNIEER FRIDAY MAY, 8, 1885

4 WHEELS COUPLED PASSENGER ENGINE.

MIDLAND RAILWAY.

This compels the entering water to spread out radially in all directions, and so flow uniformly along. The outlet pipe is fitted with an inverted bell mouth, so proportioned that the speed of the upward current through it is too low to allow any but the very finest iron to be carried up and wasted.

The cylinder is fitted with a manhole and an air cock for letting out the gases, which are sometimes apt to collect, and is driven by a spur ring cast on one of the end covers, actuated by a train of wheelwork, which is brought into motion by a small overshot waterwheel, through the instrumentality of a pitch chain.

The water from the purifier, impregnated with iron, is carried by a 3in. pipe through the bottom of a wrought iron tank, 7ft. square and 3ft. deep, which is formed into an ordinary sand filter. The water falls from the delivery pipe some 4ft., in the form of a thin bell jet, and in that way gets well exposed to the air. It runs through the sand at the rate of 12 cubic feet per twenty-four hours, and as the water is 18in. deep over the sand, it will remain for three hours before it reaches the latter, thus giving sufficient time for all the iron to become oxidised and precipitated.

The filter is capable of yielding about 2½ gallons of water per minute, the surplus delivered by the pumps, or 97½ gallons, after working the water wheel, by which means it is further aerated, flows into the return culvert leading to the centrifugal pump near the Albert Hall, where it is again lifted to play the cascades. The iron taken up by the water will be deposited in the culvert, which will thus act the part of a sand filter. Three of the Anderson revolvers, capable each of dealing with 1500 gallons per minute, or together, 2,160,000 gallons per day, were set to work in the month of March last at Antwerp, and are now purifying the whole of the water supplied to the city in a most satisfactory manner. The turbid and highly impure waters of the Nethe, quite as offensive as those of the Thames at London Bridge, are rendered perfectly colourless, brilliant, agreeable to the taste, and chemically more pure than any water supplied to London.

The quantity of iron consumed depends upon the quality of the water being treated; it is not likely to exceed one-tenth grain per gallon, or, say, 14 lb. per million gallons. The cost will depend upon the current price of iron, but as borings and turnings form the best material, the expense is, in any case, very insignificant. The power required to drive the machine is also very small, about ½-horse power per million gallons per day.

RECENT EXPERIMENTS WITH GRUSON'S CHILLED IRON ARMOUR

A TRIAL against a side plate of a turret of Grüson's chilled cast iron, constructed for two 12 cm. (4·7in.) guns took place at Buckau, January 19th and 20th, 1885.

The object and programme of the experiment was to test the shield by twenty rounds of the Prussian 15 cm. (5·9in.) gun firing hardened steel shells (Ternitz); charge, 6 9 kilogs. (15·2 lb.); prismatic powder, "const. 68;" that is to give velocity equivalent to that at 1000 metres range (1094 yards). All the blows were delivered against the left half of the plate.

The plate was sought to be divided by the first five blows rounds one to five, in two nearly equal parts, in order to attack the left half only, and in a way free from objects. Five projectiles out of the twenty to have flat heads. If the plate after fifteen blows, *i.e.*, ten per square metre of plate's vertical projection should not be breached, and its interior surface not exhibit cracks dangerous to the gun detachments, the resistance should be considered sufficient. After this five more rounds should complete the experiment.

The form experimented on differs materially from that of previous shields, its construction being based on the results of former experiments. The profile is debased or flattened considerably, so as to avoid an angle of impact exceeding 46½ deg. from a shell striking horizontally. The plate was fixed between two other side and one roof plate, so as to form nearly a half cupola. At the open side it was supported by pillars of masonry by means of intermediate iron coupling plates, the whole being protected from shell fire by earth and wood.

Fig. 1 gives dimensions and profile of shield. The greatest width, measuring round the curve—"développée"—was 3·8 m. (12ft. 1·7in.); that at the top edge was 2·15 m. (7ft. 0·6in.). The weight was 19,918 kilogs. (19 tons 12 cwt. 0 qr. 7 lb.). The Prussian 15 cm. (5·9in.) gun was mounted in position to deliver seven blows opposite to the centre of the plate at 36 m. (118·1ft.) range, for the remaining rounds at 24 deg. to the left. The projectiles employed were Ternitz hard tempered steel shells filled with sand weighing 34·5 kilogs. (76·06 lb.). The charge was 6·9 kilogs. (15·2 lb.) prismatic powder, as above stated. The initial velocity was 395 m. (1296ft.). Round 1: Weight, 33·3 kilogs. (73·4 lb.), filled with 1·2 kilogs. (2·6 lb.) sand, struck on centre line of plate—*vide* Fig. 2, which shows the plate surface unrolled—developed; angle of impact 34 deg. 15 min. Effect: a bruise of 10 cm. (3·94in.) width, and 7 mm. (0·276in.) depth. The projectile glanced off and broke up into numerous fragments, the pieces showing an excellent fracture. Round 2: Full weight (76·06 lb.) without sand. The projectile struck 26 cm. (10·2in.) to the left of the centre line—*vide* Fig. 2—at an angle of impact 40 deg. 10 min., making a bruise 11 cm. (4·33in.) wide, and 9 mm. (0·035in.) deep, glancing and breaking up. Round 3: Steel shell, 33·1 kilogs. (729·7 lb.), flat headed—that is, with a slightly concave surface 130 mm. (5·118in.) in diameter, and 10 mm. (0·394in.) deep, so as to have a cutting edge, the weight made up to 34·5 kilogs. (76·06 lb.) with lead and sand. The projectile struck 16 cm. (6·3in.) below the top edge of the shield, at an angle of impact 25 deg. 56 min. Effect: a bruise of 8 cm. (3·15in.) width, and 34 mm. (1·339in.) depth, the depth being less towards the sides and top; five short radiating air cracks; nothing visible at back of plate. The projectile glanced and broke up. Round 4: Steel shell full weight without sand. It struck 31 cm. (12·2in.) to the left of centre line—*vide* Fig. 2—37 cm. (14·6in.) below top edge; angle of impact, 29 deg. 27 min.; making a bruise of 9 cm. (3·54in.) width, and 5 mm. (0·197in.) depth, glancing and breaking up. Round 5: Steel shell, full weight, struck on centre line—*vide* Fig. 2—at an angle of 43 deg. 22 min. 30 sec., making a bruise of 12 cm. (4·7in.) width, and 8 mm. (0·315in.) depth, glancing and breaking up. Round 6: Steel shell, full weight, striking 39 cm. (15·4in.) to the left of centre line, and 12 cm. (4·7in.) above the front edge of the shield—*vide* Fig. 2—at an angle of 46 deg. 15 min., making a bruise of 13 cm. (5·12in.) width, and 12 mm. (0·472in.) depth, glancing and breaking up. Nothing was visible at the back of the shield. Round 7: Steel shell full weight. This was directed at the centre of the shield to take the place of the twentieth round of the programme, in order to save bringing the gun back to this position again. The shell struck 30 cm. (11·8in.) to left of centre line, and 42 cm. (16·5in.) above the front angle of the shield—*vide* Fig. 2—at an angle of 42 deg. 19 min., making a bruise 13 cm. (5·1in.) wide, and 4 mm. (0·158in.) deep, and one hair crack connecting points of impact 6 and 7 together. The projectile glanced and broke up. Nothing was visible at back of shield.

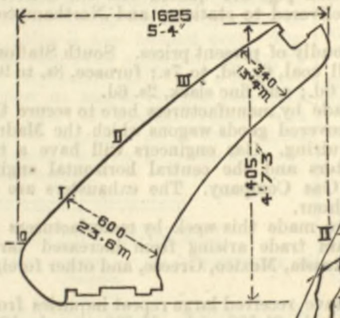


FIG. 1

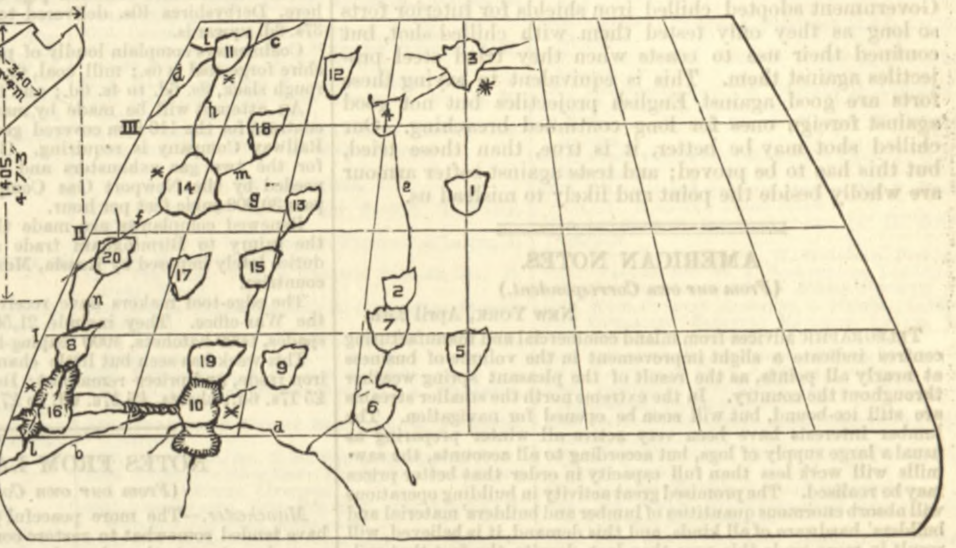


FIG. 2

FIG. 3

GRUSON'S CAST IRON TURRET.

On January 20th the gun was fired from a point 24 deg. to the left of the original position, 36 m. (118·1ft.) range; that is, the lines from axis of shield to gun in the two positions apparently formed radii of a circle 24 deg. apart, so as to give lines of fire normal to the horizontal section of the shield. Round 8: Steel shell, full weight. Struck 15 cm. (5·9in.) to the right of the left edge of the plate, and 35 cm. (13·8in.) above the front angle of the shield, at an angle of impact of 43 deg. 11 min., making a bruise 13 cm. (5·12in.) wide and 5 mm. (0·197in.) deep, and one hair crack upwards towards the left and one downwards—*vide* Fig. 2. The projectile glanced and broke up. Nothing was visible at the back. Round 9: Steel shell, weighing 33·3 kilogs. (73·4 lb.), filled up with 1·2 kilog. (2·65 lb.) of sand. It struck 100 cm. (39·4in.) from the left and 28 cm. (11in.) above the front angle of shield—*vide* Fig. 2—at an angle of impact of 43 deg. 44 min., making a bruise 11 cm. (4·3in.) wide and 9 mm. (0·354in.) deep, glancing and breaking up. Round 10: Steel shell, flat-headed, weighing 33·3 kilogs. (73·4 lb.), filled up with 1·2 kilog. (2·6 lb.) of lead and sand. It struck 74 cm. (29·1in.) from the left and 12 cm. (4·7in.) above the front angle of shield, at an angle of impact of 46 deg. 28 min., making a bruise 13 cm. (5·12in.) wide and 38 mm. (1·496in.) deep, and two cracks, *a* and *b*, about 10 cm. (0·394in.) deep, which did not appear to reach to the interior, but rather to continue under the surface. There were also two short vertical hair cracks. There was nothing visible at the back of the shield. The projectile glanced and broke up. Round 11: Flat-headed, weight 33 kilogs., and made up with lead and sand to 34·5 kilogs. (76·06 lb.). It struck 19 cm. (7·5in.) from the left edge and 15 cm. (5·9in.) from the top at an angle of 25 deg. 57 min., making a bruise 14 cm. (5·5in.) wide and 10 mm. (0·394in.) deep, with two hair cracks *c* and *d*—*vide* Fig. 2. Nothing was visible at the back; the shell glanced and broke up. Round 12: 32·9 kilogs. steel shell and 1·6 kilog. sand struck high up—*vide* Fig. 2—at 26 deg. 22 min. 30 sec., making a bruise 9 cm. (3·54in.) wide and 9 mm. (0·354in.) deep, and a crack *e* on Fig. connecting 4 and 2; the projectile broke up. Nothing was visible at the back. Round 13: Full weight, struck spot marked 13 on Fig. 2 at 34 deg. 45 min., making a bruise 10 cm. (3·94in.) wide and 3 mm. (0·118in.) deep, breaking up. Round 14: Steel shell, flat-headed, weight 32·7 kilogs. (72·1 lb.), made up with lead and sand to 76·06 lb.; struck as shown in Fig. 2 at an angle of 35 deg. 30 min., making a bruise 18 cm. (7·1in.) wide and 25 mm. (0·98in.) deep, surrounded by irregular fractured edges of slight depth, three hair cracks, *f g* and *h*, and one crack *i* developed to the left of No. 11. There was nothing visible at back of shield, and the projectile glanced and broke up. Round 15: Steel shell, full weight, struck at point shown on Fig 2 at 38 deg. 40 min., making a bruise 12 cm. (4·7in.) wide and 5 mm. (0·20in.) deep, with two hair radiating cracks. At the back the crack *e* is now visible, running from a point 54 cm. (21·3in.) from upper edge and parallel to the centre line about 22 cm. (8·7in.) distance. The projectile glanced and broke up. Round 16: Flat-headed steel shell, weight 32·9 kilogs. (70·5 lb.), made up with lead and sand, struck point shown on Fig. 2 at 46 deg. 6 min., making a bruise with small chips. The head was fixed in the plate. One crack *k* with chippings was developed from 16 to 10, also crack *l* and crack *a* was slightly increased. No change at back. The projectile broke up. Round 17: Steel shell, full weight, struck point shown in Fig. 2 at 39 deg., making a bruise 13 cm. (5·1in.) wide and 3 mm. (0·12in.) deep, the projectile glancing and breaking up. Round 18—*vide* Fig. 2: Steel shell, full weight, struck at 30 deg. 30 min., making a bruise 12 cm. (4·7in.) wide and 6 mm. (0.24in.) deep, and one crack *m*, glancing and breaking up. Round 19: Steel shell, full weight, struck at 43 deg. 35 min.—*vide* Fig. 2—making a bruise 17 cm. (6·7in.) wide and 15 mm. (0·59in.) deep, enlarging crack *a* to 10 mm. (0·39in.), and glancing and breaking up. Round 20: Steel shell, weighing 34·45 kilogs. (76·1 lb.), made up with sand, struck at 38 deg. 23 min. at spot shown on Fig. 2, making a bruise 10 cm. (3·9in.) wide and 15 mm. (0 59in.) deep, with crack *n* and *a* short hair crack upwards. At the back the crack *e* was lengthened to the lower edge. No other crack is visible at the back. The joint between the trial plate and the side plate to the left was opened 2 mm. (0·08in.).

To summarise, the plate has borne twenty blows of steel shells, each 274·6 metre-tons (886·7 foot-tons) or 276 metre-tons (891 foot-tons) per ton of entire shield, or 552 metre-tons (1782 foot-tons) per ton of half shield attacked, without destroying its powers of resistance. The crack *a*, after the removal of the front shield, is perceived to extend under the surface without reaching the edge of the plate, so that the portion affected by it is not detached from the shield. The effect of the new flattened profile is shown to be very good, all the projectiles being thrown upwards. It is true that the flat-headed shells have had more effect than the others—their points of impact are marked on Fig. 2 with an asterisk *—but they have not been able to destroy the plate. The shield has greatly exceeded the resisting power demanded of it against the fifteen rounds. It is impossible to say, even approximately, the number of blows necessary to break the shield. The Ternitz steel shells equal the Krupp steel shells as much in tenacity as in hardness. With a fractured point of the shell it is possible to scratch glass, just as with the Krupp steel.

We commend this report to the attention of our English authorities. The principal features are the following:— First, the power of resistance of the plate. 1782 foot-tons per ton of plate is a considerable quantity of energy to bear, even when delivered in so large a number of blows. So it seems to us; but our knowledge of this subject in this country is unfortunately very limited. The blows are oblique—very oblique in most cases—but this necessitates a larger surface of plate, and cognisance of this is taken in the method of proportioning the blow to the weight of the plate, which is the test we have taken.

The advantage of employing a more oblique angle of shield to steel shells than to those of chilled iron accords with the results obtained with our special committee on plates and projectiles. On the other hand, the effect produced by flat-headed steel shells is contrary to our experience even against hard armour. Altogether chilled iron shields and their attack constitute a matter on which experiments are greatly needed in this country. Were our fleet to engage any foreign cast iron fort at any time, it is practically certain that that fort would be made of Grüson's chilled iron. It is a material against which we have never fired a single round in this country, and against which our service projectiles, which are chilled iron, have been declared to be so inferior to steel that the French Government adopted chilled iron shields for interior forts so long as they only tested them with chilled shot, but confined their use to coasts when they tried steel projectiles against them. This is equivalent to saying these forts are good against English projectiles but not good against foreign ones for long continued breaching. Our chilled shot may be better, it is true, than those tried, but this has to be proved; and tests against softer armour are wholly beside the point and likely to mislead us.

AMERICAN NOTES.

(*From our own Correspondent.*)

New York, April 25th.

Telegraphic advices from inland commercial and manufacturing centres indicate a slight improvement in the volume of business at nearly all points, as the result of the pleasant spring weather throughout the country. In the extreme north the smaller streams are still ice-bound, but will soon be opened for navigation. The lumber interests have been very active all winter preparing as usual a large supply of logs, but according to all accounts, the saw-mills will work less than full capacity in order that better prices may be realised. The promised great activity in building operations will absorb enormous quantities of lumber and builders' material and builders' hardware of all kinds, and this demand, it is believed, will result in more trade this year than last, despite the fact that railroad building will be of moderate dimensions. In the larger Atlantic sea-board cities there is great building activity, reaching in some cases 10 per cent. over last year in value. The same activity is reported from many western towns and cities; and in fact throughout the country builders are taking advantage of the extremely low prices in lumber, brick, iron, steel, hardware and labour, to profitably invest large quantities of capital in view of the coming demand for house room and shop capacity. The agricultural area will not be extended so much this year as last, because of the uncertainty as to the demand for cereals. The flour interests are endeavouring to curtail production, but the possibility of an export demand is creating a good deal of interest in milling circles. The iron and steel mills are working to about two-thirds capacity. Contracts were closed this week in this city at 26.50 dols. for steel rails at mill, and for southern iron at 15 dols. for forge. Agents are closing contracts for Pennsylvania iron at 16.50 dols. for No. 2 and 17.50 dols. for No. 1. The building requirements for structural iron keep capacity steadily engaged. Mill quotations for merchant iron are 1.60 dols. for medium, 1.70 dols. for refined; plate iron, 1.90 dols.; tee iron, 2.40 dols.; shell iron, 3.25 dols.; angles, 2 dols.; beams and channels, 3 dols.; steel rails in small lots, 27.50 dols. Old rails are in active demand, but supplies are limited at 17 dols. to 18 dols. Large transactions in lumber have just been closed, and improving export demand is strengthening prices. The new English textile interests are meeting with an irregular demand for hosiery, carpets, cotton and woollen goods. Throughout the State prices have reached a point below which they cannot go. Competitions less severe at present and evidences of a reaction are visible. For months past manufacturers in many lines have been producing at cost, but this unprofitable course is tiring out capacity in many lines and working a restriction. The glass factories throughout the country are working nearly all full time, and a great deal of capacity is under erection. Private advices to-day from Pittsburgh indicate trouble between the iron employers and workmen. Nothing but a sharp improvement in demand will induce employers to pay the old scale, which was reaffirmed at a recent ironworkers' convention. Meetings take place next month to readjust working rates. A 10 per cent. reduction will be insisted upon by the manufacturers, and probably a compromise will be reached because of the threatening aspect of steel manufacturing, which certainly will crowd out iron making as rapidly as the new plant can be erected. The improvements in the new Clapp-Griffiths' process will enable makers to produce high steel at one cent per pound, and the manufacturers are aroused to the importance of utilising this new process. Any general improvement in manufacturing will result in numerous strikes. Labour has been actively organising for a year past, intending to demand higher wages when the opportunity offers. The Knights of Labour number about one hundred to one hundred and fifty thousand, and will probably lead in the movement either for higher wages or for fewer hours' labour per day.

During the first three months of this year twenty railroad companies, with a total capital stock and indebtedness of 275,289,000 dols., passed under the control of receivers. Last year thirty-seven roads went into receivers' hands, with a capital and debt of 715,000,000 dols. This indicates an increase of insolvency among railroad companies. The Dominion Government has promised to set apart 960,000 dols., the interest of which is to be enjoyed by the Grand Trunk and Canadian Pacific roads, who will have the joint ownership of the road between Montreal and Quebec. The Southern railroad lines have established new and lower freight rates. The Southern railroad companies are cutting rates, and bad faith is charged on all sides.

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

(*From our own Correspondent.*)

The effect upon 'Change in Birmingham this—Thursday—afternoon, and in Wolverhampton yesterday, of the altered political outlook, was to encourage anticipation of improved merchant buying. For three weeks orders have been very light. At present works remain poorly employed, and no one can see orders ahead.

Steel blooms and billets are coming into the district from Scotland, the West Coast, South and West Yorkshire, and Wales in increasing quantities, and are supplanting finished iron. They are being rolled down by the makers of sheets, tin-plates, small rounds, and other descriptions of iron. They are also being employed to an augmented extent in chain making and nut and bolt making, for plating and other purposes. Prices vary according to the percentage of carbon, from £4 10s. to £4 17s. 6d. and £5. Steel plating bars are £5 15s. delivered.

Finished iron prices show but little alteration. The Pelsall Coal and Iron Company quotes at date:—Bars, ½in. rounds and squares and upwards, £5 10s. per ton; hoops and strips, 1in. by 18 b.g., and upwards, £5 15s.; superior bars, £6; horseshoe bars, £6; superior hoops and strips, £6 5s.; hinge strip, £6 10s.; nail strip of from 12in. to 24in., and from 14 to 12 b.g., £5 10s.; gas strip of 6¾in. wide, £5 10s.; 7in. to 8½in., £6; 8¾in. to 12½in., £6 10s.; angles, 1½in. to 4½in., £5 15s. to £6 5s., according to quality; tees, ⅞in. to 2¼in., £7 to £7 10s.; sash iron, £7 15s.; sheets (singles) and tank-plates, £7; and steel hoops and strips, 1in. by 18 b.g., £6 15s. per ton.

Best sheet makers mostly keep well employed. Crowther Brothers and Co., Kidderminster, are busy on tinned sheets, notwithstanding that this is generally a slack time. These sheets are particularly in demand by the makers of milk-cans, gasometer engineers, and other consumers who desire iron of first quality and finish. The firm's best coke tin sheets are quoted £24 per ton; best charcoal, £26; extra best, £28; and best soft steel sheets also £26. Their ordinary cold rolled and close annealed charcoal sheets are £15; best ditto, £16 10s.; F.S.S. steel sheets, £11; best S steel sheets, £12 10s; and best homoid ditto, £13 10s.

Pig iron this afternoon was a drug. Sellers could secure but small transactions at any price. Stocks continue to go up, and one local firm is credited with holding 10,000 tons. Native part-mines are mostly 40s. to 42s., though occasionally 45s. is obtained. North Staffordshire common pigs are quoted 41s. 6d. delivered here, Derbyshires 40s. delivered to stations, and Northamptons 37s. 6d. upwards.

Coalmasters complain loudly of present prices. South Staffordshire forge coal is 6s.; mill coal, 6s. 6d. to 7s.; furnace, 8s. to 9s.; rough slack, 3s. 6d. to 4s. 6d.; and fine slack, 2s. 6d.

An attempt will be made by manufacturers here to secure the contract for the 110 iron covered goods wagons which the Madras Railway Company is requiring. Gas engineers will have a try for the two gas exhausters and the central horizontal engine needed by the Newport Gas Company. The exhausters are to pass 30,000 cubic feet per hour.

Renewed complaints are made this week by manufacturers of the injury to Birmingham trade arising from increased tariff duties lately imposed by Russia, Mexico, Greece, and other foreign countries.

The edge-tool makers have received large repeat inquiries from the War-office. They include 21,500 picks, 15,500 shovels, 5000 spades, 6000 hatchets, 4000 reaping-hooks, and other goods.

This week has seen but little change in the North Staffordshire iron trade, and prices remain at: Bars, £5 7s. 6d. per ton; hoops, £5 17s. 6d.; sheets, £6 17s. 6d. to £7.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester.—The more peaceful prospects of the last few days have tended somewhat to restore confidence to the market, and in some departments there have been more inquiries coming forward; but there is still an absence of any actual weight of business doing. Pig iron shows no signs of recovery from the extreme depression which has now prevailed for several months past. Hematites, notwithstanding the increased activity in some branches of the steel trade, continue extremely low in price, and it is only here and there that some descriptions of finished iron are meeting with a better demand. In the condition of trade generally, it cannot be said that there is any really material improvement, and even with a peaceful solution of the political complications abroad—to all appearances practically assured—the prospects for the future do not as yet develope any very encouraging outlook.

There was again only a very dull market at Manchester on Tuesday, and where business was done it was at very low prices. In the pig iron trade 40s. to 41s., less 2½, for delivery equal to Manchester, remained the generally quoted basis for good local and district brands, but at these figures makers are practically out of the market, and they are only got on occasional small parcels that are wanted for special requirements. Cheap brands are still offered at about 38s. 6d. to 39s., less 2½, delivered here, and buyers are not disposed to give much above these figures, even for the better class brands. As a rule, the leading makers decline to give way any further upon present quoted rates, but where sellers are determined to do business, they have to be prepared with considerable concessions to bring forward buyers.

Hematites are offered at as low as 51s. 6d. to 52s., less 2½, for good foundry brands, without bringing forward any weight of buying.

In the manufactured iron trade there were more inquiries stirring, and in some instances an increased weight of actual business was reported. For hoops and sheets there is a moderate demand, and some of the bar iron makers are fairly off for orders. Generally, however, trade is still only slow, and there is an eagerness for business which is an indication that, as a rule, makers are not very plentifully supplied with orders. The uncertainty which prevails as to the future checks manufacturers from entertaining any very long forward business, and in many cases they decline to book beyond the next couple of months at current rates, but for prompt specifications quite as low prices as ever are being taken; and although £5 7s. 6d. is in most instances adhered to as the minimum quoted basis for good qualities of Lancashire and North Staffordshire bars delivered into the Manchester district, a slight concession on this figure would here and there be made for anything like good orders for immediate delivery. Hoops average £5 17s. 6d., and sheets £6 12s. 6d. to £7 per ton delivered into this district.

The condition of the engineering trades remains without material change. Locomotive and railway carriage builders are still kept busy, but there is a dispute with the smiths at the Ashbury Company's works, which has led to the men turning out. Some of the toolmakers are getting moderate orders from abroad, including heavy tools for Russian Government shipyards, but the home trade continues quiet, and in general engineering work the tendency is still in the direction of decreasing activity.

The reduction of prices in the Manchester district has been accompanied by a reduction of about 10 per cent. in the rate of wages paid to the colliers and underground datalers. In the wages of the colliers the reduction is 2d. up to 3d. per ton and 2d. per yard, and the datalers 1s. per week.

Barrow.—The demand is dull for all descriptions of hematite pig iron, and I can hear on no side of any likelihood of improvement. The inquiries from home consumers are fairly maintained; but this is mainly on account of steel makers who are using large parcels of metal for conversion purposes. The continental and colonial demand has been much restricted, probably owing to the uncertainty as to whether or not war would soon be declared; but the horizon seems now more clear, and as a consequence more spirited inquiries are being made by consumers across the Channel. On American account very little trade has been done for some time; but it is noteworthy that although prices are at a point so low that it precludes the possibility of British producers competing on favourable terms with the foreign maker, occasional large consignments of pig iron find their way across the Atlantic; but nothing like a profitable trade can be done with America under existing conditions. The value of pig iron remains steady, but firm, at 43s. 6d. per ton for mixed parcels of Bessemer iron net at makers' works, prompt delivery. The steel trade is not fully employed, although as compared with last season more orders are in hand; but there is not sufficient work to keep the rail and merchant mills regularly employed, nor are the orders for special steel anything like commensurate in extent with the capabilities of production. Shipbuilders have not booked any new orders, but there is more activity observable, not only in the shipbuilding department proper, but in the engineering branches as well. Iron ore is quiet in tone at from 8s. 6d. to 10s. 6d. per ton net at mines, where large parcels are still held. Coal and coke very quiet so far as demand is concerned; but former prices are noted consequent on the strikes. The new tramways at Barrow have nearly all been laid, and in a few weeks steam tram-cars will commence running on the most important routes. Several improvements have been made in the gradients in the town, which will not only be advantageous for the tramway traffic, but a great public boon as well.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

It has been suggested that the Archbishop of York should be asked to mediate in regard to the prolonged and disastrous strike at Denaby Main. The Archbishop is a strong man, full of sympathy with the collier, and yet with a sound judgment which would keep his decision thoroughly impartial. His Grace, while earnestly desiring that the present condition of affairs should terminate, sees no hope of a satisfactory end of the rupture unless the issue is confined to the question of fact "whether the masters can or cannot pay a certain rate of wages, ascertainable by the usual rates between wages and selling prices." He thinks that question leaves no room for "inflammatory rhetoric" on either side, which is quite true; but the Archbishop appears to confound the Denaby dispute with the general strike in the different colliery districts. The two are widely different. The dispute at Denaby, which is now in its sixteenth week, refers to a change in the system of working the pits, which the men have refused even to try, while the strike in South and West Yorkshire generally is simply on the point of a 10 per cent. reduction in wages. A Yorkshire miner, who says he is ready and willing to work, expresses, it is believed, the feeling of many others. He regards the strike as downright folly, but he does not do as he wishes "for fear of those who will neither work themselves nor let others." It is a terrible thing for a man, he says, to be tabooed as a "black sheep," and to escape being regarded as an outcast of their class, he faces starvation and turns a deaf ear to the cries of his wife and children. As for the Union leaders, who have brought the men to this pass, he is incensed against them. "If they only had to live on the same pay as we miners," he says, "the strike would not last ten days."

Another large colliery, the old Silkstone Coal and Iron Company, Dodworth, has been added to those that are standing. This adds about 900 men and boys to those on strike. The men brought out their tools on the 6th inst. The Car House Colliery men—Messrs. John Brown and Co.—have been five weeks idle, and they passed a resolution on the 5th inst. to continue the strike. On the 6th a large number of the men, accompanied by a dray drawn by about forty colliers, proceeded to Sheffield to solicit aid from the public.

The last of the evictions at Denaby Main took place on Tuesday, and now the colliery village is a deserted hamlet. Half-a-dozen families are huddled together in houses at Swinton and Mexborough, and others get what shelter they can in encampments in the field, while the clergymen and ministers do their best to keep them from starving, though all that the charitable can subscribe is utterly inadequate to find even dry bread for the wretched victims of the strike—the poor women and innocent children, who frequently travel miles to get a crust of bread and struggle back again disappointed. In Sheffield the miners employed by the Nunnery Colliery Company parade the streets, with bands playing and banners flying, while men with cigar-boxes solicit the coppers of the crowd. It is a miserable business.

The Admiralty contracts have just been given out. Messrs. Harrison Brothers and Howson, of Norfolk-street, have secured the larger portion of the contracts for fine cutlery for officers' use, including 4262 ivory balance-handle table knives, 432 carvers, &c. Messrs. Atkinson Brothers, of Milton-street, have also been successful in getting part of the Admiralty work. This firm is now engaged upon soldiers' knives and forks for our Government — 84,000 — and clasp knives—6000. Messrs. E. Lucas and Sons, of the Dronfield Foundry, are actively employed upon intrenching tools, steel spades, shovels, telegraph posts, &c. A Barnsley foundry has just despatched a large consignment of wheels and axles for use on the Suakim-Berber line. It is not anticipated that any further orders for rails for this line will be given out, the policy of withdrawal having shortened the route which it was originally intended to take. So far as I have heard, of the entire quantity at first stated to be required—25,000 tons—only two orders of 2000 tons each have been placed.

The London ivory sales included only 91 tons; still, in spite of the limited supply, Sheffield firms had to pay a fair price for the sorts required for Sheffield purposes. Zanzibar tusks declined £2 to £4 per cwt., and West Coast African fell £2 to £3 per cwt.; hard Egyptian was higher by £1 and £2, and Cape better by £2. The total of 96 tons is but little over three-fourths of an average supply to the second series of sales for the previous twenty-two years. The reduced quantity is attributed to the smaller supply from Egypt, and to the scarcity of Cape of Good Hope. Mother-o'-pearl shells, which are also largely used in the Sheffield trades, were generally dearer at the London sales, Manilla being disposed of at 5s. advance.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

There has been no improvement in the tone of the Cleveland pig iron trade during the past week. The outlook as regards the future is, however, less gloomy than it was. Stocks have decreased during April, and there are now prospects of an amicable settlement of the dispute with Russia. For the present consumers hold off, and at the market held at Middlesbrough on Tuesday scarcely any business was transacted. Prices are not lower than they were a week ago. Merchants continue to quote No. 3 g.m.b. at 33s. 3d. per ton, but makers will not take less than 34s., as they are for the most part well supplied with orders. The price of forge iron is firm at 33s. per ton, and as makers hold almost all the stock of this quality, it is not likely that any concession will be made.

The month's shipments of pig iron from the Tees have been so far unsatisfactory, only 6985 tons having been shipped in the first four days, as against 10,538 tons in April.

Finished iron manufacturers are doing better than they were. The demand is greater than it has been for a long time, especially as regards plates, and makers are firm in their prices. Ship-plates are £5 to £5 2s. 6d. per ton; angles, £4 12s. 6d. to £4 15s.; and common bars, £5; all free on trucks at makers' works, cash 10th, less 2½ per cent. discount.

The Cleveland ironmasters' statistics for April, issued on the 5th inst., show that the total make of pig iron of all kinds was 204,591 tons, being a net decrease of 4053 tons when compared with March. The stock of pig iron in the whole district was 388,398 tons, being a decrease of 856 tons. The shipments reached 70,998 tons, of which 25,700 tons were sent to Scotland, 11,665 tons to Germany, 8410 tons to Wales, 5620 tons to Holland, 4562 tons to Norway and Sweden, and 4075 tons to France.

The average net selling price of coal by members of the Durham Coal Trade Association during the three months ending April 30th was 4s. 6·01d. per ton. Under the sliding scale the rate of wages payable to operatives will therefore be reduced 1¼ per cent.

The directors of the Hull and Barnsley Railway Company announce that their dock and railway will be opened in July next.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

The iron market has been quiet in the past week, with only a moderate business. There have been several fluctuations in prices, the tendency of which is slightly downward. The past week's shipments of Scotch pigs were 11,491 tons, as compared with 8896 in the preceding week, and 15,233 in the corresponding week of 1884. There has been a fair demand for Canada, to which considerable quantities of iron have been despatched in the past four weeks. Germany and Holland are also taking a little more Scotch pigs, but the requirements of the United States are very easily met. There are 90 furnaces in blast, against 97 at the corresponding date. Nearly 400 tons of pig have been added to the stock in Messrs. Connal and Co.'s Glasgow stores.

Business was done in the warrant market on Friday at 41s. 9½d. Monday being a Scotch Bank Holiday, the iron market was closed on that day. Business resumed on Tuesday morning at 41s. 10½d. cash, and the price declined in the course of the day to 41s. 9½d. cash. Business was done on Wednesday at 41s. 9½d. to 41s. 11d. cash. To-day—Thursday—transactions took place at 41s. 11½d. to 42s. 0½d., closing at 42s. cash.

The demand for makers' iron is quiet, and the quotations are as follow:—Gartsherrie, No. 1, 50s. 6d.; No. 3, 46s.; Coltness, 52s. 6d. and 49s. 6d.; Langloan, 52s. 6d. and 49s. 6d.; Summerlee, 50s. 6d. and 46s.; Calder, 51s. 3d. and 46s.; Carnbroe, 48s. and 45s. 6d.; Clyde, 46s. 9d. and 42s. 9d.; Monkland, 42s. and 40s.; Quarter, 41s. 9d. and 39s. 6d.; Govan, at Broomielaw, 42s. and 40s. 3d.; Shotts, at Leith, 50s. 6d. and 50s.; Carron, at Grangemouth, 52s. 6d. and 47s.; Kinneil, at Bo'ness, 44s. and 43s.; Glengarnock, at Ardrossan, 47s. 6d. and 42s.; Eglinton, 42s. 3d. and 39s. 6d.; Dalmellington, 46s. and 42s.

Hematite pigs, Nos. 1, 2, and 3 Bessemer, are 43s. 6d. f.o.b. at Maryport or Workington. The stock held at the ports by the West Cumberland Storing Company amount to 79,700 tons, including 2000 of other kinds of pig iron.

The steel trade continues to prosper. Several additional orders are reported, amongst them being one-half of the steel work for the ironclad to be constructed by the Thames Ironworks Company, which has been given to the Steel Company of Scotland. It is also reported that a large part of the steel for the belted cruisers to be built on the Tyne will go to Scotland.

Messrs. Tangye Brothers, of Birmingham and Glasgow, have obtained an order for twenty-four 10in. centrifugal pumping engines, for circulating water through the condensers, &c., of the six cruisers now under construction for the Admiralty by Messrs. J. and G. Thomson, of Glasgow.

The past week's shipments of iron and steel goods from Glasgow embraced three large locomotives and tenders, valued at £9150, for Sydney; machinery worth £1500; and £26,000 worth of iron and steel goods, including pipes, &c., to the value of £10,950, for New South Wales.

In the past week the coal trade has again been fairly active, particularly in the shipping department. From Glasgow the quantity despatched was 25,835 tons; Irvine, 2202; Ayr, 7044; Troon, 8399; and Grangemouth, 4712 tons. There has been a moderately good business at Leith. From Burntisland returns are not always available, but it appears that the shipments there during April reached a total of 73,178, as compared with 72,286 tons in April, 1884. Within the last week or two the shipping inquiry in Fife has improved, admitting of the miners being placed on full time at a number of the collieries. Steam coals at Burntisland are quoted f.o.b. at 6s. 3d. to 6s. 9d. a ton. The inland demand is fair all over the country, and the increased quantities of fuel required for the steel works have had a beneficial effect.

Messrs. Addie and Son, Coatbridge, have struck a seam of smithy coal below their steam coal seam, at Herbertson, near Denny, in Stirlingshire. This field is 2000 acres in extent, and it is expected to turn out a valuable and productive one.

The directors of the Armiston Coal Company have intimated an *interim* dividend, at the rate of 10 per cent., for the six months ending with March last.

The affairs of the late Monkland Iron and Coal Company, under liquidation, were under the attention of a meeting of the shareholders in Glasgow a few days ago. It was intimated by the liquidators that the amount in hand, after satisfying creditors, was £9453, and that if there was no appeal to the House of Lords in the case of Lord Elphinstone against the company, that amount would be divided among the shareholders.

Last Friday the ceremony of letting water into the James Watt Dock at Greenock, and of putting the last coping stone on the walls, took place in the presence of a large and interested gathering. Provost Wilson laid the stone, and Mr. John Scott, shipbuilder, let the water into the dock. The James Watt Dock has occupied nearly seven years in construction. Outside it a large tidal harbour is being formed. The works, which are from the designs of Mr. Kinipple, C.E., will cost £550,000. They will form a magnificent addition to the harbour accommodation of the port.

The withdrawal of large quantities of tea, spirits, and tobacco from bond in Glasgow during April, in anticipation of the Budget, greatly increased the Customs revenue, which has amounted to £197,172 as against £90,895 in April last year.

During the first four months of the year 500 vessels have arrived at Clyde ports, with a total tonnage of 431,729, being an increase of 29,673 tons over that of the same period in 1884. There is, however, a decrease of 19,766 in the sailings.

WALES & ADJOINING COUNTIES.

(*From our own Correspondent.*)

There is a slightly better tone in the iron trade, shown so far in an increase in inquiries, and some few orders being placed.

There is a good deal of room yet for improvement in all branches, more particularly in rails, and but for the colonies the depression in trade would be greater. Last week some fair foreign cargoes left Newport, principally for Canada. One to Port Alfred was over 2000 tons. A little more dulness has exhibited itself of late in tin plate. Prices have a tendency to droop. A proposition has now been put forward by a maker that there shall be a week's stoppage per month, and this is under discussion, though not brought under consideration in a formal way before the makers. It is discussed individually, some having one solution of the difficulty, others another. One thing is certain, that the stoppage one week per month is not a natural solution. If there is too much tin-plate made, then workers are too numerous.

I see that an offer has been made by the Avon Vale Iron and Tin Works to their workmen of a 12½ per cent. reduction. The offer of the men is to give two or three turns a month free. This, again, is not a natural solution of difficulties, and the tin-plate workers as a body are setting their faces against it.

German sheets, as they are called, terne plates, roofing sheets, and large sheets show best in respect of prices. Ordinary cokes are not so firm.

In ores Bilbao and Carthagena are coming in more freely.

It is expected that the furnace at Taff Well will be blown out.

The coal trade is certainly better.

Mr. James Davies, of Nixon's Collieries, Mountain Ash, has been appointed to the management of Merthyr Vale Colliery, vacant by Mr. Prichard having accepted the Clydach Vale management in the room of the late Mr. Hayhurst.

Mr. W. T. Lewis has completed the transfer of the Glamorganshire Canal for the Marquis of Bute, and everything is now handed over. The canal, which was formed to supply the docks, by an independent proprietary more than a hundred years ago, is now at length merged into dock property, and with its ancient rights and privileges, may be regarded as of the highest strategic importance, and its acquisition by Mr. Lewis as a master stroke.

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.

28th April, 1885.

5206. Producing Blank Maps, &c., W. S. Brook, Birmingham.
5207. Mortice Locks, J. Blakeley, Cardiff.
5208. Fac-simile or Autographic Telegraphy, P. B. Delany, London.
5209. Button Fasteners, F. A. Smith, jun.—(*E. D. Steele, United States.*)
5210. Compound Marine Engine Governor, J. P. Rawlings, Leith.
5211. Moving Points on Tramway Lines, J. Hardman, Pendleton.
5212. Alphabetical Electric Telegraph Instruments, R. C. Williams, Sparkbrook.
5213. Pressing Bricks, &c., T. C. and J. D. Fawcett, Halifax.
5214 Looms for Weaving, R. and S. S. Hall, Manchester.
5215. Looms for Weaving, R. Hall and J. Hobson, Manchester.
5216. Producing Phosphate of Soda, &c., W. P. Thompson.—(*L. Imperatori, Germany.*)
5217. Knitting Machines, W. P. Thompson.—(*G. E. Nye and E. Tredick, United States.*)
5218. Fire Telegraph System, L. H. McCullough, Liverpool.
5219. Non-interfering Fire-alarm Telegraph System, L. H. McCullough, Liverpool.
5220. Cash Carriers, W. P. Thompson.—(*E. Picard, Belgium.*)
5221. Serviette or Napkin Ring, G. Hirst, Whitby.—*27th April*, 1885.
5222. Spark Arresters, &c., W. H. Reynolds.—(*L. I. Doyle, United States.*)
5223. Covered Buttons, G. L. Aston, Birmingham.
5224. Springs for Rabbit Traps, I. Waine, London.
5225. Electric Arc Lamp, H. Trott, Battersea, and C. Fenton, Isleworth.
5226. Mounting Lawn-tennis Nets, E. Biddell, London.
5227. Treatment of Human Excrements, &c., C. Lehofer, London.
5228. Vibrating Engines, H. J. Allison.—(*W. E. Crist, United States.*)
5229. Shoe Clasps, &c., H. J. Allison.—(*F. Armstrong, United States.*)
5230. Bullets for Small-arms, &c., J. J. Talman, Harbledown.
5231. Braiding Machines, H. Botten, London.
5232. Jacket applicable for Wear in Fencing, &c., C. J. S. Batt, London.
5233. Rendering Leather Flexible or Pliable, H. E. Howe, London.
5234. Gates for Railway, &c., Crossings, P. M. Justice.—(*The Copeland Manufacturing Company, United States.*)
5235. Telephone Transmitters, J. E. Fuller, London.
5236. Frames of Upright Pianofortes, E. Whitfield, London.
5237. Fastening Frames of Writing Slates, C. W. Jones, London.
5238. Cork Extractors, R. B. Jackson, London.
5239. Timepieces, M. V. B. Ethridge, London.
5240. Receptacle for Crinoline Steel, A. Phillips, London.
5241. Gas Regulators, J. Winsborrow, London.
5242. Refrigerating Machines, W. S. Squire, London.
5243. Ventilating Hay or other Ricks, J. Starkie, London.
5244. Mechanical Oilers, &c., for Shafting, H. P. Humphrey, London.
5245. Explosion Motors or Gas Engines, A. T. Markurth, London.
5246. Cards for Jacquard Apparatus, J. H. Johnson.—(*T. J. Sloan, France.*)
5247. Centrifugal Pumping Apparatus, J. Brunton.—(*G. Brunton, India.*)
5248. Riddling and Cleaning Potatoes, &c., G. W. Randolph, London.
5249. Drying Machine, W. Horsfield, London.
5250. Shaft Couplings, H. E. Newton.—(*S. Stuart, United States.*)
5251. Excluding Oil and Grease from Condensers, &c., H. E. Newton.—(*S. Stuart, United States.*)
5252. Explosive Compounds, H. E. Newton.—(*A. Nobel, France.*)
5253. Working Cages in the Shafts of Mines, G. F. Redfern.—(*A. R. and C. Piret, Belgium.*)
5254. Self-inking Cylinder Hand Press, G. Wackerbarth, London.
5255. Bottle, &c., Stoppers, A. and M. Mackay, and R. E. Goolden, London.
5256. Voltaic Batteries, A. R. Bennett, Glasgow.
5257. Lubricators, P. Jensen.—(*The Vulcan Stöberi og Mekanisk Verksted, Norway.*)
5258. Protecting Vessels from Torpedoes, C. R. Parkes, London.
5259. Self-acting Pump, C. Robin, Paris.
5260. Chromates and Acid Chromates, J. Brock and W. A. Rowell, London.
5261. Bottles and Jars, A. W. Birt and R. J. Forster, London.
5262. Apparatus for Burning Naphtha, &c., T. Nordenfelt, London.
5263. Mines and Torpedo Apparatus, C. A. McEvoy, London.
5264. Hinges, E. A. Clowes, London.
5265. Metal Cylinders, W. R. Lake.—(*W. H. Brown, United States.*)
5266. Securing Railway Rails in their Chairs, A. B. Ibbotson, London.
5267. Supporting Boots in Burnishing Machines, W. R. Lake.—(*The Beaudry Edge Setting and Heel Burnishing Machine Company, United States.*)
5268. Grooving the Necks of Bottles, W. R. Lake.—(*W. L. Roorbach, S. and O. Twitchell, United States.*)
5269. Attaching Heels to Boots and Shoes, W. R. Lake.—(*F. F. Raymond, United States.*)
5270. Training Gear of Central Pivot Gun Mountings, J. Vavasseur, London.
5271. Securing Lamp Sockets to Tongues of Bicycle, &c., Lamps, H. Salsbury, London.
5272. Preventing Bolt Nuts Working Loose, E. Partridge, Birmingham.
5273. Securing Wheels on their Axles, E. Partridge, Birmingham.
5274. Making Steel by the Bessemer Process, A. Davy, London.
5275. Making Steel by the Bessemer Process, A. Davy, London.
5276. Chair Bedstead, H. A. Wilson, London.
5277. Combined Shafts and Poles for Vehicles, A. M. Clark.—(*J. Pettinger, United States.*)
5278. Warm Air Stove, B. Verity, London.
5279. Removing Snow from Railways, &c., A. M. Clark.—(*E. Leslie, Canada.*)
5280. Effecting the Decarbonation of Earthy Carbonates, W. L. Wise.—(*R. Radot, France.*)

29th April, 1885.

5281. Fastenings for Window Sashes, R. Warry, Woolwich.
5282. Switch for Incandescent Electrical Lamps, A. Swan, Gateshead-on-Tyne.
5283. Finishing Web or Textile Fabrics, &c., G. Dyke, Yeovil.
5284. Knobs for Doors, &c., R. Harrington, Wolverhampton.
5285. Fastener for Bracelets, &c., C. F. Herold, Birmingham.
5286. Ventilators, S. A. Luke, Rochdale.
5287. Packing for Steam Engines, A. MacLaine, Belfast.
5288. Permanent Way of Railways, W. F. Batho, Liverpool.
5289. Omnibuses, &c., T. Startin, Birmingham.
5290. Caustic or other Drum Heads, &c., H. Bott, and J. and J. Billinge, Liverpool.
5291. Corrugated Zinc Perambulator Bodies, W. Wroe and B. Fowell, Manchester.
5292. Swivel for Watch Guards, &c., W. H. Hemming and G. H. Hazlewood, Birmingham.
5293. Semaphore Indicator for Electric Bells, J. D. Adams, London.
5294. Shirt Collars, R. Glover, Stratford.
5295. Malt Cocoa, J. W. C. Moeller, London.
5296. Spinning, &c., Machines, F. Wadsworth, London.
5297. Rollers for Drawing, &c., Machines, J. Hall, London.
5298. Induction Coils for Telephonic, &c., Purposes, S. Williams, Newport.
5299. Pneumatic Composition Pedal Apparatus for Organs, W. G. Wilkinson, London.
5300. Button-hole Sewing Attachments for Sewing Machines, F. Egge and C. J. A. Sjoberg, London.
5301. Solitaires, R. Bateman, Birmingham.
5302. Dabbing Brushes for Combing Wool, J. J. Richardson, Bradford.
5303. Nail-making Machinery, J. Etheridge and J. H. Lloyd, London.
5304. Velocipedes, H. A. Barrow, London.
5305. Bodkins, A. I. L. Gordon, London.
5306. Driving Mechanism of Tricycles, J. Beeston, London.
5307. Fixing, &c., Vertical Mill-stones, R. A. Lister and G. S. Richmond, London.
5308. Striking or Chiming Apparatus, C. Shepherd, London.
5309. Door-closing Apparatus, C. H. Maxsted, London.
5310. Ruling Parallel Lines, I. Beutelrock and Count H. Seilern, London.
5311. Turning and Tapping Lathe, A. Emanuel, London.
5312. Metal Dental Plates, W. Whitehouse, London.
5313. Hair Brushes, S. J. Hill, London.
5314 Regulation of Electrical Circuits, D. L. Salomons, London.
5315. Kitchen Ranges, R. A. Perrott, London.
5316. Drilling Machine, H. Noyes, London.
5317. Stamper for Crushing Ores, &c., W. Husband, London.
5318. Stamper for Crushing Ores, &c., W. Husband, London.
5319. Doors, &c., for Coal-boxes, &c., C. Sims, London.
5320. Tricycles, W. Starley, London.
5321. Coupling for Endless Driving Chains of Velocipedes, W. Starley, London.
5322. Clothing for Life-saving, &c., Purposes in Water, D. H. Sisson, London.
5323. Imitation Astrachan Trimming Fabrics, A. G. Darby and A. L. Jordan, London.
5324. Driving Bicycles, &c., C. W. J. L. de Robert, London.
5325. Pianofortes. W. R. Lake.—(*V. A. Thibout, France.*)
5326. Lifeboats, W. R. Lake.—(*D. P. Dobbins, United States.*)
5327. Time Locks, J. B. Young, London.
5328. Cases of Thread for Sewing Machines, A. Dewhurst, London.
5329. Passenger Fare Checking, &c., F. Elmore (F. Edward), London.

30th April, 1885.

5330. Soap Cutting Apparatus, J. Petrie, Glasgow.
5331. Combined Surface Speed and Revolution Indicator, G. Oldfield, Glasgow.
5332. Apparatus for Indicating Amounts of Money Received, A. J. Lyon, Cambridge.
5333. Keyless Puzzle Lock for Work-boxes, &c., F. W. Amsden, Birmingham.
5334. Steam Steering Gear for Vessels, J. Brown, Manchester.
5335. Travellers for Ring Spinning, J. M. Hetherington, and S. Thornton, Manchester.
5336. Rotary Engines and Pump, H. P. Fenby, Leeds.
5337. Jars and Lids, G. Gardner, Liverpool.
5338. Framework of Umbrellas, &c., P. Meyer, jun., Liverpool.
5339. Cylinder with Pistons and Vent Holes, W. F. Cotterill, Leicester.
5340. Centrifugal Machines, known as Hydro-extractors, J. Laidlaw, Glasgow.
5341. Galvanic Cells, C. D. Richardson, London.
5342. Making Coffee Capsules, L. Hamel, London.
5343. Striking Work of Clocks, U. V. Jaeggi, London.
5344. Ornamenting Rails of Metallic Bedsteads, &c., L. Brierley, London.
5345. Centrifugal Bolting Machines, E. Strietz, London.
5346. Hydraulic Cements, P. C. Lovett, Liscombe Park.
5347. Electrical Relays, P. G. Forbes, London.
5348. Purifying Drainage Waters, &c., M. Nahnsen, London.
5349. Tanks and Cells, D. A. Davis, London.
5350. Razors, &c., E. P. Alexander.—(*R. J. Reidy and A. L. Alexander, Brazil.*)
5351. Rotary Engines, J. M. Hall, London.
5352. Tuning Free Reeds, G. Cousins, London.
5353. Railway Signalling, A. Sauvée.—(*H. Supéry, France.*)
5354. Decorative Concrete of Slag, &c., E. Robbins, London.
5355. Advertising, M. Anquez, London.
5356. Lock-up Stands for Bottles, &c., A. Watson, London.
5357. Adapting Designs from Curtains to Table-cloths, A. F. Link.—(*H. Jensen, France.*)
5358. Transmitting Motion to Sewing Machines, W. Beecroft, London.
5359. Preparation of Leather, W. R. Lake.—(*J. B. Dupret, Belgium.*)
5360. Artificial Tooth Crowns, C. S. Case, London.
5361. Electro-medical Apparatus, A. T. King, London.

1st May, 1885.

5362. Self-acting Mules, W. T. Watts, Manchester.
5363. Instantaneous Photographic Camera Shutters, W. J. Lancaster, Birmingham.
5364. Photographic Cameras, W. J. Lancaster, Birmingham.
5365. Detachable Tire or Hoop for Wheels, T. Snowball, Newcastle-on-Tyne.
5366. Fabric for Window Blinds, &c., H. Lee, Manchester.
5367. Portable Stands for Photographic, &c., Purposes, A. Pilley, G. A. Cubley, and J. Preston, Sheffield.
5368. Tramway Points, A. Dickinson and L. C. Clovis, Kingshill.
5369. Opening and Closing Windows, W. Rigby, London.
5370. Enclosing Railway Signals in Cases, C. J. and J. G. Howe, Sunderland.
5371. Drying Wool, &c., J. B. and W. Whiteley, Halifax.
5372. Army and Navy Combination Reel, J. O. Gysi, Manchester.
5373. Washing and Storing Dishes, W. P. Thompson.—(*J. S. Stevens, United States.*)
5374. Sharpening Circular Saws, G. H. Garrett, Glasgow.
5375. Lock Furniture, &c., W. Trubshaw, Peckham.
5376. Electric Motors, A. Reckenzaun, London.
5377. Venetian Blinds, A. W. Adams, Penarth.
5378. Wool Combing Machines, J. Midgley, London.
5379. Operating Electric Railway Trains, T. J. Handford.—(*F. J. Sprague, United States.*)
5380. Brooches, &c., S. Pearce, Birmingham.
5381. Painting on Clay, J. Gildea, London.
5382. Distilling Glycerine, A. G. Brookes.—(*R. Giebermann, United States.*)
5383. Refining Glycerine, A. G. Brookes.—(*R. Giebermann, United States.*)
5384. Union Joints or Couplings for Pipes, &c., J. Evans, London.
5385. Aerated Waters, C. E. Avery, London.
5386. Air, Steam, and Water-tight Connections, O. J. Williams, jun., London.
5387. Switches for Electric Lamps, H. J. Haddan.—(*Schumann and Koepe, Saxony.*)
5388. Hyposulphates and Sulphates of Alkalies, H. Bollmann, London.
5389. Metallic Sleeper for Rails, F. W. Rafarel, London.
5390. Corsets, C. D. Abel.—(*La Société Farcy et Oppenheim, France.*)
5391. Calcining Sulphides, &c., G. H. Blenkinsop and J. G. Gordon, London.
5392. Recording, &c., the Speed of the Wind, A. S. Garrigon-Lagrange, London.
5393. Testing, &c., Electric Currents, J. H. Davies, London.
5394. Securing Non-conducting Materials to Boilers, &c., J. Fyfe, Glasgow.
5395. Metallic Packing, A. Farquhar, Glasgow.
5396. Potato Digging Machines, A. Pollock, Glasgow.
5397. Flyers for Spinning Machinery, T. Oxley, Manchester.
5398. Transmission of Motive Force, J. Graber, London.
5399. Bars of Sugar, W. R. Lake.—(*F. Napravil, Austria.*)
5400. Electrical Incandescent Lamps, O. E. Woodhouse and F. L. Rawson, London.
5401. Steam Boiling Apparatus, S. Schatzky, London.
5402. Tentering Bars, E. Walker, London.
5403. Pipe Couplings, A. Rollason, London.
5404. Electrical Train Signalling Apparatus, A. M. Clark.—(*E. J. Jérôme de Baillehache, France.*)
5405. Metal Plates, W. R. Lake.—(*J. Noel and C. Long, France.*)
5406. Gassing Yarns, J. W. Dawson, London.
5407. Spinning and Doubling Cotton, &c., J. W. Dawson and H. Simpson, London.
5408. Spinning and Doubling Cotton, &c., J. W. Dawson and H. Simpson, London.
5409. Supporting the Spindles of Mules or Jacks, A. G. Brookes.—(*J. T. Meats, United States.*)

2nd May, 1885.

5410. Dyeing, J. K. Kaye, Halifax.
5411. Reservoir Penholders, W. E. Heys.—(*T. Juliusberger and L. Markwald, Prussia.*)
5412. Flour Sifting Machines, W. Brierley.—(*R. Lanzsch, Germany*)
5413. Dust Collectors for Flour, &c., Mills, W. Brierley.—(*T. Buchlmann, Hungary.*)
5414. Expanding Writing Cabinet, A. Paice, Isle of Wight.
5415. Preventing Horses, &c., from Slipping, B. Harris, Newcastle-on-Tyne.
5416. Rotary Pump for Exhausting, &c., Liquids, &c., R. Wagstaff, Hyde.
5417. Macrame Lace, F. Anyon, Manchester.
5418. Window Blind Roller, H. W. Bean, Wellingborough.
5419. Automatic Drilling Lathe, J. Parry, Birmingham.
5420. Combined Electric Bell Push and Incandescent Lamp-holder, &c., C. K. Falkenstein, London.
5421. Keeping Wedges, &c., in Position, G. H. Wells, Sheffield.
5422. Insulating Wires, &c., for Electrical Purposes, I. L. and P. Lawrence, London.
5423. Gutters, E. de Pass.—(*L. J. Hardy, France.*)
5424. Closing Boxes, &c., H. Harris, London.
5425. Stands, &c., for Holding Cloth, &c., E. Haslem, London.
5426. Opening and Closing Doors of Hansom Cabs, F. and C. Forder, London.
5427. Reversing Latch Bolts of Locks, &c., J. Woodward, London.
5428. Self-acting Hemispherical-ended Labels, J. Woodward, London.
5429. Hydraulic Elevators, E. Heurtebise, London.
5430. Box Ends of Lathes for Looms, D. H. Hesslegrave, London.
5431. Taking Buckle or Flats out of Steel Tubes, E. S. Brett, London.
5432. Perspective Demonstrator, R. Elmore, London.
5433. Decorated China and Earthenware, J. Holdcroft, London.
5434. Self-acting Cooling Apparatus, for Injuries to Domestic Animals, G. Downing.—(*L. V. Swaine, Germany.*)
5435. Stoppering Bottles for Ginger Beer, &c., E. Stiff and G. J. Chambers, London.
5436. Sulphuric Acid, W. S. Squire, London.
5437. Preventing Formation of Ice upon Windows, A. F. Link.—(*E. Diez, Wurtemberg.*)
5438. Watches, &c., driven by Coiled Springs, L. V. Bemmel, London.
5439. Preventing Subsidiary Fermentations, C. D. Abel.—(*C. Meyer, London.*)
5440. Blanks for Bottom of Cartridge Cases, A. Julien, London.

5441. METALS and LININGS for CONDENSERS, G. W Chinnery, London.
5442. CEMENT, F. Ransome, London.
5443. TREATMENT of GAS, F. Leslie and J. A. Wanklyn, London.
5444. BOAT-LOWERING TACKLE, E. J. Hill, London.
5445. BOAT-LOWERING TACKLE, E. J. Hill, London.
5446. COCK, C. J. Bates, London.
5447. FASTENING for FURNACE DOORS, C. J. Bates, London.
5448. PURIFYING SEWAGE, W. H. Hartland, Glasgow.
5449. TREATMENT of SLAG FIBRE or WOOL, D. H. Dade, London.
5450. TANDEM VELOCIPEDES, G. Singer and R. H. Lea London.
5451. BITS for HORSES, &c., J. Roarke, London.

4th May, 1885.

5452. CUTTING BOARDS, C. J. Corbitt, Manchester.
5453. DECORATION of TINNED PLATES, S. Groves, Birmingham.
5454. CORRUGATED PLATES, J. D. Morrison, sen., Newcastle-upon-Tyne.
5455. BOLTING BREECH-LOADING DROP-DOWN GUNS, R. Jackson and G. W. Toney, Birmingham.
5456. BORING WELLS, C. Chapman, Manchester.
5457. SELF-ACTING FUEL ECONOMISING and SMOKE-PREVENTING APPARATUS for BOILERS, F. Kennedy and A. Stewart, Glasgow.
5458. LATHE CARRIER or DOG, J. Barlow, Nottingham.
5459. FINISHING LEATHERS, H. S. Barrow, J. Bostock, and G. A. Hardy, Nottingham.
5460. EDUCATIONAL APPLIANCES, T. Barker, Rock Ferry, and J. F. Williams, Liscard.
5461. MAKING MILLBOARDS, B. Donkin, Blackheath, and A. Lehmann, Cricklewood.
5462. WARP LACE MACHINES, A. Dawson and E. Smith, London.
5463. INCREASING the EFFICIENCY of ELECTRICAL INCANDESCENT LAMPS, R. P. Fuge, London.
5464. SHUTTLES, J., J., and H. Ingham, Halifax.
5465. TUBES for CAP SPINNING FRAMES, J. Bairstow, Halifax.
5466. ROTARY PRESSURE BLOWER and EXHAUSTER, H. Wilkinson, Sheffield.
5467. FORGING NUTS, E. Davies, London.
5468. PLUNGERS or PISTONS of SYRINGES, J. H. Stone, London.
5469. RAISING WATER, &c., S. H. Wright, London.
5470. BRACE FASTENER for TROUSERS, G. Schädler, London.
5471. IRONING and BRUSHING SILK HATS, G. Schädler, London.
5472. PURIFYING and FILTERING WATER, L. Schröter, London.
5473. OPENING and CLOSING HANSOM CAB DOORS, C. Kahn, London.
5474. TROUSERS, W. H. Stevens, London.
5475. ENABLING the BLIND to PLAY at CARDS, T. W. Morris, London.
5476. STEAM BOILERS, M. Gehre, London.
5477. TURNING the HEADS of CASKS, A. Ransome and T. J. Wilkie, London.
5478. TRUSSING CASKS, A. Ransome and T. J. Wilkie, London.
5479. CARPET SWEEPERS, B. C. Evers.—(*W. H. Castle, United States.*)
5480. LAND and WATER VELOCIPEDE, &c., R. Brooks, London.
5481. BACK BAND GUIDES of HARNESS SADDLES, T. Wincer, London.
5482. DISCHARGING DREDGER GRABS, &c., H. J. Coles, London.
5483. FERMENTS, M. Blumenthal, London.
5484. SPOOL CABINETS, J. H. New, London.
5485. COATING IRON, &c., with TIN, &c., E. Morewood, Llanelly.
5486. CANDLES, S. Clarke, London.
5487. LAMPS, G. Castleden, London.
5488. APPARATUS for FILING, A. T. Booth, London.
5489. STARTING TRAM-CARS, W. L. Wise, London.—(*A. Krüzner and F. Tentschert, Austria.*)
5490. PLATE SLEEPERS, &c., for RAILWAYS, J. Livesey, London.
5491. GENERATING STEAM, &c., J. Imray.—(*F. H. F. Engel, Germany.*)
5492. PRESSES for PUNCHING METALS, J. P. Woodcock, London.
5493. WATER MOTOR, J. Bowie, W. Turner, and M. Hill, London.
5494. DYNAMO MACHINES and ELECTRO-MOTORS, C. A. A. Capito and M. P. Hardt, London.
5495. ROTARY ENGINES, D. McKellar and J. Robertson, Glasgow.
5496. DUPLEX CRANK PISTON PUMPS, J. Dow, London.

SELECTED AMERICAN PATENTS.

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

313,974. BELT LACE, *Nicholas I. Allen, Rochester, N.Y.—Filed April 18th*, 1884.

Claim.—A belt lace made of lamp wick treated with asphaltum or coal tar, provided with metallic tips at

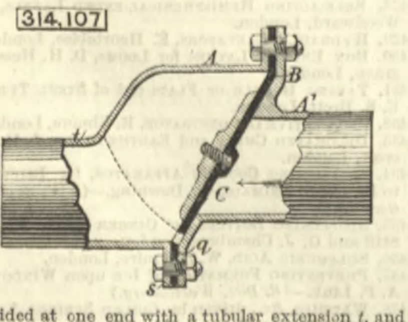
313,974

its ends, and having strands of wire running longitudinally through the lace, as and for the purpose specified.

314,107. CHECK VALVE, *William Chapell, Chicago, Ill.—Filed March 6th*, 1884.

Claim.—A valve to be inserted in a waste pipe leading from a bath tub to a water closet, comprising in combination, the following elements, viz.: A bulb A,

314,107

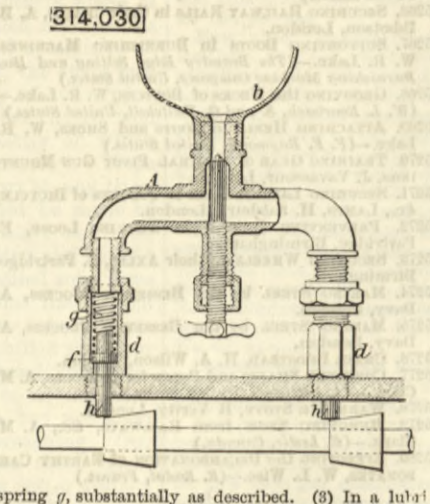


provided at one end with a tubular extension *t*, and with a flange *s* at the opposite end, a tube A^1 of narrower dimensions than the bulb A, and provided with a flange *q*, a disc B, of pliable material, secured between the flanges *s* and *q*, which are secured together, and a flap C, formed by cutting part way around the centre of the disc B, and hanging at one end from the same, all being constructed and arranged to operate substantially as described.

314,030. LUBRICATOR FOR STEAM CYLINDERS, *Fortunatus G. Kellogg, Winnipeg, Manitoba, Canada.—Filed September 6th*, 1884.

Claim.—(1) The lubricator consisting of tube A, cup *b*, cylinders *d*, attached to the tube ends, valves *f*, projecting stems *h*, and springs *g*, combined for operation, as specified. (2) The combination, in a lubricator, of cup *b*, tube A, cylinder *d*, valve *f*, stem *h*, and

314,030

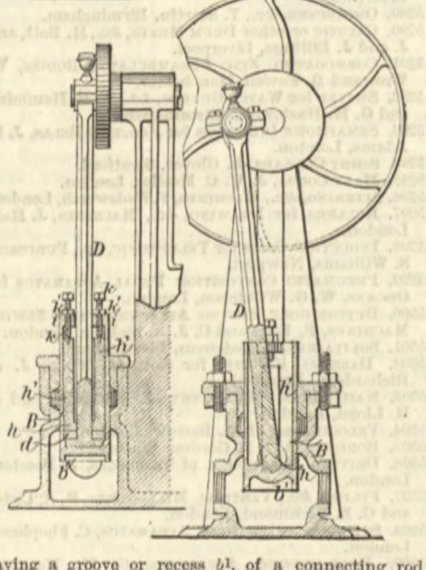


spring *g*, substantially as described. (3) In a lubricator, the combination, with the lubricant feeding valves, with their stems extending into the steam chamber, of the steam valves acting upon said stems to open their valves, substantially as and for the purpose set forth.

314,078. PUMP, *David P. Stewart, Buffalo, N.Y.—Filed April 9th*, 1884.

Claim.—(1) The combination, with the piston or plunger B, of the connecting rod D, provided with a head or knuckle *d*, bearings *h*, having vertical arms h^1, and screw bolts *k*, substantially as set forth. (2) The combination, with the piston or plunger B,

314,078

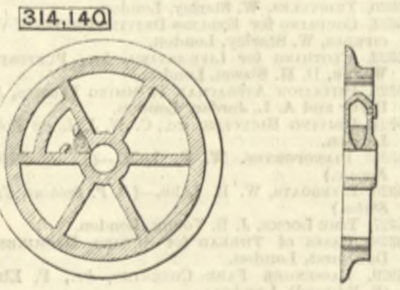


having a groove or recess b^1, of a connecting rod D, provided with a knuckle *d*, seated in said groove, bearings *h*, arms h^1, and screw bolts *k*, substantially as set forth. (3) The combination, with the tubular plunger B, having a groove or recess b^1, and lugs *i*, of the connecting rod *d*, provided with a T-shaped head or knuckle *d*, bearings *h*, provided with vertical arms h^1, screw bolts *k*, and jam nuts k^1, substantially as set forth.

314,140. SELF-OILING CAR WHEEL, *Herman L. Kirchman, Centreville, Iowa.—Filed December 10th*, 1884.

Claim.—A car wheel having two of its spokes connected by walls or webs, so as to form a chamber radiating from the hub, an opening at the inner end of the said chamber extending through the hub, a screw plug affording access to the said chamber, and

314,140

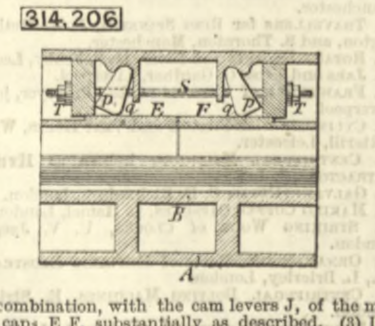


lugs or flanges extending into the said chamber from the spokes, forming the end walls thereof, in combination with packing placed in the inner end of the said chamber and retained by such lugs or flanges, substantially as set forth.

314,206. SHAFT COUPLING, *William B. Turner, New York, N.Y.—Filed November 19th*, 1884.

Claim.—(1) In a shaft coupling, the cam levers J, substantially as described. (2) In a shaft coupling,

314,206

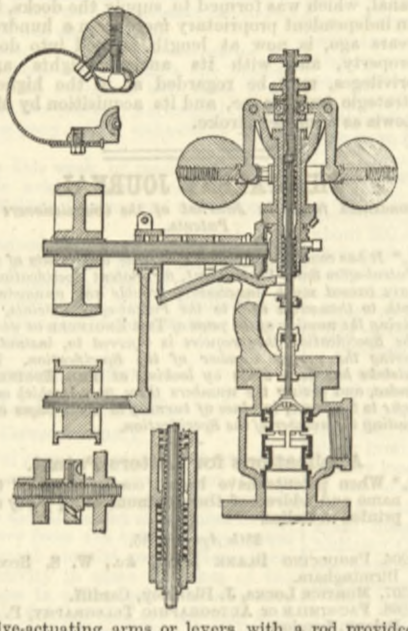


the combination, with the cam levers J, of the movable caps E F, substantially as described. (3) In a shaft coupling, the combination, with the cam levers J and rod S and nut or nuts T, of the movable caps E F, substantially as described. (4) In a shaft coupling, the combination, with the cam levers J, of the movable caps E F, and stationary seat B, substantially as described. (5) In a shaft coupling, the combination, with the yoke shaped cam levers J, of the movable caps E F, substantially as described. (6) In a shaft coupling, the combination, with the casing A, of the movable caps E F, levers J, and cams *p q*, substantially as described.

314,528. GOVERNOR FOR STEAM ENGINES, *Alvah E. Hardy, Everett, Mass.—Filed September 29th*, 1884.

Claim.—(1) In a governor for steam engines, the combination, with the valve and revolving weights controlling the same, of the spring-actuated stopping device for wholly or partially closing the valve, and the lever, whereby the said stopping device is retained inoperative while the governor is properly actuated, substantially as described. (2) In a governor for steam engines, the combination of the valve and revolving weights controlling the same with the spring-actuated stopping device and the lever and idle pulley, whereby the said stopping device is retained inoperative while the governor-actuating belt is in its normal operative condition, substantially as described. (3) In a governor, the combination of the revolving weights and their supporting springs with the valve-actuating levers and yielding bearing pieces engaging the said levers, substantially as described. (4) The combination of the revolving weights and their supporting springs with the valve-actuating levers, bearing pieces engaging said levers and springs, and adjusting devices whereby the pressure of said bearing pieces and the consequent frictional resistance to the movement of the parts may be regulated, substantially as described. (5) The combination of the revolving weights and

314,528

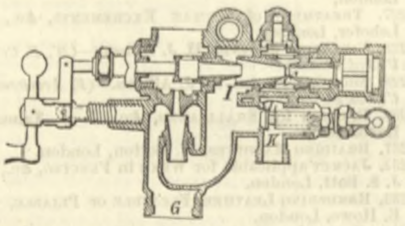


valve-actuating arms or levers with a rod provided with flanges or collars engaged by the levers, the said collars being provided with an oil chamber surrounding the rod, and an inlet passage to said chamber in one flange or collar, and an outlet passage in the other flange or collar, substantially as described. (6) In a steam engine governor, the combination, with the revolving weights and valve stem and valve controlled thereby, of an auxiliary spring acting upon the said valve stem, whereby the effect of the weights thereon may be varied, substantially as described. (7) In a governor for steam engines, the combination of the valve stem and revolving weights controlling the same with the spring actuated stopping device and engaging projection on the valve stem co-operating therewith, substantially as described.

314,533. INJECTOR, *James Jenks, Detroit, Mich.—Filed June 4th*, 1884.

Claim.—(1) The combination, in an injector or ejector, of the steam jet, combining tube, and delivery tube, situated in relation to each other, substantially as described, with a piston controlling the admission of steam to the jet, tightly fitting in and having a reciprocating motion within a perforated cylinder, and a valve upon a yielding stem controlling the overflow passage, substantially as and for the purposes specified. (2) In an ejector having an injector inclosed in the same shell, and adapted to draw water from a plane below that of the implement, and deliver the same to said injector, a perforated cylinder in the steam chamber having a reciprocating piston

314,533

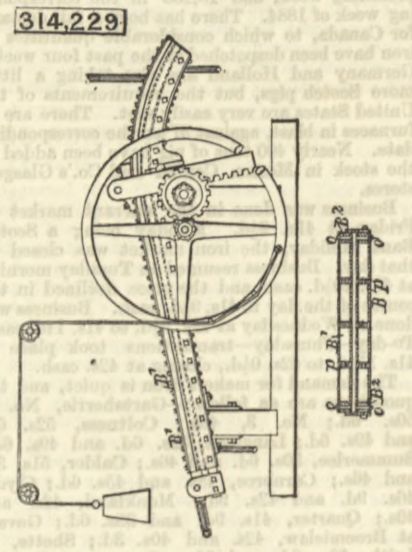


tightly fitting therein, a steam jet, a combining tube and a delivery tube, such cylinder, steam jet, and tubes being on the same axial line, in combination with a water chamber surrounding the adjacent ends of said tubes, having an opening in its top communicating with an overflow passage, such opening being controlled by a valve which is opened by internal pressure and closed by gravity, substantially as specified. (3) In a steam injector provided with inlet, exit, and overflow passages, the chambers I and C^1, the latter independently formed within the body of the casing, and surrounding the combining and delivery tubes thereof, passage G^1, wholly within the said casing, and the overflow pipe K communicating with the chambers I and C^1, in combination with the valve L, mounted on a yielding stem, and regulating the exit from the chamber I to the overflow pipe K, and the valve I^1, automatically regulating the overflow from the chamber C^1 to the overflow pipe K in the rear of and independently of the valve L, substantially as shown and described.

314,229. WOOD-BENDING MACHINE, *John R. Cross, Chicago, Ill.—Filed January 14th*, 1882.—*Renewed November 20th*, 1884.

Claim.—(1) In a wood-bending or drying machine, the hollow platen constructed of upper and lower boiler iron plates B B^1, intermediate wrought metal frame B^2, marginal rivets *o*, and central stay bolts *p*, substantially as specified. (2) The combination of under stationary platen, the upper platen hinged to the lower one, the rack bars secured to the upper platen, the crank wheel, and the gearing, whereby the power of the wheel is transmitted to the rack bar for operating upper platen, substantially as specified. (3) In a wood-bending or drying machine, the combination of two hollow platens adapted to be heated by steam, one of said platens being provided with overlapping plates inclosing the side edges of the board without preventing the escape of the vapour thereat substantially as specified. (4) The combination, with the moving platen, of a drying an machine, and the mechanism for depressing platen, of a weight connected to said mechanism

314,229

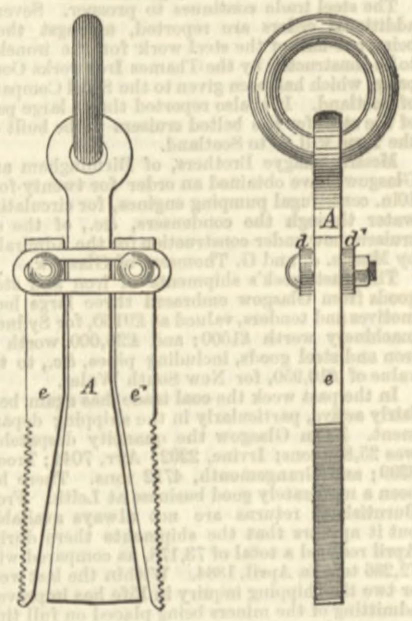


exerting a steady force thereon, whereby the shrinkage in the wood is taken up, and an unvarying pressure is secured substantially as specified.

314,243. STONE LIFTER, *Thomas Heathcote, Allegheny City, Pa.—Filed October 18th*, 1884.

Claim.—The herein-described stone lifter, consisting of the cone-shaped plug *a*, with the ring *c* and slotted

314,243



links *d* d^1, with the ribbed feathers *c* c^1, as shown and described, and for the purposes intended.

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