RADIAL VALVE GEARS.

By Robert Hudson Graham, C.E.

No. V.

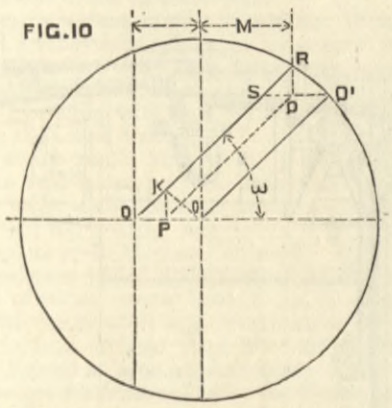
At the end of the last article on "Radial Valve Gears," which appeared in the issue of The Engineer for June 29th, 1883, pages 497-9, it was intimated that, in completion of the subject, another paper might follow dealing with the adjustments necessary to effect an equal distribution of steam in Brown's radial beam-lever valve gear. The tardy appearance of this article must be ascribed to a desire I had to develope and annotate some passages in this part of Herr Hoffman's manuscript, which seemed obscure and in need of further explanation. This I now give by way of an appendix, with numbered notes, for which, therefore, I am alone responsible. It will be advisable for those interested in the subject to re-peruse, before reading this article, paper No. 4 of the series, which appeared in the issue of The Engineer above mentioned, and to which frequent reference will be made.

In ordinary cases one of the leading causes of unequal steam distribution is the obliquity of the connecting-rod. In the Brown system the difference, due to obliquity, may be compensated, either wholly or in part, by controlling the action of the beam lever A G B, Fig. 4, page 499 *ante*, which object can be attained by keying the small crank of this lever upon the crank shaft at the same angle as the main crank. Were the main and lever cranks keyed diametrically opposite to each other, the differences due to obliquity would be additive and augmentative, not subtractive and mutually corrective. The maximum difference arising from this cause is expressed by—see page 498 *ante*—

$$OO^1 = \frac{r^1}{R} \cdot b\left(1 - \sqrt{1 - \frac{R^2}{b^2}}\right) - \frac{r^1}{r} \cdot a\left(1 - \sqrt{1 - \frac{r^2}{c^2}}\right).$$

Let us first suppose the valve diagram symmetrical, so that, for the same phase, all the four ordinates $\frac{B}{2}$ are equal to each other. It is then clear that the steam admission will be greater on the stroke towards than on that from

FIG. 10



the crank shaft, because, at any phase ϖ, the excentricity OO^1 of the crank circle would occasion a difference, equal in the sum to $2 \cdot Q Q^1 = \frac{2\,O O^1 \cdot \sin.^2 \varpi}{2\,R}$—see Fig. 10 and Appendix, Note 1.

This difference must be eliminated by operating upon the term z_0 and u_0. The term z_0, Fig. 4, page 499 *ante*, represents the maximum distance $N^1 N^{11}$ of the curve $B_0\, N^{11}\, B_1{}^0$ from the circle described about the centre M, with a radius L = B C. In order to eliminate the evil influence of the excentricity OO^1, the lengths of the ordinates $\frac{B}{2}$ must be arranged so that those on the right of the axis of y may be shorter than those on the left—see Appendix, Note 2.

It will be remembered, page 498 *ante*, that the term z_0 lengthens the ordinates $\frac{B}{2}$ above, and shortens those below, the axis of x; hence it follows that the differences in steam admission are always augmented on one and shorted on the other stroke, in virtue of the alternate addition and subtraction of the term z_0.

The diagram, Fig. 8, p. 499 *ante*, taken with the text, shows that the term u_0, when negative, shortens the ordinates $\frac{B}{2}$ on the stroke towards the crank shaft, and augments the same values on the opposite stroke, whether the engine be set in forward or backward gear. This term, therefore, can be used as a means to balance the evil effects of obliquity, or, in other words, of the excentricity OO^1 of the crank circle. See Appendix, Note 3.

In the case of machines whose motion can be reversed, the evil influence of obliquity can be perfectly eliminated only by adjusting the curve described by the end of the valve radius rod. In machines which turn always in one sense, the term z_0 may prove a very useful means of compensation. We must then make z_0 negative on the forward. and positive on the return stroke. See Appendix, Note 4 But in many arrangements the curve of z_0 cannot be varied' and in such cases the evil effects of obliquity must be prevented, as far as possible, by operating upon the term u_0; then whatever difference remains will be unavoidably intensified by the action of the term z_0. If, in consequence of the radial suspension of the system, the variable u_0 became greater or less than what is strictly required to compensate the obliquity, one stroke would be favoured more than the other.

In the equation of valve motion, formula 4, page 498 *ante*, it was assumed that

$$x = r \cos. \varpi - a\left(1 - \sqrt{1 - \frac{r^2 \sin.^2 \varpi}{c^2}}\right).$$

The correct value of this term is—see Fig. 4—

$$x = r \cos. \varpi - a\left(1 - \sqrt{1 - \frac{(A A^1 + G G_1)^2}{c^2}}\right)$$

$$= r \cos. \varpi - a\left(1 - \sqrt{1 - \frac{(r \sin. \varpi \pm p(\cos. \phi - \cos. \phi_0)^2}{c^2}}\right)$$

Substituting in this formula the particular values $\varpi = 90^0$ and $\varpi = 270^0$, we obtain

$$x = r \cos. \varpi - a\left(1 - \sqrt{1 - \frac{\left(r \pm \sqrt{1 - \frac{r^2}{p^2}}\right)}{c^2}}\right)$$

Substituting these values for x in the expression for the excentricity O O¹, we obtain—

$$OO_1{}^1 = \frac{r_1}{R}\, b\left(1 - \sqrt{1 - \frac{R^2}{b^2}}\right) - \frac{r^1}{r}\, a\left(1 - \sqrt{1 - \frac{\left(r + \sqrt{1 - \frac{r^2}{p^2}}\right)}{c^2}}\right)$$

and

$$OO_2{}^1 = \frac{r_1}{R}\, b\left(1 - \sqrt{1 - \frac{R^2}{b^2}}\right) - \frac{r^1}{r}\, a\left(1 - \sqrt{1 - \frac{\left(r - \sqrt{1 - \frac{r^2}{p^2}}\right)}{c^2}}\right)$$

See Appendix, Note 5.

These equations show that the excentricity O O¹ has two distinct values, one corresponding to the area above, the other to that below the axis of x. Hence, rigorously speaking, the half crank circle above the axis of x ought to be described about an independent centre O'_1, Fig. 11, and the lower half circle about a second independent centre O_2. See Appendix, Note 6.

The mean linear direction O E¹, Fig. 13, of the beam lever makes an angle E O E¹ = T O N¹¹ with the central

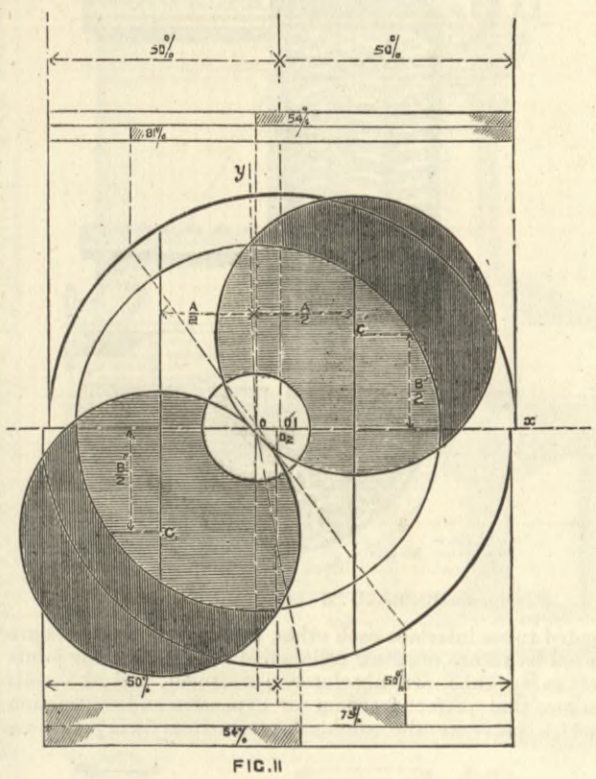


FIG. 11

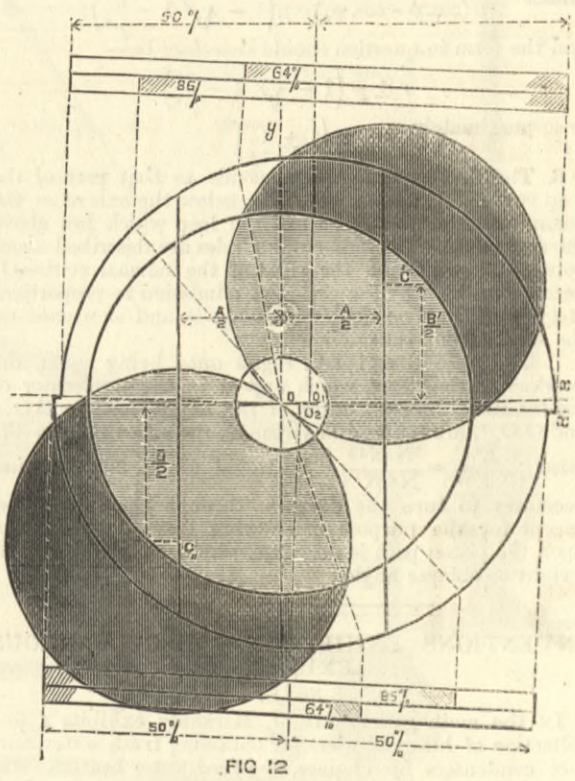
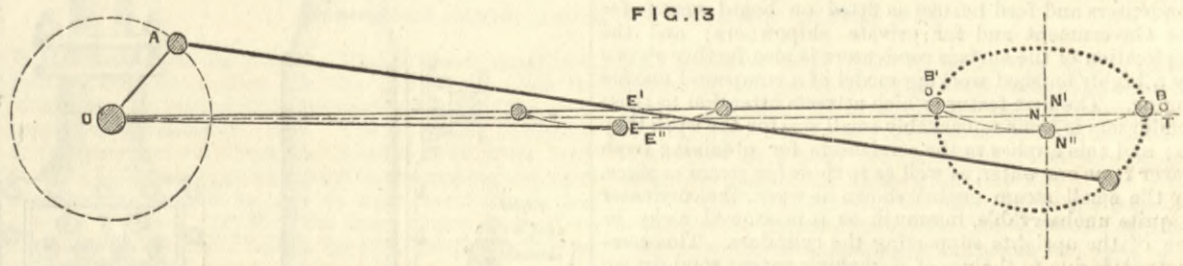


FIG. 12

FIG. 13



axis of the machine, and, therefore, the points $B_1{}^0$ and B_0 will lie above the axis O T. Consequently, the differences N N¹¹, E E¹¹, and the difference between the excentricities $OO_1{}^1$ and $OO_2{}^1$ are then smaller, which is an advantage in view of the more equable distribution of steam. The dead points would not in this case coincide with B_0 and $B_1{}^0$, but would fall earlier or later in proportion to the magnitude of the angle E O E¹. In order to take account of this angularity of the dead points, the centre line, Fig. 12, is deviated so as to make an angle with the axis of x equal to E O E¹—see Appendix, Note 7. Wherefore the whole system, which serves to correlate valve and piston displacements, is turned through an equal angle.

In the construction of a new gear we can use the formula $\epsilon = A \cos. \varpi \pm B \sin. \varpi$, which by Zeuner's methods enables us to find all the dimensions of the valve. Assuming, for example, the linear advance $OP_0 = A$, Fig. 5 *ante*, and a given maximum admission; draw the two centre lines of valve circles, each distant $\frac{A}{2}$ from the centre O. Next represent the crank in the position O R^2, corresponding to the given cut-off; then describe the crank circle about O as a centre, and lastly the outer lap circle. The lap circle will then intersect the crank arm, assumed in position, at a point v_2; and if a circle be described from a centre C^1 on the corresponding line of centres, so as to pass through the three points O, v_2, and P_0, this centre will determine the length of the ordinate $\frac{B}{2}$, and thereby the diameter of the valve circle, namely, $\sqrt{A^2 + B^2}$, which also represents the maximum valve displacement on the side of its centre of travel corresponding to the forward piston stroke.

The valves A and B being once fixed, it is an easy matter to establish the ratio $\frac{l}{L}$, the excentricity r, and the angle of cant α^0, necessary to obtain a total horizontal displacement equal to twice A, and a total vertical movement equal to twice B.

Mr. Charles Brown, the manager of the Winterthur Works and the author of the system just described, had made some 500 sets between the years 1876 and 1883. He generally uses a working beam, so as to get the cylinders well away from the road and to place the slide valves under the cylinders. So, also, as far as is practicable, he adopts a combination of radial rods, in preference to the radial slot, which is liable to frictional wear, especially in dusty continental towns.

The method developed in the fourth and in the present article of this series affords a good illustration of the intrinsic difficulties which oppose the reduction of a radial system to the stereotype analytical expression of Zeuner's polar diagram. The purely graphic method which, in the first three articles, we demonstrated and applied to a Crewe goods engine, and which we have since tested by numerous examples, is, we venture to think, more direct, constructive, and expeditious, whilst it is certainly not less correct, than Herr Hoffmann's able, elaborate, and well-digested application of Zeuner's diagram to a radial system.

APPENDIX.

1. Draw, Fig. 10, the line O¹K at right angles to O¹Q¹, and K P at right angles to O O¹; then, in virtue of similar ratios, the line P Q will be parallel to O R and O¹Q¹. Hence

$$O^1K = OO^1 \sin. \varpi;\ O^1P = QQ^1;$$

so that

$$QQ^1 = O^1K \cos. P\,O^1K = O^1K \sin. \varpi = OO^1 \sin. {}^2\varpi.$$

There would be a like difference, with unlike sign, on the opposite stroke; whence the total difference or algebraical sum would be

$$2\,Q\,Q^1 = 2\,O\,O^1 \sin. {}^2\varpi;$$

or, expressed in percentage of the piston stroke, the difference in admission is

$$2\,Q\,Q^1 \div 2\,R = \frac{2\,O\,O^1 \sin. {}^2\varpi.}{2\,R.}$$

2. The stroke towards the crank being taken from right to left, the cut-off on this stroke must be hastened, because the piston displacement is accelerated on the stroke towards the crank shaft. This can be effectively done by reducing the ordinates of the centres C_{111}, Fig. 8 *ante*, of the valve circles, which throws the point of cut-off v_2 nearer to the beginning of the stroke. We shall explain this principle more fully in a subsequent note; in the meantime it must be taken for granted that the period of steam admission is lengthened or shortened with the increase or decrease of the ordinates $\frac{B}{2}$.

3. In the preceding note we have already laid down the principle that the period of steam admission is lengthened or shortened concurrently with the increase or decrease of the ordinates $\frac{B}{2}$ of the valve circle centres. This will be seen more clearly on referring to Fig. 8, page 499 *ante*, where it is manifest that by increasing the ordinate $\frac{B}{2} = C_1{}^0\, C^1{}_{111}$ of the valve circle centre, we displace the point of cut-off v_2, which is also the point of intersection of the lap and valve circles, towards the left, and the period of admission will be thereby increased. Now on this stroke, that is from right to left or towards the crank shaft, the acceleration of the piston, due to the obliquity of the connecting rod tends to lengthen the period of admission expressed in terms of the piston stroke; hence

this effect can be prevented by using the term u_0 to shorten $\frac{B}{2}$ on the forward stroke.

4. Referring to the equations for forward and backward gear—column 3, page 498 *ante*—it will be seen that on the forward stroke, here used for stroke towards the crank shaft, the term z_0 is plus or additive; that is to say, it tends to increase the ordinates $\frac{B}{2}$ of the valve circle centres. Therefore, the proper effect of z_0, as it exists in Fig. 4 page 499 *ante*, is to increase $\frac{B}{2}$ and with it the period of admission on the forward stroke. But we can well imagine that if the curve of z_0 were laid above instead of below the curve of ordinates $B_0 N^1 B_0^1$, z_0 would become negative on the forward stroke and thus serve to reduce the ordinates $\frac{B}{2}$.

5. There is apparently an error in the numerator of the fractional term in brackets, either existing in Herr Hoffman's original manuscript, which is no longer in my possession, or made in the transcription; for, referring to Fig. 4, we have—

$$p \sin. \phi = r \cos. \varpi; \text{ whence } \sin. \phi = \frac{r}{p} \cos. \varpi;$$

and

$$\cos. \phi = \sqrt{1 - \left(\frac{r \cos. \varpi}{p}\right)^2};$$

whence, if $\varpi = 90$, $\cos. \phi = 1$, and $\phi = 0$.

Again, if $\varpi = 0$, $\phi = \phi_0$, and

$$\cos. \phi_0 = \sqrt{1 - \frac{r^2}{p^2}}.$$

Hence

$$p(\cos. \phi - \cos. \phi_0) = p\left(1 - \sqrt{1 - \frac{r^2}{p^2}}\right);$$

and the term in question should therefore be—

$$r \pm p\left(1 - \sqrt{1 - \frac{r^2}{p^2}}\right)$$

or approximately

$$r\left(1 \pm \frac{r}{2p}\right).$$

6. The first equation corresponds to that part of the loop curve, Fig. 4 *ante*, which lies below the axis of x; the second equation to that part of the loop which lies above the same axis. The half crank circles are described about points O_1^1 and O_2 on the right of the normal centre O; because in this way the period of admission is proportionately lengthened on the stroke towards, and shortened on the stroke from, the crank shaft.

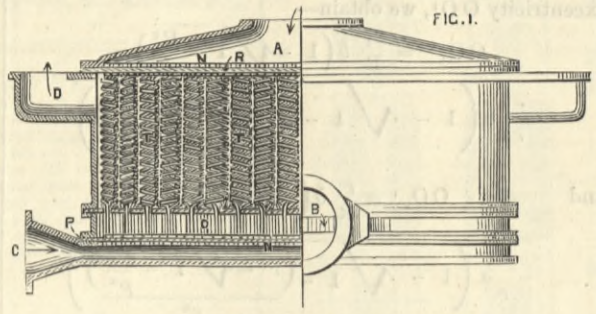
7. The radii p and BC, Fig. 4 *ante*, being equal, the versines of their arcs, which appear in the numerator of the fractional bracket terms of the expressions for $O O_1^1$ and $O O_2^1$, are reduced in virtue of the given cant in the ratio $\frac{E E^{11}}{E^1 E^{11}} = \frac{N N^{11}}{N^1 N^{11}}$. It would seem, however, unnecessary to turn the diagram through the cant angle, except for the purpose of showing how the projection upon the piston path is the same, whether it be drawn at a right or oblique angle. R. H. G.

INVENTIONS EXHIBITION.—MISCELLANEOUS EXHIBITS.

No. II.

IN the main gallery Mr. J. Kirkaldy exhibits a fine collection of his condensers for obtaining fresh water, surface condensers for engines, and feed-water heaters. He also exhibits a fine collection of drawings showing these condensers and feed heaters as fitted on board vessels for the Government and for private shipowners; and the application of the surface condensers is also further shown by a highly finished working model of a compound marine engine. The first feature which attracts attention to these condensers is their remarkably small size for the work they do; and this applies to the condensers for obtaining fresh water from sea water, as well as to those for steam engines. In the small steam engine shown at work, the condenser is quite unobservable, inasmuch as it is stowed away in one of the uprights supporting the cylinders. This compactness is due to the use of Kirkaldy's patent solid-drawn corrugated tubes, and to the way in which coils of these tubes are interlaced, thus presenting very large surface in a most effective form, and completely breaking up the inrushing jets of steam, and equally breaking up the stream of cooling water. Several forms of the condensers and the feed-water heater are illustrated by the accompanying engravings. We may first, however, refer to the condensers or stills for obtaining fresh water. These it is unnecessary to illustrate here, as they were illustrated in our description of them published some time ago; but we may give some figures showing their remarkable efficiency, as obtained by the Government tests of those fitted on board the Calabria, the International, and nine other vessels, for obtaining fresh water at Suakim. These vessels are fitted with condensers together amounting to a productive power of 220,000 gallons per day, thirty-nine condensers being used, most of them being of the size for condensing 6000 gallons per day. These condensers are so small that, when not fitted with filters, they occupy a space of but 12in. square and 27in. in height, and even when fitted with a filter weigh but 370 lb., the filter occupying about as much space as the condenser, and forming a stand upon which the condenser is fixed. They are thus in size and weight almost incredibly small for the work they will perform, but the Government tests showed them fully up to the power, and it was found by these tests that steam at 47 lb. per square inch was condensed to water at 70 deg. at the rate of 128·34 lb. per foot of tube surface per hour, the circulating water entering at the temperature of the Thames in March last, and leaving the condenser at 90 deg. It should, however, be remarked that the surface was taken as if of ordinary circular tube, but the Kirkaldy tube really gives much more surface than thus measured. This, however, is, of course, the essential feature in favour of the condenser, but it is not simply that greater surface is given in the same space by this corrugated tube, but that the steam being caused to pass along narrow grooves having very small capacity but large surface, and thus being rapidly condensed to water, which has rapid effect on the main body of the steam in the tube. The steam is, moreover, caused to rub continually against edges or angles, which are most easily cooled by the circulating water. The great success of these fresh water condensers some time since led Mr. Kirkaldy to the adaptation of the system to the construction of surface condensers

FIG. 1.



KIRKALDY'S SURFACE CONDENSER.

and feed-water heaters, and with equal success. One form of these condensers is shown by the engraving Fig. 1A, which is an elevation partly in section, and a plan, also partly in section. This engraving almost explains itself, except that it should be mentioned that the coils of corrugated tubes interlace each other, and that all the tubes are fixed by means of screw collars and nuts, so that the joints of every tube are absolutely permanent, and the coils secure that perfect freedom for expansion and contraction which prevents the slightest stress from being thrown

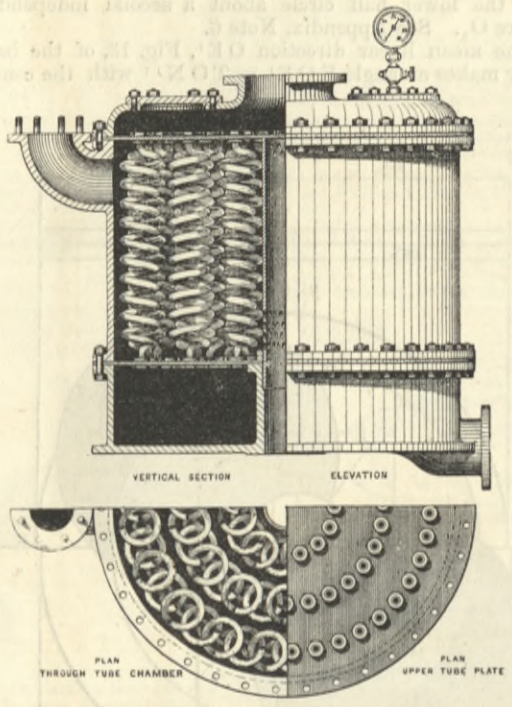
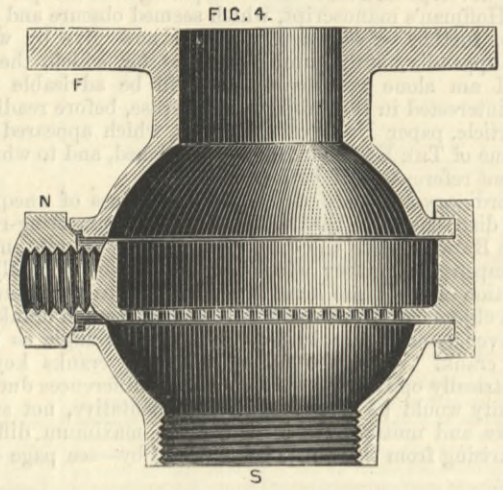


Fig. 1A—KIRKALDY'S SURFACE CONDENSER

upon its joints. One of the larger sizes of the condensers is shown in Fig. 1, in which A is the admission of the exhaust steam from the engine, P the outlet for the condensed steam, B the inlet for the circulating water, and D the outlet for the circulating water. Every coil is fixed by a nut N, making a metallic joint in the upper plate R and lower plate P, and passes through a hole in the intermediate plate C. The circulating water passes through the holes in the plate C round the tube, and thus enters as an annular stream, which is rapidly broken up in its passage amongst the coils. The holes in the plate C are made of different sizes, so that the quantity of circulating water passing through to the different coils may accord with the quantity of water passing the tube as due to its position. Thus the tubes near the exits D will have a larger quantity of water passing them than those near the centre, and thus need not have so much admitted to them through the water tube plate C. The steam may be passed either through the tubes or amongst them, as desired by engineers. The smaller forms of these condensers, as exhibited, are made up much in the same form as shown at Figs. 2 and 3, which are elevations partly in section, and a plan in

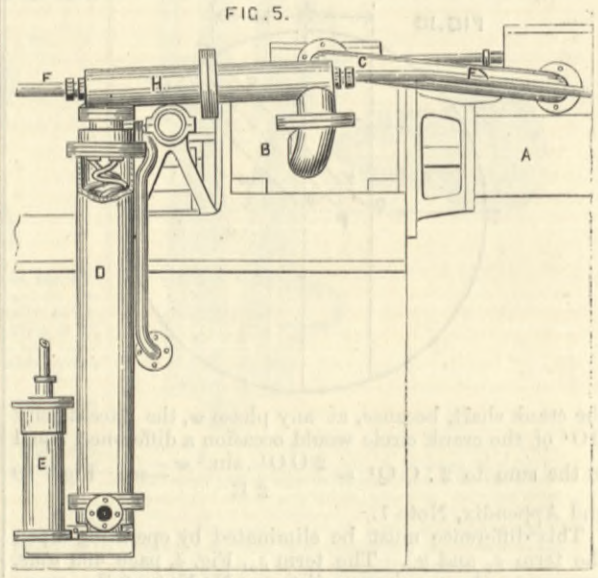
FIG. 4.



DIRT ARRESTER.

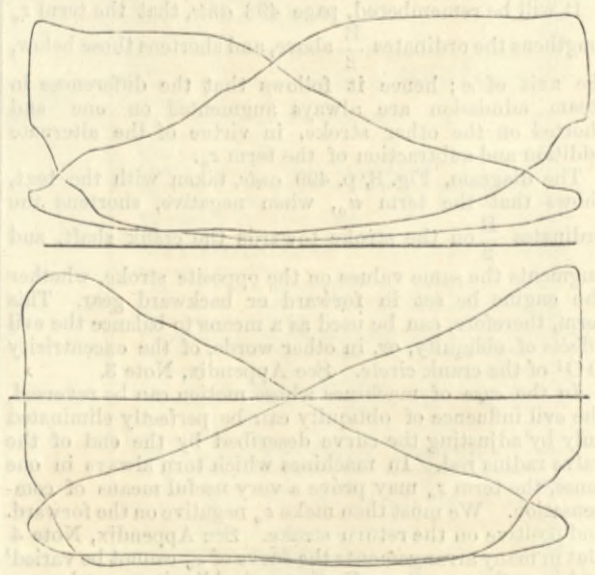
section of a feed-water heater. The application of one of these condensers to a small compound horizontal engine driving machinery in Mr. Kirkaldy's works is shown at Fig. 5, which also shows the application of the smaller size of feed heater. In this engraving, which only shows a small part of the engine, A and B are respectively the high

FIG. 5.



CONDENSER AND FEED-WATER HEATER.

and low-pressure cylinders, C the steam pipe from the high to the low-pressure cylinder, H the feed heater through which the exhaust steam from B passes on its way to the condenser D, the cold feed entering at F and passing away to the boiler at F^1. This engine has cylinders 7·25 and 13·25 diameter and 1·5ft. stroke, and when running at 100 revolu-



tions per minute indicates about 24-horse power. The two pairs of diagrams, Figs. 6 and 7, are taken from it. The condenser D is but 6·5in. diameter, its length being 4ft. 5in., and the air pump E 4in. This air pump was, before the introduction of the new condenser, 8in. diameter, the stroke being, as now, 8in. With a view to experimental determination of a sufficient size for an air pump, the diameter was reduced to 5in., and then to 4in., and with results that showed it to be as efficient as the 8in. pump. The engine has been at work many years, but the high-pressure cylinder was recently added, and some economy obtained; but the gain resulting from the employment of the feed-heater and condenser has been much greater than that resulting from compounding. The diagrams, Figs. 6 and 7, from the high and low-pressure cylinders are reduced from diagrams of respectively 30 lb. and 8 lb. to the inch.

The feed-heater shown at Figs. 2 and 3 is made for use either with live or exhaust steam, and some remarkable

FIG. 3.

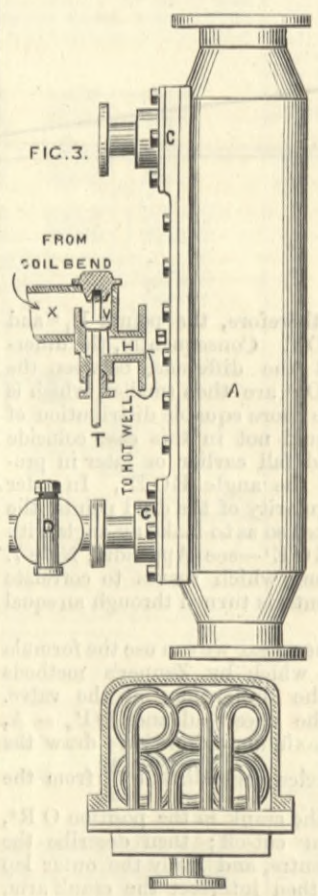


FIG. 2.

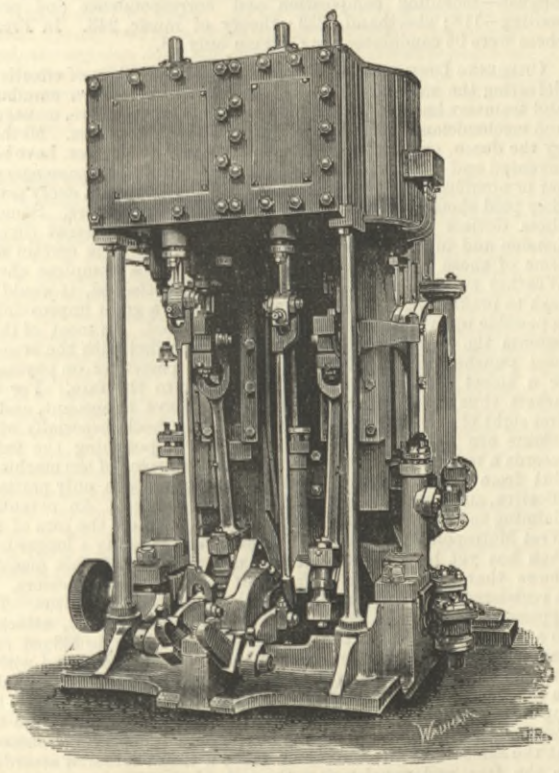
FEED-WATER HEATER.

results have been obtained with it. In this the coils of tubes are all fixed to the one plate B, the ends of the tube being fixed with nuts, making a metallic joint at T, and covered with covers C, which can be separately removed when necessary for examination. This method of fixing the tubes on the cover plate B makes it quite easy to remove the whole in one mass when, after long use, cleaning may be necessary. To prevent the passage of dirt with the steam or the feed-water into the heater, the dirt arrester, Fig. 4, is attached, this arrester being fitted with a tray held in by one nut N, which makes a metallic joint. While being large and numerous enough to permit the free passage of the steam or water, the holes in this tray are small enough to intercept dirt; and its efficient action seems to depend less upon the action of the tray as a mere strainer than upon its mechanical action as a collecting obstacle. The tray may be removed and returned in two or three minutes, as the joint does not need re-making. Its application is shown at D, Fig. 3.

A large number of these heaters have been fitted to the ships of the Great Western and other lines, and are arranged to work with live steam. There would seem to be no cause for any economy from heating feed-water by this means, but the experience of a large number of voyages with several ships between England and America points to a very decided gain. On board the Devon, for instance, the result of continued working is given by the chief engineer as 1 ton 14 cwt. 2 qrs. per twenty-four hours. To make the admission of steam to the heater automatic, so that it enters only when feed-water is passing to the boilers, a flap valve is fitted in the short cylindrical piece seen at the bottom of Fig. 2, and this by means of a small disc and crank pin M, on its spindle N, moves the spindle T; this controls a valve V—see section—which permits the water of condensation to pass to the hot well, the admission of steam being stopped at the outer end of the condenser. The heater thus requires no attention on the part of the engineers or stokers. To some ships the heater is fixed between the low-pressure cylinder and the existing condenser, the heater thus merely forming a part or the whole of the eduction pipe.

A very important application of Mr. Kirkaldy's heater is by an arrangement which he has secured by patent for fitting up boilers after they have been emptied in port. It is well known that more damage is often done to marine boilers by filling with cold water and getting up steam than by the actual working. To avoid this, and the costly repairs which result, Mr. Kirkaldy arranges his heater so that the feed-water may be heated by steam from the donkey boiler while the main boilers are being pumped up, and so that the heating may be done by steam from the main boilers when they are at work. By this means the main boilers are filled up with water at, say, 160 deg., and instead of taking several hours to get up steam, and even then with the greatest care, steam can be had in the largest boilers in from an hour to an hour and a-half, as the fires may be lighted as soon as the furnace crowns are covered with the hot water forced in by the donkey pumps. Not only is this arrangement especially valuable for preventing the stresses due to unequal expansion in boilers when getting up steam, but hot feed may be passed into the boilers when the ship is stopped in entering ports.

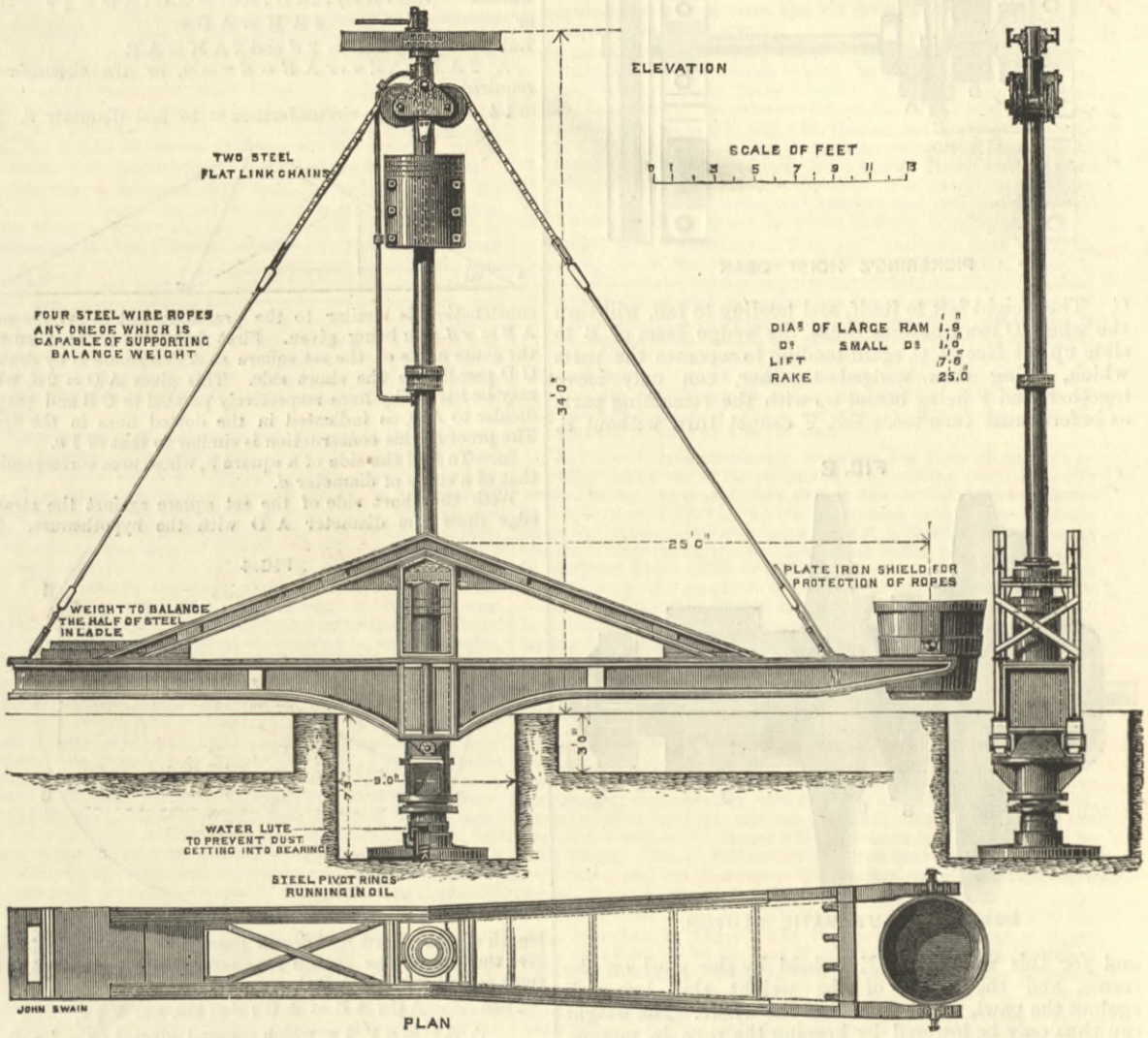
Messrs. Hawthorne and Co.'s special compound engines are designed for yachts, line fishing boats, steam launches, &c., and should, on account of their simplicity and general design, be very popular amongst the owners of such craft



HAWTHORNE'S COMPOUND ENGINE.

as they are intended for. There is nothing exceptional beyond this in their general arrangement, which can be at once seen on reference to our illustration, or on a visit to the stand of Messrs. Hawthorne and Co. at South Kensington, but in the details they are new in several points. They are compound surface condensing, having a high-pressure cylinder of 8in. diameter and a low-pressure of 16in., the stroke in both being 12in. They are fitted with Chapman's patent combined air and feed pump. The part of the pump below the piston does the duty of an air pump, and is $2\frac{1}{16}$in. diameter, having a stroke of 12in. The ram, which is $1\frac{3}{8}$in. diameter, leaves a space on the top of the piston to act as feed pump, having separate suction and delivery valves. This pump is materially assisted by the action of the circulating pump, which, without interfering with its own work, is able to keep a vacuum of from 20in. to 22in. in the hot well, and so taking the load off the air pump discharge allows that pump to be considerably reduced in size. All the pumps are worked direct from the crossheads, which arrangement dispenses with the usual levers and links, and by reducing the working parts, reduces the wear and tear of the engine while leaving a larger proportion of the work done to be absorbed usefully. The slide valves are on the front of the cylinders, and are easily got at for examination. The frame bars in front of the engine are connected to a weigh bar on top of the cylinders, which is carried through the engine-room skylight, on which a double-handled lever is fitted, one end being in the engine-room and the other on deck. A connection is also made from the weigh bar to the steam regulator, so that in order to stop or reverse the engine it is merely necessary to move the main handles either on deck or below.

The centre crane, which we illustrate below, is shown by drawing in the main gallery. It has now been in very successful use about two years. It was designed by



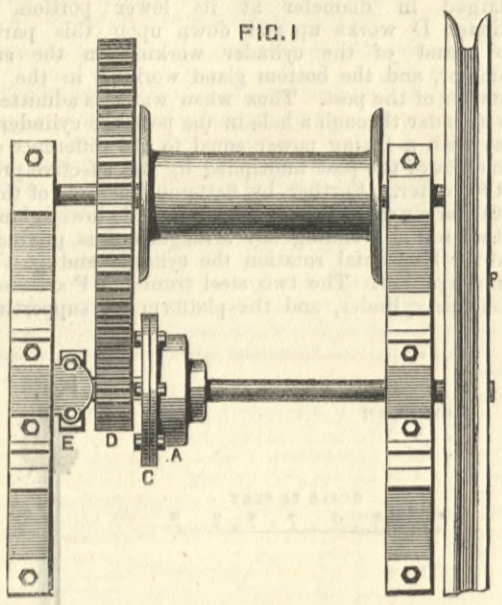
WRIGHTSON'S CENTRE CRANE FOR BESSEMER CASTING PITS

Mr. T. Wrightson, and made by Messrs. Head, Wrightson, and Co., Stockton-on-Tees. In the Bessemer process the molten steel is poured from the converters into the ladle supported by the centre crane. The ladle must be capable of motion in several directions in order to fulfil its functions. (1) To accommodate itself to the tipping motion of the converter, it must be able to move vertically up and down a few feet. (2) For the same object it must be capable of a horizontal motion for a few feet. (3) It must be able to move round horizontally at a considerable radius, so as to discharge successively into the ingot moulds placed round the pit. Where there are such large masses of highly heated material to deal with as in a Bessemer pit, it is desirable to make the pit as large as practicable, to keep the hot ladle and ingots as far from the machinery and men as possible. The original Bessemer crane has been increased in rake to meet these requirements, and owing to this the strain upon the ram, with an overhanging weight of increased amount and increased distance from the centre, become so great that its safety is questionable. To get rid of these strains, and to gain greatly increased rake, and to retain generally the conditions of structure first settled by Sir Henry Bessemer, this crane was designed. In our engraving A is a ram or crane post revolving on a pivot, and carrying the cylinder D with it in its horizontal rotation by means of a key; B are frames for sheaves fixed on ram, and also revolving with it; C is a top support for the ram, attached to the roof, maximum horizontal strain not exceeding $4\frac{1}{2}$ tons in a 15 ton crane with 25ft. rake; D is the lifting cylinder with 21in. gland at bottom and 12in. gland at top; E is the cradle for carrying machinery and ladle; F, pivot fixed at bottom of cylinder on which the cradle has a slight rocking movement; G, ladle containing when full 12 tons of steel; H, balance weight, adjusted so as to balance the cradle when the ladle contains half its charge, or 6 tons of steel; I, annular balance of such weight as will balance the whole 6 tons maximum preponderating weight at any time possible on the cradle; K, steel pivot plates running in oil; the outer chamber is filled with water, and forms a water lute, to prevent dust getting into pivot; L, revolving joint on top of crane post, for conveying water to and from cylinder; M, stop to prevent the cradle from drooping when the preponderance is on ladle end. The stop is left off the opposite side, so that if the bottom of ladle be lowered upon anything unyielding, the frame simply hinges upwards on its pivot. N is a pipe conveying water to and from cylinder, the lower end terminating in a hole bored through the centre of ram, the upper end also entering the post, to pass water through top bearing. A reference to the engraving will show how the balancing of the strains is effected. The wrought iron post A is carried from a socket K in the foundation to a socket C in the roof. The post is enlarged in diameter at its lower portion. The cylinder D works up and down upon this part, the top gland of the cylinder working on the smaller diameter, and the bottom gland working in the larger diameter of the post. Thus when water is admitted into the cylinder through a hole in the post, the cylinder itself rises with a lifting power equal to the difference of the two areas of the post multiplied by the effective pressure of the water. Further, by flattening one side of the post at the larger diameter, and adapting the lower gland box to this form, a sliding key arrangement is produced, so that for horizontal rotation the cylinder and post move round together. The two steel trunnions F are mounted upon this cylinder, and the platform for supporting the ladle is poised upon these in such a way that a rocking motion of the platform upon these trunnions can take place. The platform is made very rigid by trussing, and half the maximum weight of steel to be lifted in the ladle is balanced by a fixed counterweight H at the opposite end of the platform. There is still left one half the weight of the steel unbalanced, the effect of which has to be neutralised or removed to another portion of the structure. To accomplish this, chains are led from each end of the girders forming the platform over sheaves fixed in a strong frame B at the top, and forming part of the crane post immediately under the top socket, so that the sheave frame can rotate horizontally with the crane post and cylinder. The two sets of chains, after passing over their respective sheaves, descend to a heavy balance weight I of annular form surrounding the upper portion of the crane post, which acts as its guide, the point of connection of both sets of chains being the same, and in a plane passing through the centre of gravity of the weight, so that it may hang indifferently on either one or the other set of chains. The crane of this form at the North-Eastern Steel Works deals with 2000 tons of ingots per week. In the Wrightson crane all the hydraulic joints and glands are above ground and easy of access, and any leakage which occurred could be seen at once, and easily repaired.

Mr. Pickering, of Stockton-on-Tees, exhibits the pulley blocks and hoists known by his name, the ingenious self sustaining device of the latter of which we illustrate below. Fig. 1 is a plan of the overhead gear of a hoist, Fig. 2 is a perspective of the clutch gear, and Fig. 3 a section of this same part. The hand rope pulley P and the box A are fixed to the spindle; the box flange A is bolted to the disc C, which turns freely upon the body of the clutch B. This clutch B is in one piece with the toothed wheel D that drives the chain barrel wheel, and at B is a clutch face with inclined teeth that interacts with a similar face on C which forms part of the flange C. The ratchet wheel E can only be turned in one direction, being held by a pawl fixed to the hoist framing, and the disc F is in one piece with E. Thus the box A C, the pieces B D and E F, are all independent one of the other. Assuming that the last operation was the lowering of a load, to raise the weight the rope pulley must revolve so that the clutch on C will slip upon the clutch face of B, and there would be no motion imparted to B, and therefore to D, and through D to the hoist, but for the fact that, in slipping upon each other, the clutch faces also must tend to separate. This they cannot do because they are too close a fit in the box

A C, and thus, by the wedging action of the faces B and C, the whole of the different parts shown in Fig. 3 become, as it were, a single piece, and all turn together, the ratchet E partaking of the general motion, the rotation in that direction not being checked by the pawl, and the flange F being held by the wedge-like action of the clutches B and

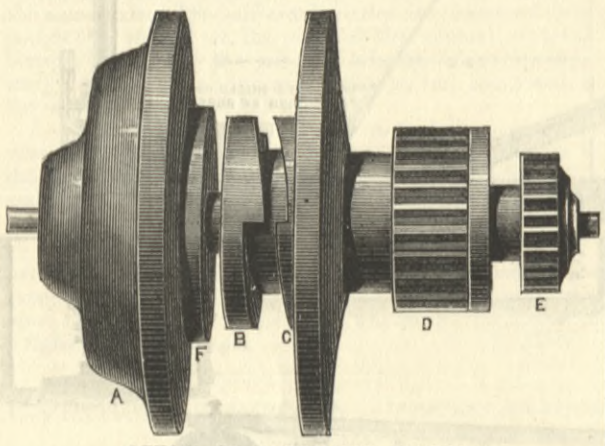
FIG. 1



PICKERING'S HOIST GEAR

C. The weight left to itself, and tending to fall, will turn the wheel D towards and cause the wedge faces of B to slide up the face of C, again tending to separate the parts which, being thus wedged together, can only move together, and F being bound up with the remaining parts as before must turn too. But F cannot turn without E,

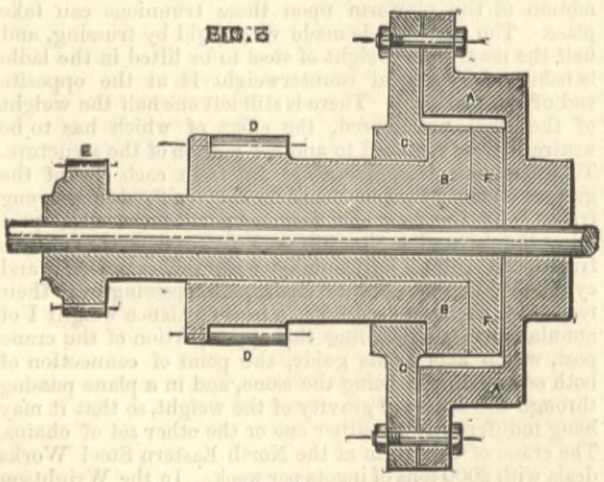
FIG. 2



DETAIL OF AUTOMATIC CLUTCH.

and for this way round E is held by the pawl on the frame, and the action of the weight thus brings E against the pawl, which thus fixes the whole. The weight can thus only be lowered by keeping the rope in motion, when the clutch C will drive the clutch B just at the speed desired; and if B should overrun C the wedging

FIG. 3



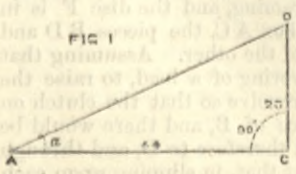
SECTION OF CLUTCH.

action is at once set up and the apparatus brought to rest. It is essential that the fact be kept prominently before the mind that A and C are united by bolts, and that A alone is attached to the rope pulley spindle, the ratchet E being free upon it, and only acting when the wedge action of the inclined faces B and C press the disc F firmly into contact with A.

SIMPLE CIRCLE SQUARING.

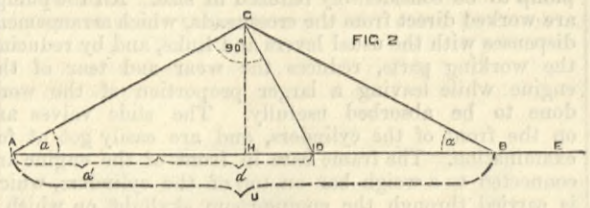
THE following simple method of solving problems involving the rectification and quadrature of the circle by construction, has been devised by Mr. E. Bing, manager of the Russian-Baltic Wagon Works at Riga, and is likely to be of considerable service in mechanical investigations where graphic methods are used. The only special instrument required is a set square, Fig. 1, having the acute angle $\alpha = 27° 35' 49{\cdot}636''$, whose cosine $= \sqrt{\frac{1}{4}\pi}$. This may be easily constructed, as it corresponds almost exactly to a right angle triangle having base : perpendicular = 44 : 23, or tan $\alpha = 23/44$. The following are examples of its use with proofs of the solutions:—

FIG. 1



1 *a*.—Given diameter d of a circle to find circumference u.

FIG. 2



On A E set off A D $= 2d$, place the hypothenuse of the set square and straight edge parallel to A E, and from A draw a line parallel to the longer side, and from D one parallel to the shorter side of the right angle intersecting at C. Then reversing the set square, draw from C a line parallel to the longer side of the right angle, which will intercept on A E the length A B $= u$, or the required length of the circumference. For proof draw H C perpendicular to A B.

Then $\quad A C : A D = A H : A C = \cos.\alpha = \sqrt{\frac{1}{4}\pi}$

whence $\quad (A C : A D) . (A H : A C) = A H : A D = \frac{1}{4}\pi$

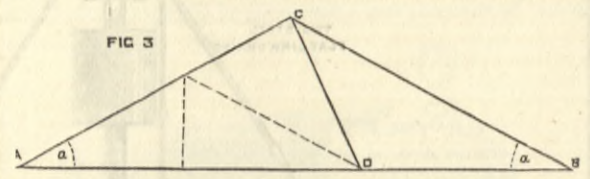
or $\quad 4 A H = A D \pi.$

But $\quad A D = 2d$ and $2 A H = A B$

$\therefore \; 2 A B = 2 d \pi$ or $A B = d\pi = u$, or the circumference required.

1 *b*.—Given the circumference u to find diameter d. The

FIG 3

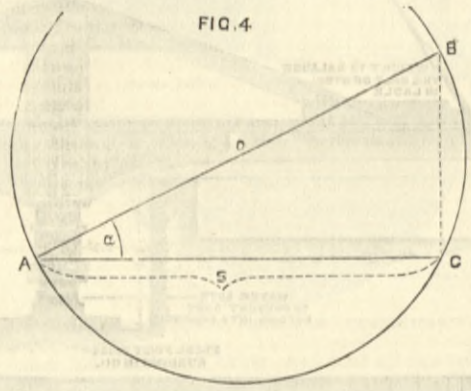


construction is similar to the preceding but in reverse order A B $= \pi d = u$ being given. First find C, as above, then with the acute angle of the set square at A determine D by drawing C D parallel to the short side. This gives A D $= 2d$, which may be halved by lines respectively parallel to C B and perpendicular to A D, as indicated in the dotted lines in the figure. The proof of this construction is similar to that of 1 *a*.

2*a*.—To find the side of a square S, whose area corresponds to that of a circle of diameter d.

With the short side of the set square against the straight edge draw the diameter A D with the hypothenuse. The

FIG. 4



length of the chord A C drawn parallel to the third side will give the side of the square required. For proof complete the right-angled triangle A B C.

Then $\quad A C : A B = A C : d = \cos.\alpha = \sqrt{\frac{1}{4}\pi},$

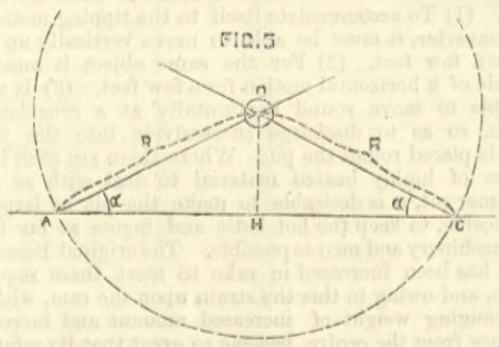
$\therefore \; A C = d\sqrt{\frac{1}{4}\pi}$, which squared gives $\overline{A C}^2 = \frac{1}{4}\pi d^2$,

and $\quad A C =$ the side of the required square.

2*b*.—Given S to find the diameter d or radius r of the circle, whose area is equal to S^2.

Make A C $= S$, and with the longer side of the right angle parallel to the straight edge, draw lines parallel to the hypothenuse with the acute angle alternately to right and left; the point O, where these lines intersect, will be the centre, and the lines

FIG. 5



A O A C radii of the required circle.

For roof draw O H perpendicular to A C.

Then $\quad A H = H C = \frac{1}{2} S,$

and $\quad \frac{1}{2} S : A O = \cos.\alpha = \sqrt{\frac{1}{4}\pi} = \frac{1}{2}\sqrt{\pi},$

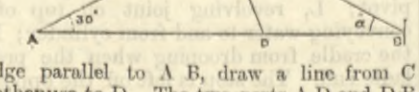
or, $\quad S = A O \sqrt{\pi},$

which squared gives $S^2 = \overline{A O}^2 \pi$ and A O $= r$.

It will be readily understood that these four problems may be solved by other methods, those given being only the simplest, both in execution and proof, as, with the exception of No. 2*a*, they may be solved by square and straight edge alone, without compasses.

The same set square is also applicable to other problems involving the factors as π, $\sqrt{\pi}$, π^2, such as the quadrature of the ellipse, &c., and in combination with one of 30 deg., it affords a ready method of effecting the so-called golden section—*sectio aurea*—*i.e.*, the division of a line into two unequal parts, so that the longer is a mean proportional between the shorter part and the entire length. This is done in the following manner:—Let A B be the given line. From A draw A C inclined 30°, and from B B C inclined α° to A B. Then, with the short side of the right angle on the straight edge parallel to A B, draw a line from C parallel to the hypothenuse to D. The two parts A D and D B will then divide A B into the proportions required. This result is not strictly accurate, as the trigonometrical proof shows an

FIG. 6



error of 0·0C0568, or $\frac{1}{17\frac{1}{81}}$th part of the entire length, which, however, is sufficiently small to be disregarded, especially as no greater accuracy is likely to be attained, even with the most carefully executed drawing, by the more complicated construction previously used.

We are indebted to *Dingler's Polytechnic Journal* for the above extract, which is taken from a lecture on drawing instruments delivered at Munich by Professor Fischer. The set square under the name of Bing's Kreiswinkel is made in two sizes, both in wood and ebonite, by J. Schröder, of Darmstadt.

THE TREVITHICK MEMORIAL.

WE are informed by the honorary secretary that it is the intention of the committee to close this fund. A meeting was held at the Institution of Civil Engineers on May 13th to decide upon how the funds collected are to be disposed. The following resolutions were proposed, and it was decided to send a copy of the minutes, with a statement of account, to all members of the committee, in order to elicit a full opinion upon the disposition of the fund:—

"(1) That a sufficient sum of money be offered to the Council of the Institution of Civil Engineers for the establishment of a triennial Trevithick Gold Medal and premium of books."

"(2) That the Trustee or Council of Owen's College, Manchester, be asked to accept a triennial Trevithick Scholarship tenable for one year."

"(3) That a copy of the bust of Trevithick now in the theatre of the Institution of Civil Engineers be placed in Truro Cathedral—if permission is obtained—together with a brass mounting on the base, showing how the memorial fund was raised and how it had been expended."

Statement of Account of the Trevithick Memorial Fund, 13th May, 1885.

DR.							
1885.							
May 13.	To amount paid E. and F. N. Spon for printing			66	10	0	
,,	Ditto Waterlow and Sons			12	15	8	
,,	Ditto Bedford Press			21	18	6	
,,	Ditto R. Tilling			46	5	6	
,,	Ditto various postages, &c. &c.			59	6	6	
							206 16 2
,,	Balance down						1491 13 6
							1698 9 8
CR.							
,,	By amount in the hands of the hon. treasurer as per minute-book, May 13th, 1885			1683	6	6	
,,	Interest on deposit account 1st January 1885, to 13th May, 1885			15	3	2	
							1698 9 8
,,	By balance down			1491	13	6	
,,	By amounts promised, viz.:—	£	s. d.				
	R. G. Tangye, Esq.	105	0 0				
	Sir C. W. Siemens, the late	5	5 0				
May 28.	W. C. Borlase, Esq. (paid)	2	2 0				
,,	R. W. Richardson, Esq. (paid)	2	2 0				
				114	9	0	
				1606	2	6	
,,	By subscription from J. Vivian, Esq.			1	1	0	

SOCIETY OF ARTS.—The results of the Society of Arts' examinations have just been published. There was a satisfactory increase in the number of candidates, 1208 having presented themselves at 44 centres; whereas last year there were 991 candidates and 38 centres. Of these 1208 candidates 953 passed and 255 failed. The number of papers worked was 1321; of these 145 took first-class certificates, 410 second-class, and 474 third-class, while to 292 papers no certificate was awarded. Eleven of the thirteen subjects set down for examination were taken up. In two no examination was held, as the requisite number of candidates (25) did not present themselves. The largest number of papers worked (336) was in book-keeping. Other favourite subjects were:—Arithmetic, 171; English—including composition and correspondence and précis writing—118; shorthand, 253; theory of music, 243. In French there were 96 candidates; in German only 28.

CHECKING DISHONEST CONDUCTORS.—The problem of effectively defeating the malpractices of dishonest conductors on omnibuses and tramcars has long perplexed the minds of directors, managers, and mechanicians, but hitherto without positive success. Methods by the dozen, embodying an immense variety of devices, have been invented and tried, with a view to ensuring that while passengers by car or omnibus should pay no more than the legal fare, every penny they paid should reach the hands of the lawful owners. Some of these devices may be seen in operation at the present time in London and in the large provincial towns, but it is certain that none of those hitherto adopted has provided a complete check. Whether such a happy result will ever be attained, it would be rash to predict, but there is no question that a great improvement is possible upon the methods heretofore applied. In most of these patents the ruling principle is that of a ticket with the amount paid punched into it being given to each passenger on payment, or a ticket of a certain colour according to the fare. For the tickets thus given in receipt conductors have to account, and at first sight that would seem to be a sufficient check, especially when colours are used, as also where the act of punching the ticket records a mark on a register, as is the case in some of the machines. But from various causes these devices have been only partially effective, and a satisfactory machine is still wanted. An invention claiming to meet this want is now being tried on the cars of the West Metropolitan Tramway Company, and pending a longer trial than has yet been practicable, an examination of this machine shows that it is far in advance of any of its predecessors. It is registered as O'Kelly and Ullman's Checking Apparatus. The apparatus is a small metal box weighing only 10 oz., attached to a short leather tube, the opposite end of which is affixed to a bag slung over the conductor's shoulder. The box is fitted with a handle, and with a hook by which, when not in use, it is suspended to the conductor's coat collar. A slit in the top of the box—the top being made of glass to enable those concerned to see the money—admits the coin into the box, where it rests for a moment. At the same time the conductor takes a ticket coloured according to the fare, and punches it; the act of punching opens a valve through which the penny passes through the tube already mentioned into the locked bag, and the selfsame action drops the clipping from the ticket into another receptacle, and records the mark on a register also inside the box, dialled up to 1000. Thus there is a five-fold check—first, the penny carried into the bag; second, the clippings retained in the box; third, the record on the dial; fourth, the tickets issued each day to be accounted for; fifth, the obligation on the conductor to punch and give to each passenger a ticket of the right colour. The pennies can be counted against the absent tickets; the clippings against the pennies, and the register marks against all. This seems to go as far as mechanical ingenuity can go to prevent fraud, and only one thing appears wanting to make this an absolute check, and that is that each passenger shall make sure that his coin is put into the box, and shall insist upon having a punched ticket. If that is not done there may be room for embezzlement, but it is fair to assume that the public will at least do this much in the interests of honesty. This invention has only been in operation on the West Metropolitan cars for a few weeks, but we understand that it has received high commendation from qualified authorities.

RAILWAY MATTERS.

THE report that the plant of the Suakim-Berber Railway has been offered as a gift to the Government of Cyprus is untrue.

THE Suakim-Berber Railway having been definitely abandoned, Messrs. Lucas and Aird's staff sailed from Suakim on the 28th ult.

IT is not true that the London, Chatham, and Dover Railway Company intends converting its second and third-class coaches into covered sheep trucks at present.

INTERNATIONAL parcels post arrangements are being made by the General Post-office. Arrangements are not yet made by which a letter can be sent as cheaply to the Cape or the Australian Colonies as to China or Persia or Tahiti.

BY the completion of the Canadian Pacific Railway, troops can now be dispatched from England to Halifax or Quebec in seven or eight days, and carried thence to New Westminster in six or seven days more, and once arrived there they will be available for concentration in India or in the southern Colonies, or for a descent on the only vulnerable point in Asia of Russia—viz., at Vladivostock or Petropaulowski.

THE Great Northern Railway are lighting one of their trains with E.P.S. accumulators, placed in each coach. The cells are charged by a dynamo driven from the axles, and an E.P.S. magnetic switch closes the circuit when the electro-motive force of dynamo rises above that of the cells. The Electrical Power Storage Company have lately supplied accumulators for use on the Lancashire and Yorkshire Railway, as well as the Great Eastern Railway.

AN interesting account of the hydraulic motive power at the extremities of the St. Gothard Tunnel, and of its employment during the construction of the tunnel, is being published in the *Schweizerische Bauzeitung* by M. D. Colladon, who was consulting engineer on the tunnel works. The account is of the diary order, and is of much importance as bearing upon the employment of water power for the purpose, and upon the recently settled litigation between the trustees of M. Favre and the railway company.

THE Australasian debts are in total £110,000,000; but, with the exception of a small sum spent by New Zealand in quelling the rebellion of the native tribes, this has been expended almost entirely in railways, telegraphs, and other works of a reproductive character. In the ten years from 1872 to 1882 the united debts of the Australasian Colonies had increased from £42,000,000 to £99,000,000; the length of railways opened had increased from 1362 miles to 6207 miles. Thus, greatly as the debts have grown, the increase being no less than 112 per cent., the mileage of railways opened for traffic has increased by no less than 356 per cent.

EIGHTEEN acres of land adjoining Woolwich Arsenal have been hired by Government for the purpose of storing the Suakin-Berber railway plant, which is on its way back to England in thirty-two steam vessels, which are ordered to the Arsenal to discharge their cargoes. To facilitate the removal of the plant, a broad-gauge line is being constructed from the pier to the place of storage. The working of this line, which is about two miles long, presents a novel appearance, in consequence of the locomotives, carriages, stations, ticket-offices, &c., being painted with the words, "Suakin-Berber Railway."

THE London, Chatham, and Dover Railway Company have begun the construction of a new pier at Queenborough, for the further development of the continental traffic *vid* Flushing. The new pier, which will be built of wood and iron, is to be 650ft. longer than the present structure, and will admit of two large steamers anchoring alongside to load and unload at the same time. As soon as the pier is completed it is intended to supplement the present night service of boats—by which the Dutch and German mails are carried—with a day service, and in anticipation of the increased traffic, three powerful steam packets are being built for the Royal Zealand Steamship Company, whose boats run between Queenborough and Flushing, in conjunction with the London, Chatham, and Dover Company's trains.

ANOTHER branch of the great system of tramways being formed round Birmingham was officially inspected by Major-General Hutchinson, of the Board of Trade, on Monday. It is a new line which has been laid between Birmingham and Dudley by the Birmingham and Midland Tramways Company, and is some fifteen miles in length. Steam power will be employed, and already twelve engines and sixteen cars have been procured from Messrs. Kitson and Co., Leeds. At the trial the speed maintained throughout the day was three miles an hour. General Hutchinson expressed the opinion that the Birmingham Tramways ought to command more traffic than tramways in other large towns. Steam as a motive power for tramways is only on its trial in Birmingham, and it will depend much upon the careful management of the engines whether it will continue to receive the support of the authorities.

FOR several years oculists have engaged attention in Germany by their writings on colour-blindness. The number of railway men found to be uncertain as to the colours of signal lights has caused our Board of Trade to look into the matter. Dr. Brudenell Carter, F.R.C.S., in a lecture on optics, stated that colour-blindness affected 4 per cent. of the whole male population of civilised countries, and of 9200 engine-drivers, an examination detected the fact that 400 were colour-blind. Dr. Brailey, secretary to the Opthalmological Society, mentioned that out of 18,088 persons examined, including Eton, Westminster, and Christ's Hospital, and 5000 members of the metropolitan police, 750 were defective. On the 1st of May, 1877, the testing of the sight of candidates for masters' and mates' certificates came into operation. By a parliamentary return it was shown that for the two years ending in May, 1879, there were 2929 individuals who had been examined. Out of that number thirty-nine were rejected, but twelve out of those unsuccessful candidates subsequently passed, and this reduced the proportion to twenty-six out of the 2929. Attention was called to colour-blindness, in the first instance, in consequence of the proved difficulty on the part of an engine-driver to distinguish a green from a red shaded light.

THE following from the *Chicago Herald* is as much a comment on the American Railway bridges as a proof that the driver referred to was no longer young:—"Yes," remarked an old engineer, "I used to run on the New York Central, but I quit 'em voluntarily." "Didn't you like the road?" Yes, all but the double tracks. It was a two-track road then. I don't want any double-track running in mine. It isn't safe. Give me a single-track road every time. You think it funny, don't you? 'Tis queer for a fact, but I know what I am talking about. Did you ever ride on a locomotive? On the cow-catcher? Well then you must have noticed that whenever she strikes a bridge she seems to drop down a little, It's the bridge setting under the terrific pressure. As you first strike, it feels as if you were going down, sure enough. Perhaps you never thought of the tremendous blow a locomotive strikes on a bridge. It's not alone the weight of her, but when she's making forty or fifty miles an hour and comes down on a bridge it's enough to make it settle. Right here comes in my objections to double-track roads. The bridges on these roads are generally built continuous—one bridge for both tracks. I was running along one day and was just approaching a bridge, when I saw another train coming toward me. All of a sudden the thought ran through my brain—what if both locomotives should strike the bridge at the same instant one at either end? The very thought of it startled me so that I shut off steam and put on the brakes. I ain't a coward, but I don't want any of that in mine. I wouldn't risk 50 per cent. of the railroad bridges in the country to stand a blow from both ends at the same instant. Of course, a road may go along a year and two trains may never happen to meet just that way—and even then the bridge might stand it—but I thought so much about the thing that I lost confidence in myself on the Central and resigned. I've been a single-track engineer ever since.

NOTES AND MEMORANDA.

IN greater London last week 2847 births and 1894 deaths were registered, corresponding to annual rates of 28·6 and 19 per 1000 of the population.

IN Greater London, during the week ending the 23rd ult., 3027 births and 1945 deaths were registered, corresponding to annual rates of 30·4 and 19·5 per 1000 of the population.

AT a recent meeting of the Paris Academy of Sciences a paper was read on "The Radiation of Heat during the Night in connection with the Normal Lowering of the Temperature during the Months of April and May," by M. J. Jamin. This lowering of the temperature, often so destructive to the spring crops, is rightly attributed by meteorologists to nocturnal radiation, which the author finds attains its maximum about the months of April and May.

IN a recent number of the *Comptes Rendus* experiments are described by M. J. Thoulet on the effect of immersing various solid bodies in saline solutions, such as marble, quartz, &c., in aqueous solutions of sodium or barium chloride. In each case a portion of the dissolved salt was precipitated on the surface of the immersed solid. The conclusion is drawn that there is an attraction between the dissolved salt and the solid immersed, and that the amount of attraction is proportional to the surface of the solid.

THE Hydrographic Bureau at Washington published lately the following results of a series of observations carried out in order to determine the length, depth, and duration of ocean waves. The longest wave hitherto observed is said to have had a length of half-a-mile, and to have spent itself in 23 sec. During storms in the North Atlantic waves sometimes extend to a length of 500ft. and 600ft., and last from 10 to 11 sec. The most careful measurements of the height of waves give from 44ft. to 48ft. as an extreme limit; the average height of great waves is about 30ft.

IT is time that a ship's caulking machine were made, for the members of the Greenock branch of the Associated Shipwrights' Society are adopting a very arbitrary course, and intend to work in future according to the following scale:—(1) That a day's work on caulking at old work on a ship's side shall not exceed 80ft.—old ships' decks, 150ft. per day. (2) That a day's work on metalling shall in no case exceed twenty-five sheets on hardwood ships, and twenty-eight sheets on softwood ships, and that the strake amidships finish at twenty-five to twenty-eight sheets, as the case may be—the same to constitute a day's work fore-and-aft. (3) That a day's work at stripping shall in no case exceed thirty-five sheets per day—the stages to be lowered fore-and-aft, the berths being of equal length.

A NEW process has been devised by Dr. Thresh for treating the sewage of Buxton. The precipitant used is a mineral water derived from the lower coal formation about two miles above Buxton. It contains 1·2 grains of iron per gallon in the state of ferrous carbonate, held in solution by carbonic acid. On exposure to the air, the carbonic acid escapes, and the iron, taking up more oxygen, subsides in the state of ferric hydroxide, in combination with a considerable part of the organic impurities, suspended and dissolved. The results, according to an analysis quoted in the *Leek Times*, are very satisfactory. The sewage before treatment contains free ammonia, 11·74 per million, and albuminoid ammonia, 1·60. After treatment these figures are reduced to, free ammonia, 4·00 parts per million, and albuminoid ammonia, 0·30.

IN London, during the week ending the 23rd ult., different forms of accidental violence caused 39 deaths; 36 were the result of negligence or accident, among which were 18 from fractures and contusions, 5 from burns and scalds, 4 from drowning, and 5 of infants under one year of age from suffocation. The 18 deaths from fractures and contusions were thus returned:—Male, aged 3, and female 9, run over by van; male 43, run over by omnibus; male 69 and female 2, run over by cab; female 4, run over by cart; male 32, fell from dray; male 33, fell from omnibus; male 38, fell from cart; male 52, knocked down by horse; male 43, fell from scaffold; male 65, fell from ladder; male 4 and female 75, by fall; male 17, run over by train; female 2, struck by swing; male 90, fell from bed; and female 54, fell downstairs.

THE coal-beds of New South Wales are said to be of enormous extent. The mineral has been traced for hundreds of miles along the coast, and has been worked at various levels from 450ft. below, to 1500ft. above the sea. The lower beds are geologically older than any that have been yet worked in Europe, and the quality of the coal which is taken from these inferior strata is therefore unsurpassed. Not only so, but in certain districts immense seams of this mineral are found in immediate juxtaposition with an abundance of iron ores, limestone, and fire-clay. Up to the present time, coal has been ascertained to exist over an area of something like 25,000 square miles of country; and it is almost everywhere within easy reach of water or railway communication. When it is remembered that the coalfields of Britain only cover one twentieth part of the area of the country, or about 4000 miles, and that nevertheless the output of this mineral in the mother-country is upwards of 120,000,000 tons per annum, it would be difficult to over-estimate the magnitude of the proportions to which the coal trade of New South Wales may be expected to grow hereafter.

AT a recent meeting of the Chemical Society a paper was read on "A Calorimetric Method for Determining small Quantities of Iron," by Mr. Andrew Thomson, M.A., B.Sc. The author has applied the well-known thiocyanate reaction of ferric salts to the quantitative determination of small quantities of iron. The method is almost universally applicable, silver and copper, and in some cases cobalt, being the only common metals that interfere. To perform the analysis, a weighed quantity of substance is dissolved in acid, the excess of acid driven off by evaporation, the iron, if necessary, converted into ferric salts by means of potassium permanganate, and finally the solution is diluted to 1 litre. Into each of two similar cylinders 5 c.c. of dilute chlorhydric or nitric acid (1 : 5), and 15 c.c. of potassium thiocyanate solution, containing 40 grams per litre, are poured, and to one a measured bulk of the solution to be tested is added. Both cylinders having been filled up to the same height with distilled water, a standard solution of ferric salt containing 0·0001 gram Fe per c.c. is added to the other cylinder in quantity sufficient to produce a colour matching that in the cylinder containing the substance under examination.

MR. WILLIAM TEBBUTT, of Windsor, New South Wales, has constructed a private observatory, which has taken a place among the principal observatories recognised by the authorities of the *Nautical Almanac*. Occasional astronomical observations were made here as far back as 1854, and it was not till ten years afterwards that an observatory was erected. It comprised a transit room with two meridian openings, and a prime vertical room. The local time was determined by means of a transit instrument of 2in. aperture and 20in. focal length. A small octagonal tower rising from the centre of the building and covered by a conical revolving roof accommodated a refracting telescope of 3¼in. aperture, and 48in. focal length. In 1873 a round building of pine, 12ft. in diameter, was erected close to the old building for the temporary reception of a new and excellent Frauenhofer equatorial of 4¼in. aperture and 70in. focal length, the work of Messrs. Cooke and Sons, of York. This instrument is furnished with a position filar micrometer, ring micrometers, square bar micrometer, first surface reflection prism, and a battery of Huyghénian eye-pieces, with powers ranging from 55 to 400 diameters. In 1879 a substantial observatory of brick was erected. From the centre of a room at its west end rises a pyramidal pier of brick and cement, which passes through a floor above, and is surmounted by the 4¼in. equatorial already referred to. The equatorial room is covered by a roof of galvanised iron, revolving on ten wheels, and similar to that which covers the great Northumberland telescope at the Cambridge Observatory. The meridian room is furnished with an excellent 3in. transit instrument.

MISCELLANEA.

THE entries for the Wirral and Birkenhead Agricultural Society's Show close on the 8th instant.

THE Cape Cod Canal is being pushed forward with considerable energy by the Massachusetts people. Dredging machines have been at work for two years cutting through the hard blue clay, and about half a mile of the seven miles has been dug. The canal is to be 200ft. wide and 23ft. deep, and is estimated to cost £1,400,000.

AT the Artists' fancy dress ball recently held at the Princes Hall, Piccadilly, a large number of photographs were taken throughout the evening by Mr. Barraud, of Regent-street, by the electric light, and the negatives are stated to be as good as those taken by daylight. Two arc lamps with 10 ampères current were supplied with current from E.P.S. accumulators. The installation was carried out by the Electrical Power Storage Company.

THE Panama Canal has been commenced along its whole length of 73 kilometres. The works are, of course, much more advanced at some places than at others, but increasing activity prevails everywhere. The *Nautical Gazette* says:—"Some idea of what is being done may be formed from the fact that there are over twenty thousand navvies at work on the canal, and that on the 73 kilometres along which the works extend there exist as many as two hundred kilometres of rails, and six thousand trucks of all sorts used in the excavation works."

AN interesting little book, entitled "Walks in Epping Forest: a Hand-book to the Forest Paths, with Cycling and Driving Routes," written by Mr. Percy Lindley, has lately been published at 125, Fleet-street. It contains 117 pages, but as it is printed on thin paper it is not bulky, and with its map and many illustrations forms a very interesting and instructive companion on a visit to the beautiful but comparatively little known forest half an hour from London and belonging to London. The historic associations of the Forest, and its towns and hamlets, are well described, and the Forest should become a favourite haunt of Londoners.

A COPY of a "Desometric Diagram" has been sent us by its designer, Mr. W. S. Mackenzie, of 76, De Grey-street, Elswick. The weights of iron bolts of any size from 0·25in. to 1·5in. diameter, either with hexagonal or square heads and nuts, and from 0 to 36in. in length, and the weights of iron rivets of any size 0·25in. to 1·25in. and up to 6in. length are given by it. It gives these weights with very little trouble and in a fraction of the time required to calculate them. A few minutes serves to learn to use the diagram, which is a lithograph about 14in. by 8in. It will be found very useful in engineers' offices, but we may suggest that it would be improved if made to a larger scale.

THE price of dynamo-electric machines has been so reduced in Germany that some of the makers already say the trade is hardly worth having. It is said that during the past six years dynamos to the number of 6000 have been constructed in the different workshops in Germany, representing a value of £700,000. The number of arc lamps made during the same period was 20,000, realising £250,000. In the four years 1880 to 1884, the number of telegraph offices open to the public rose from 5114 to 7529, and the mileage of the wires from 121,520 to 150,040 miles. The telephone was introduced into Germany in 1880; there are to-day 58 country exchanges, having 7311 subscribers, and possessing a network of wires extending over a distance of 10,100 miles.

THE Council of the Parkes Museum propose to hold in the museum a series of exhibitions of domestic gas appliances, and have accepted an offer from Mr. Fletcher, of Warrington, to supply the apparatus for the first of the series, which will include—gas cooking and heating stoves, incandescent gas fires, instantaneous water heaters, washing and drying machines, grillers, hotplates and ranges, confectioners' ovens, coffee roasters, workshop tools. Lectures upon cookery and the practical demonstrations of the uses of the various appliances will be given daily in the museum by Miss Young. The exhibition will be open each day from 10 a.m. to 7 p.m., and on Mondays, Wednesdays, and Saturdays until 9 p.m., from the 8th to the 27th inst.

A STRIKE has begun in the Pittsburg ironworks against a 20 per cent. reduction in wages. The workmen offer to accept a 10 per cent. reduction, to which several of the masters agree, including Carnegie Brothers; Dilworth, Porter, and Co.; and the Republic Iron Company. These mills will continue to be worked, but most of the others in the district will be closed, and nearly 100,000 workmen will be idle. All the mills in the Mahoning region, Ohio, were closed last Saturday, 10,000 men losing employment, and also all at Wheeling, West Virginia, where 3000 become idle. According to careful reports sent in from all the places where the strike exists, 78,000 men are idle, and 4300 are working. The daily wages of the idle strikers amount to 160,000 dols.

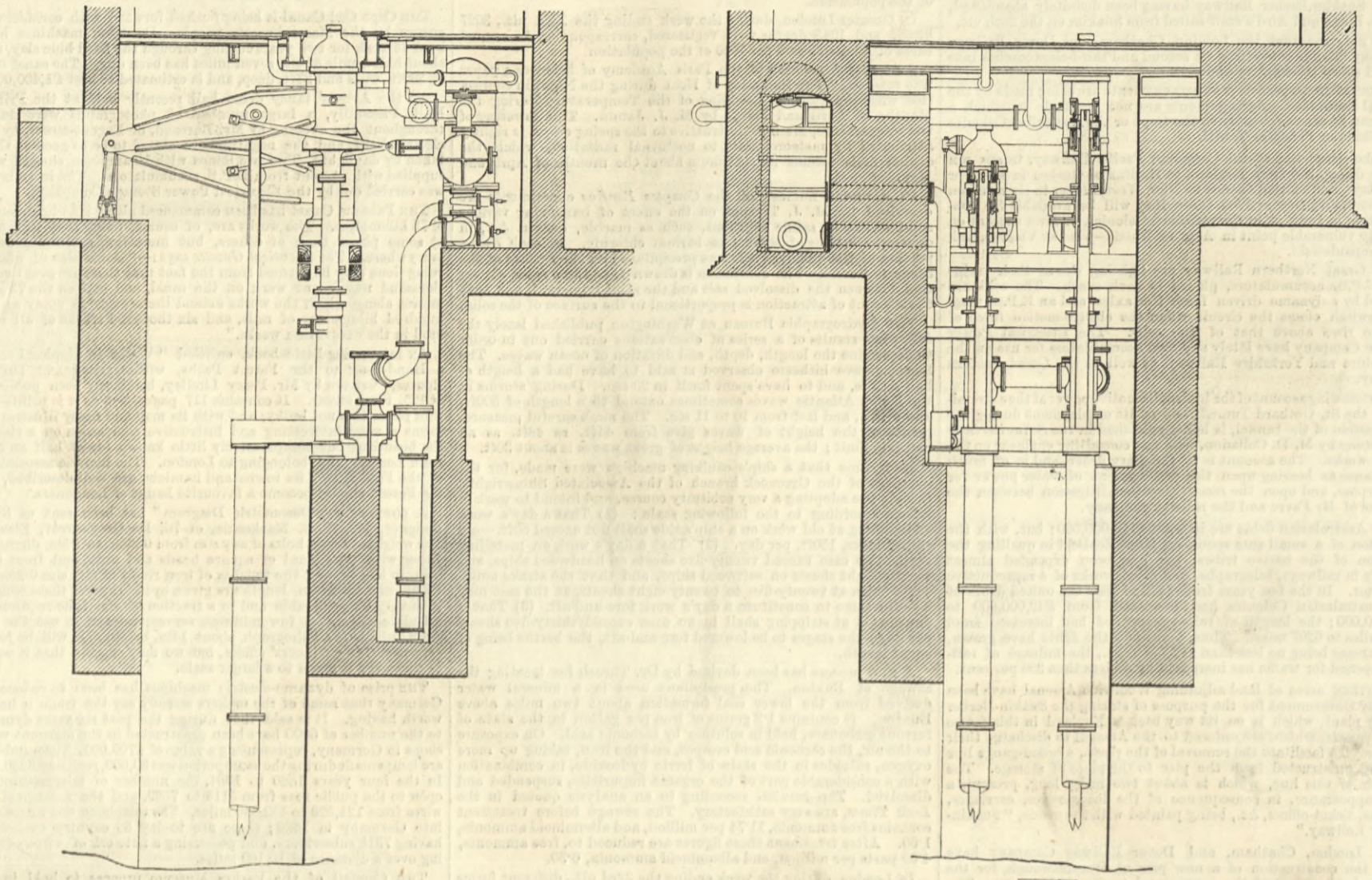
MESSRS. H. B. BARLOW & Co., of Manchester, have introduced a new mandril, in which they have worked out several improvements upon the Harrison expanding mandril manufactured by this firm for some years past. In the new mandril, pulleys or heavy wheels can be turned upon it without any back centreing, and one great advantage is that it brings the work very much closer up to the face plate than in the old mandril. The body of the mandril consists of a steel forging, flanged with a taper nose, bored up, in which a bolt works. The split dies, which are bevelled at each end, work upon the taper nose, and the mandril is expanded by simply turning an ordinary hexagon-headed bolt and released by turning this bolt in the opposite direction.

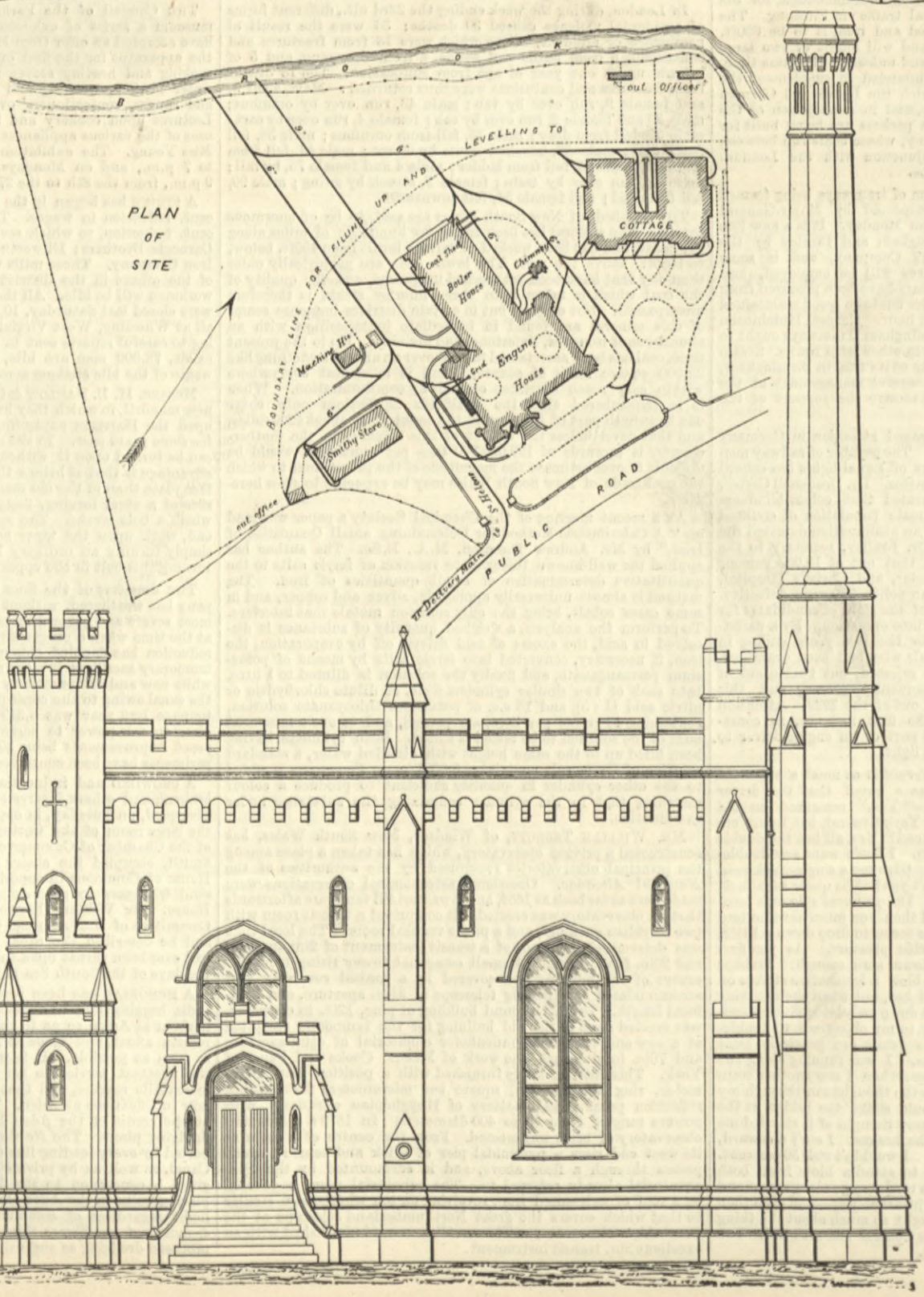
THE directors of the Suez Canal Company report that the company has weathered, without appreciable diminution of profits, the most severe and general economic crisis ever experienced, and this at the time when a progressive reduction of rates fell due. This reduction has enabled shipowners to go on building, and to make temporary sacrifices for the sake of retaining their old customers, while new and comparatively poor merchandise could pass through the canal owing to the consequent reduction of freights. The total tonnage last year was 8,319,967, against 8,051,307 in 1883. The directors ask power to borrow 100,000,000f., the total cost of proposed improvements being 209,000,000f. The electric lighting experiments have been continued, and have given satisfactory results.

A CROWDED and influential meeting of merchants, shipowners, brokers, and others interested in mercantile matters, was held at Liverpool, on Tuesday, in opposition to the ship canal scheme, in the large room of the Cotton Association, and under the auspices of the Chamber of Commerce, the president of which body, Mr. E. Smith, occupied the chair. It was decided to memorialise the House of Commons in opposition to the ship canal scheme, and to send witnesses to give evidence before the Committee of that House. Sir William Forwood, chairman of the Parliamentary Committee of the Liverpool Corporation, was one of the speakers, and he described the canal scheme as "the greatest bubble that had ever been thrust upon the credulity of the British public since the days of the South Sea bubble."

A MEMORIAL has been presented to the Secretary of State for India begging him to direct that the work of deepening the inner harbour at Aden, so as to enable vessels of deep draught to enter, remain afloat, and leave at all states of the tide, shall be begun as soon as possible. It is pointed out that the work will be of the greatest service to her Majesty's ships as well as to the mercantile marine, and that it is a necessary complement to the new fortifications at Aden. There is, it is stated, a large balance at the credit of the Aden Port Fund, which would provide the dredging plant. The *Nautical Gazette* says the memorial is supported by every leading line of steamers trading through the Suez Canal, as well as by private shipowners. The Government have given a concession to the firm of Messrs. Tylor and Bright for placing hulks in the Aden Harbour, so that vessels can coal day or night regardless of communication with the shore. A correspondent of the *Times* thinks this obviates the necessity for any proposed dredging as suggested by several correspondents.

ST. HELENS WATERWORKS—KNOWSLEY PUMPING STATION.





By the engravings on pages 416 and 436 we illustrate the buildings of the new waterworks in course of construction for the supply of St. Helens. We also give general views of the pumps; the engines we do not illustrate, as they are duplicates of the Luton engines, also by Messrs. Hathorn, Davey, and Co., of Leeds, which we illustrated a short time since.

In 1881 the Council of the borough of St. Helens, finding their sources of water supply would soon be unable to meet the growing demands of the borough, authorised the town clerk and water engineer, in September of that year, to take action in preparation for parliamentary proceedings for a new water supply. At the same time plans and sections showing the contemplated works, with sites for wells, at Knowsley and Kirkby, were submitted and approved. The sites for the wells were first selected by Mr. D. M. F. Gaskin, M.I.C.E., water engineer, and Mr. Alderman McBryde, chairman of the Water Committee, and subsequently approved by Professors Hull, F.G.S., and C. E. de Rance, F.G.S. During the progress of the Bill through Parliament several important clauses were inserted for the protection of Lords Derby and Sefton, as well as an alteration in the site for the Kirkby well. The Council were successful in obtaining their Act, and immediate steps were taken for the carrying out of the works at the Knowsley site and laying the pipes from there to the service reservoirs at St. Helens. Mr. John Villiers, of Beverley, having obtained the contract for the well sinking and borehole at Knowsley, the mayor cut the sod on the site of the south well on the 28th of October, 1882. The works consist of two 11ft. diameter wells, each 170ft. deep, connected by a driftway 22ft. by 6ft.; and one 6ft. diameter well, 160ft. deep, connected with the north well by a driftway 6ft. by 5ft. The borehole was sunk from the bottom of the smaller well by a Mather and Platt boring machine, commencing with a 24in. hole, diminishing to 18in.; the total depth of the borehole is 536ft. These works are sunk in the pebble beds and lower mottled sandstone of the new red sandstone formation; the quantity of water obtained is at the rate of one and a-half million gallons per twenty-four hours, the bulk of which is obtained at a depth in the borehole of 316ft., or 476ft. from the surface of the ground; arrangements have been made so that the water in the borehole can be controlled or completely shut off. The permanent buildings which we illustrate are now being erected, and consist of an engine-house for duplicate engines, with compensation tank on the top; boiler-house for three boilers, chimney, four cottages and smithy and store-house; only one engine and two boilers are at present to be put down. The buildings will be principally constructed of brick, and are a plain adaptation of the Scottish baronial style of architecture. The contractors for the various works are as follows:—Contract No. 1, well sinking and boring, Mr. John Villiers, of Beverley, Yorkshire; contract No. 2, 21in. pipes, between Knowsley and St. Helens, Cochrane, Grove, and Co., Middlesbrough; contract No. 3, laying above pipes, H. Fotherby and Son, Burnley; contract No. 4, valves for 21in. pipe line, Hamilton, Woods, and Co., Manchester; contract No. 5, permanent engine, &c., Hathorn, Davey, and Co., Leeds; contract No. 6, permanent buildings, &c., Messrs. George Harris and Sons, St. Helens; the engineer for the whole works being Mr. D. M. F. Gaskin, M. Inst. C.E., F.G.S.; and clerk of works, Mr. James McIlwaine.

The whole of the pumping machinery has been supplied by Messrs. Hathorn, Davey, and Co., of Leeds. The engine is of their vertical compound direct-acting type, which since its introduction some years ago by Mr. Davey is becoming increasingly popular for waterworks and sewage pumping. It is handsome in appearance, takes less room than the beam or rotary engine, is less costly, and works with great economy. The cylinders, which are steam jacketted, are 28in. and 52in. diameter, with a stroke of 6ft. They rest upon a massive cast iron entablature, which is supported by eight ornamental columns. The piston-rods are coupled direct to the ram pump rods by means of crossheads in the beam below. These beams are each composed of two malleable iron plates, with distance pieces

THE INVENTIONS EXHIBITION—THE FIELDING HIGH-SPEED ENGINE.

MESSRS. FIELDING AND PLATT, GLOUCESTER, ENGINEERS.

FIG. 10

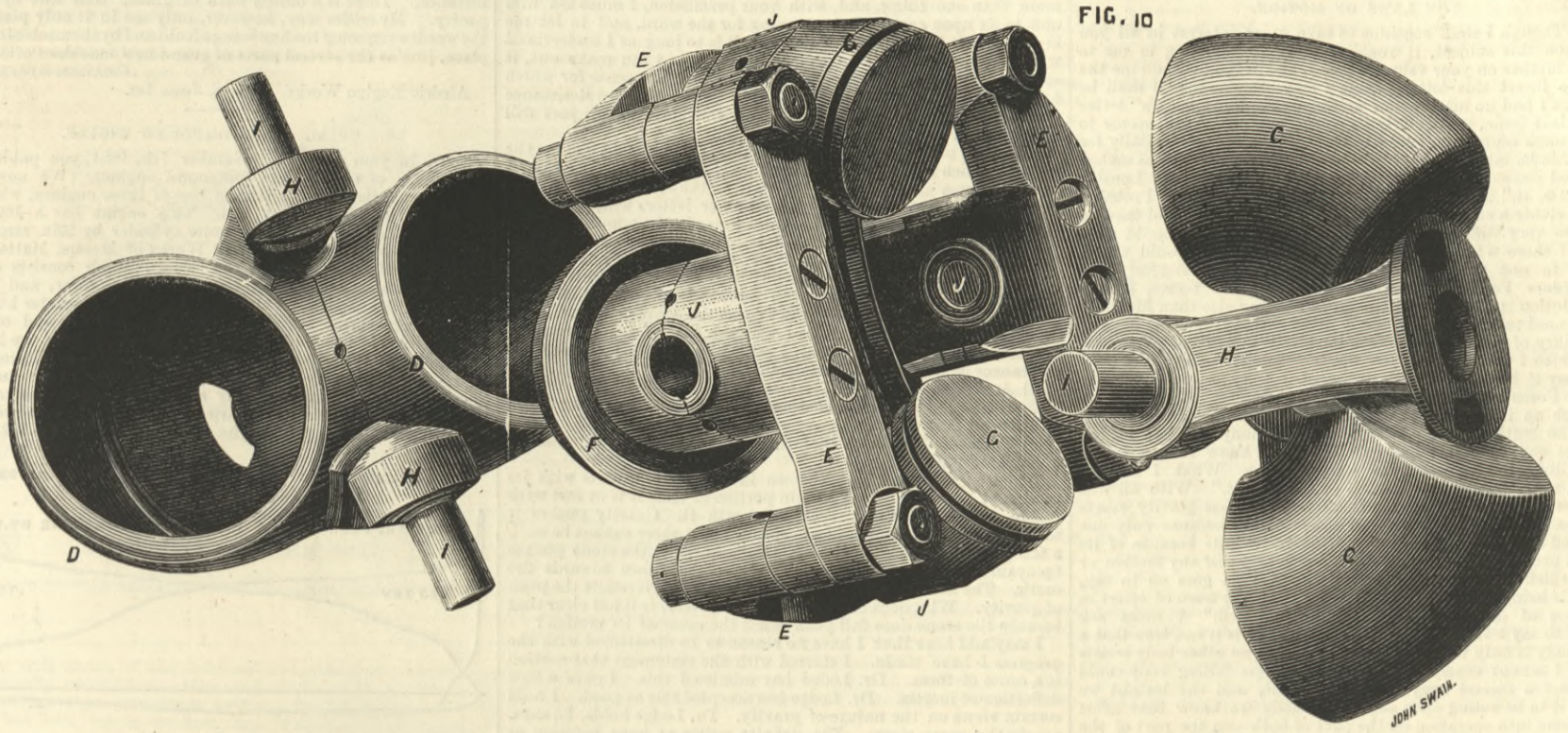


FIG 12

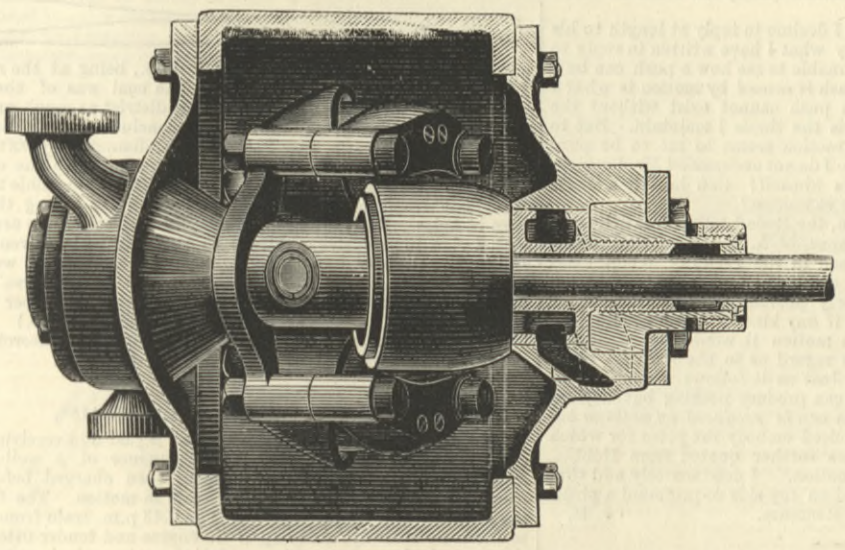
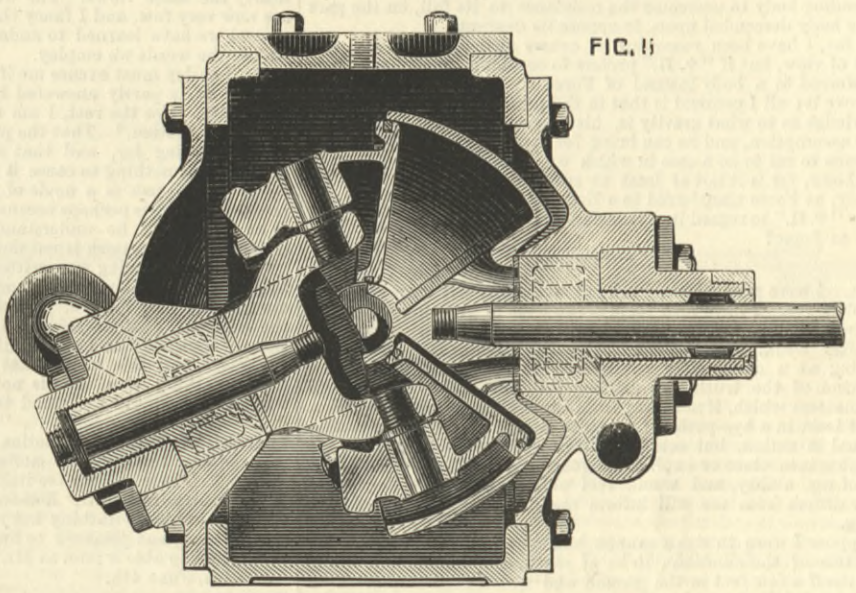


FIG. 11



between, and form the parallel motion. The valves are Cornish double beat, and are actuated by Mr. Davey's differential gear, which has all the latest improvements. The air pump is worked from an arm on the side of one of the rams, and is the same stroke as the engine. The surface condenser is cylindrical in form, and is fitted with gun-metal tube plates and brass tubes. The whole of the water pumped passes through the condenser around the tubes. There is a bye-pass arrangement, so that the engine can be worked non-condensing if required. There are two 16in. by 6ft. stroke ram pumps, one fixed directly below each cylinder, which pumps force the water from a cistern formed in the foundations of engine-house through 6¼ miles of pipes to a vertical height of 154ft. The bucket pumps are 20in. diameter by 4ft. stroke, and are worked by means of two wrought iron counter beams connected at their inner ends to the ram pump rods, and at their outer ends to fulcrum links. These pumps raise the water from the well, 155ft. deep, to the supply cistern for the ram pumps. The bucket and suction valves are of gun-metal double beat. On the rising main a large air vessel is provided. The engine and pumps will raise 1½ million gallons of water in twenty-four hours a total vertical height of 309ft., exclusive of friction in pipes, through 6¼ miles of pipe, to the high-level service reservoirs in St. Helens.

THE FIELDING HIGH-SPEED ENGINE.

THIS engine, exhibited at South Kensington by Messrs. Fielding and Platt, of Gloucester, consists virtually of an universal joint connecting two shafts whose axes form an obtuse angle of about 157 deg. It has four cylinders, two being mounted on a chair coupling on each shaft. The word cylinder is used in a conventional sense only, since the cavities acting as such are circular, whose axes, instead of being straight lines, are arcs of circles struck from the centre at which the axes of the shafts would, if continued, intersect. The four pistons are carried upon the gimbal ring, which connects, by means of pivots, the two chair couplings.

Fig. 10 shows clearly the parts constituting the coupling, cylinders, and pistons of a compound engine. C C are the high-pressure cylinders; D D the low-pressure; E E E E the four parts forming the gimbal ring, to which are fixed in pairs the high and low-pressure pistons G G and F F; HH HH are the chair arms formed with the cylinders carrying pivots I I I I, which latter fit into the bearings J J J J in the gimbal ring. Figs. 1, 2, 3, 4 show these parts connected and at different points of the shaft's rotation. The direction of rotation is shown by the arrow. In Fig. 1 the lower high-pressure cylinder C is just about taking steam, the upper one just closing the exhaust; the low-pressure pistons are at half stroke, that in sight exhausting, the opposite one, which cannot be seen in this view, taking steam.

In Fig. 2 the shaft has turned through one-eighth of a revolution; in Fig. 3, a quarter turn; Fig. 4, three-eighths of a turn. Another eighth turn brings two parts into position, represented by Fig. 1, except the second pair of cylinders now replace the first pair. The bearings K L support the two shafts and act as stationary valves, against which faces formed on the cylinders revolve; steam and exhaust ports are provided in the faces of K and L, and two ports in the revolving faces, one to each cylinder. The point at which steam is cut off is determined by the length of the admission ports in K and L. The exhaust port is made of such a length that steam may escape from the cylinders during the whole of the return stroke of pistons.

Fig. 5 shows the complete engine. It will be seen that the engine is entirely encased in a box frame, with, however, a lid for ready access to the parts for examination, one great advantage being that the engine can be worked with the cover removed, thus enabling any leakage past the pistons or valve faces to be at once detected. The casing also serves to retain a certain amount of lubricant.

The lubrication is effected by means of a triple sight-feed lubricator, one feeder delivering to steam inlet, and two serving the main shaft bearings.

Fig. 6 and 7 are an end elevation and plan of the same engine. There is nothing in the other details calling for special notice.

Fig. 8 and 9 show the method of machining the cylinders and pistons, the whole of which can be done by ordinary lathes, which is evidently a great advantage in the event of re-boring, &c., being required in the colonies or other countries where special tools are inaccessible.

Figs. 11 and 12 are sections which explain themselves.

THE BRUSSELS INTERNAL NAVIGATION CONGRESS.

THE Brussels Internal Navigation Congress has met and had its say, and done its navigation excursions and visits. Very numerous questions relating to inland navigation were discussed, and the value of canals, as compared with railways for heavy traffic. From the composition of the Congress it was to be expected that railways for this work were not to be painted in the most attractive colours. They were allowed to have their uses, though they had had their day for heavy traffic. For this the railway men have to be thankful. The canal questions discussed were, however, of great importance, even if we exclude the long description of the Manchester Canal, which Mr. Leader Williams and Mr. D. Adamson were not at all averse from giving, with various opinions on the Liverpool people who are not quite ready to embrace the scheme. Some interesting facts were given on the Suez Canal improvements by M. Dirks, engineer-in-chief of the Dutch Waterstaat, a member of the International Committee of the Suez Canal. He gave some of the questions which had been put to captains and pilots respecting room required in different parts of the canal for large ships to cross each other, as to the depth below keel necessary for easy steering at a speed of 8 knots per hour, and the speed at which full size ships might travel. The following are the conclusions arrived at by the Committee:—That the existing canal should be enlarged; that it should ultimately be deepened to 9 metres—nearly 30ft.—below low-water mark of ordinary spring tides, but that for the present a deepening of 8½ metres is sufficient; the width at bottom between Port Said and the Bitter Lakes should be 65 metres—213ft.—in the straight portion, and 75 metres—246ft.—in curves of 2500 metres—2734 yards—and upwards, and 80 metres—262ft.—in curves of less than 2500 metres; while between the Bitter Lakes and Suez the straight parts should be 75 metres—246ft.—wide, and the curves all of 2500 metres radius, 80 metres—262ft.—wide. Among the different systems for protecting the banks already applied to the canal, the Committee preferred, where possible, a stone pitching, carried 2 metres—6ft. 6in.—below low-water mark of ordinary spring tides, and to a height of about 1 metre above high-water mark of ordinary spring tides. M. Dirks concluded by expressing the opinion that the future speed in the canal, improved in accordance with the suggestions of the International Committee, would be about 8 knots an hour, or nearly double the present speed. Signor Gioia, also a member of the Suez Canal Committee, said that planting the banks with date palms was the best means of protecting them. Where this was not possible, they should be pitched; and this would enable the passage of the canal to be made in ten instead of twenty-four hours as now. M. Tcharnowsky, civil engineer, of St. Petersburg, described the method adopted in the Goutonieff dock of the Petersburg and Cronstadt Ship Canal, 17 miles long and 22ft. deep, the cost of which amounts to £1,200,000. The walls consist of a framework of fir logs, forming hollow cubes, well tied together with half logs and bolts. As the timber work is not carried high enough to be ever uncovered by water, it will last for a great length of time, and is not liable to the attack of teredos. The timber framework is filled in with boulders and pebbles, and has a layer of concrete laid on the top, on which masonry is carried up to 5ft. above high water mark. Herr Düsing, of Frankfort, engineer-in-chief of the works for the canalisation of the Main, gave some particulars of that enterprise between Frankfort and Mayence, to be completed on 1st October, 1886. The useful depth of the Main will be increased from less than a metre to two metres, or 6ft. 6in., while the locks are constructed in view of a further deepening of half a metre. Herr Stahl, of Frankfort, gave an account of the port to be made in connection with the Main navigation, which will put Frankfort in direct water communication with the Dutch and Belgian ports.

Mr. Mulvany, of Frankfort, formerly Commissioner of Public Works in Ireland, said he did not believe that, in the long run, Liverpool and Antwerp, Rotterdam and Amsterdam, would suffer through the making of ship canals. He had not a very high opinion of the English parliamentary system, whereby a separate law was required for each public improvement, thus leading to the waste of both time and money. Every effort to take the sea as far as possible into the interior should, he thought, be made.

M. De Maere Limnander described the projected ship canal between Bruges and Heyst on the sea coast, and an excursion to that place on the following day was made.

Professor Schliehsint, of the Berlin Polytechnicum, gave an account of the canalisation of the Weser and the Port of Bremen.

The congress certainly brought inland navigation into special consideration.

LETTERS TO THE EDITOR.

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

THE LAWS OF MOTION.

SIR,—Though I shall continue to take great interest in all you publish on this subject, it would scarcely be becoming in me to trespass further on your valuable space, and if you will do me the favour to insert this letter I think I may promise that it shall be the last. I had no intention of writing again, but "Φ. Π.'s" letter in your last issue, particularly its concluding paragraph, seems to call for some reply from me. I thank "Φ. Π." very cordially for the trouble he takes not only to read my letters, but also to understand and answer my objections, and I agree with Mr. Lousley that if "Φ. Π." should see fit to alter his statement to "Probably Force is either a condition or a mode of Motion" he would take up a position very difficult to attack. I, at any rate, should then feel that there was some ground upon which we could agree. Indeed, in one part of his letter he seems to suggest that he considers Force and Motion interchangeable terms, for he says "Motion is Energy, and Energy is nothing else than Motion." But his next paragraph completely overturns my dawning hope of a possibility of agreement between us, and it is this last paragraph about which I want to say a few words. "Φ. Π." asks me what I should say if he gave me an instance of a body acquiring velocity while no Force whatever was being exerted upon it. I should say that such an instance, if proved, would go far indeed to convince me of the truth of his theory. What I deny is, that he has given me any such instance. Of course, I know that a heavy body falling freely ceases to have weight. What I do *not* know is, that "gravity exerts no push upon it." With all due deference to "Φ. Π.," I should think it is *because* gravity exerts a push or rather pull upon it, in other words because only one unresisted force is acting upon it. The body falls because of its inherent property of inertia, *its incapacity to resist* any motion or energy which is exerted upon it. "Φ. Π." then goes on to say, "Work is being done, and yet not the slightest trace of effort in the shape of downward push can be detected." I must ask "Φ. Π." to say *what* work is being done? For is it not true that a falling body is only without weight so long as no other body resists its fall? I cannot conceive any work that this falling body could do without a second body on which to act, and the instant we suppose it to be acting upon any other body we know that *effort* would come into operation on the part of both—on the part of the descending body to overcome the resistance to its fall, on the part of the body descended upon, to oppose its descent.

So far, I have been reasoning of course entirely from my own point of view, but if "Φ. Π." prefers to consider, gravity as motion transferred to a body instead of Force exerted upon it, I cannot disprove it; all I contend is that in the present crude state of our knowledge as to what gravity is, his theory as to its nature is a mere assumption, and he can bring forward no proof of its verity. It seems to me to be a case in which we must be content to take our choice, for is it not at least as reasonable for me to consider gravity, as Force transferred to a Body and manifested in Motion, as for "Φ. Π." to regard it as transferred Motion, capable of showing itself as Force?

A GIRTON GIRL.

SIR,—I have read with a degree of attention the various letters on the above. I have read them in the hope of gleaning something that would make my own ideas clearer on the subject. Week goes on after week, however, and your correspondents, instead of arriving at a satisfactory solution as to the truth, or a correct definition of the truth, are drifting into discussions on problems and matters which, if not away from the main question altogether, are at least in a bye-path. I see quite clearly myself that reaction is equal to action, but confess I have a difficulty in putting my thoughts into clear or explicit language. This I have done to the best of my ability, and would feel obliged if any reader of this letter differs from me will inform me in his opinion where I am wrong.

Suppose I were to fire a cannon ball at a mountain; given the substance of the mountain to be of earth, the cannon ball would bury itself a few feet in the ground and would then stop dead. I see very clearly here that the force the mountain opposes to the cannon ball, or the reactionary force, is equal to the active force of the cannon ball; if it were not so, why does the ball stop.

Again, take two balls of lead the same size, suspend one by an imaginary thread. Then get the other cast at it with a force capable of doing 300 lb. of work, that is, going with a velocity that would take 300 lb. to stop it. If these balls have cannoned fair on the surface, when you go after them and pick them up the indentation, or rather flattening, on each ball will be the same. This experiment could not be practically carried out. In the first place, the lead composing each ball would not be perhaps equally pure; in the second you might never get a true enough aim. If you want a proof of the truth, you could make really the same experiment with two eggs of the same strength. Hold one between the forefinger and thumb with the sharp end up; get a friend to take the other, and let him give your egg a smartish tap with the sharp end of his own. You will find that both eggs will break. This is still subject to difficulties, as you perhaps never would get eggs of equal strength.

Where the mistake is made is in the wrong conception of the word action. Take the instance of the two cannon balls. One is moving with a force of 300 lb. That is not to say it strikes the other with a force of 300 lb.; if it did so it would stop dead. But it does not; it goes on in its career till it encounters something with a greater inertia than its own. Then action = reaction comes into play, and it stops dead. But what force did it strike the stationary ball with? With an amount of force exactly equal to the resistance of the passive ball to be moved with the imparted velocity. That is to say, if it moves the passive ball with a velocity corresponding to 50 lb. of work, then the imparted force or action equals 50 lb. The acting ball then evidently has 250 lb. of energy, if I may use the expression, left. In the case of a horse and cart, I imagine the horse to have, for convenience' sake, a trace 20ft. long. Start him with his tail at the cart with a pulling power of 420 lb. The resistance of the cart to be moved with the same velocity as the horse is, say, 140 lb. When the horse gets to the end of his trace his pull comes in of 420 lb. Of this amount the cart feels 140 lb.—the amount equal to its resistance to be moved with the imparted velocity—and exerts a reactionary force of the same amount. You will say, How is the rest of the force expended? In the case in point it has not been expended at all; because the horse has not been brought to a dead stop by its load. A portion of it can be expended by accelerating the motion of the cart. With this example the mistake has been made, as was pointed out by Professor Lodge in your last week's issue, of supposing that the cart's reactionary force was opposed to its own motion, whereas it is opposed only to that of the horse.

This is how I define action, viz.: The action used against a body is always equal to the resistance of the body, either in imparting velocity or altering structure. To prove this by the cannon balls: If the acting ball's action—I hope this may be correct—is not equal to the resistance or reaction of the passive ball, but greater than it, why does it not impart a greater force than 50 lb.? If, on the other hand, it is less, why so much? I hope I make my case clear, and would feel greatly flattered by Professor Lodge's attention to the ideas of a humble

STUD. INST. C.E.

Goole, June 2nd.

SIR,—Dr. Lodge's last letter is a very remarkable letter in so far as it applies to me. It is remarkable in the sense that whereas Dr. Lodge is usually extremely lucid, he is in it so vague and indefinite that I confess I have entirely failed to grasp his meaning. I need hardly point out that the simple assertion that I am wrong conveys no conviction to anyone, and contributes nothing of value to this discussion. We want proofs, not words; and, of course, there is no proof or attempt at proof in Dr. Lodge's reply to my communication.

For some time past I have suspected that whereas I always use the word "Force" to mean one thing, Dr. Lodge uses it to signify more than one thing, and, with your permission, I must ask him now to fix upon some single meaning for the word, and to let me know what it is; I do not care what it is so long as I understand what idea he intends it to convey. So far as I can make out, it seems to me that he sometimes employs it in the sense for which I should use the word Work, and that he does not regard Resistance pure and simple as Force at all. A few lines on his part will clear this up.

It may be proper, on the other hand, that I should define the sense in which I use the word Force, even more precisely than I have yet done. I always use the word in the sense of Effort; but to narrow the ground, I will in any further letters which you may favour me by publishing use the word Force in the popular sense of Push. I might, of course, add pull, but I will not do so, for virtually they are the same thing; and as Dr. Lodge has said in one of his letters, that motion can only result from an impulse from behind —*vis a tergo*—the word push will serve all purposes admirably. This much presumed, I will now repeat the statement I made in my last reply to Dr. Lodge, and will ask him, if I am wrong, to favour me with a proof; and I will leave Sir Isaac Newton's utterances on one side for a moment.

(1) A push is a Force.

(2) Dr. Lodge admits that there cannot be such a thing as an unbalanced Force.

(3) Therefore he admits that there cannot be such a thing as an unbalanced push.

When a stone has been thrown into the air, it parts with its motion by degrees. For a certain portion of time it is at rest with regard to a spot on the earth beneath it. Gravity pushes it towards the earth; but we have seen (3) that there cannot be such a thing as an unbalanced push. Consequently, the stone pushes up against gravity as much as gravity pushes it down towards the earth. The stone does not resist its own motion, it resists the push of gravity. Why does the stone fall? or rather, is it not clear that because the stone does fall push is not the cause of its motion?

I may add here that I have no reason to be dissatisfied with the progress I have made. I started with the statement that motion is a cause of force. Dr. Lodge has admitted this. I gave a new definition of inertia. Dr. Lodge has accepted this as good. I hold certain views on the nature of gravity. Dr. Lodge holds, he says, nearly the same views. The definite points at issue between us are now very few, and I fancy that they may entirely disappear as soon as we have learned to understand clearly the sense in which we use the words we employ.

Mr. Lousley must excuse me if I decline to reply at length to his letter. It is partly answered by what I have written in reply to Dr. Lodge. For the rest, I am unable to see how a push can be a "mode of motion." That the push is *caused* by motion is what I am contending for, and that a push cannot exist without the motion of something to cause it is the thesis I maintain. But to assert that a push is a mode of motion seems to me to be pure nonsense. This is perhaps because I do not understand Mr. Lousley. Is he quite sure he understands himself? Can he cite a single instance in which push is not due to motion?

Since the preceding was written, the Rede Lecture was delivered at Cambridge by Mr. G. J. Romanes, M.A., F.R.S. I find in the abstract of this lecture, published in the *Times* of Wednesday, the following passages, which I commend to Dr. Lodge's attention:—"Science has now definitely proved the correlation of all the forces, and this means that if any kind of motion could produce anything else that is not motion it would be producing what science would be bound to regard as in the strictest sense of the word a miracle." . . . "Just as it follows from the conservation of energy that motion can produce nothing but motion, so it equally follows *that motion can be produced by nothing but motion.*" The words I have italicised embody the point for which I am contending. Mr. Romanes further quoted from Hobbes, "motion produces nothing but motion." I need scarcely add that it gives me great pleasure to find on my side so profound a philosopher and so able a man as Mr. Romanes.

Φ. Π.

London, June 4th.

STEAM HAMMERS.

SIR,—Your last issue contains a letter by Messrs. Glen and Ross, Glasgow, criticising at great length my steam hammer illustrated in your issue of 15th May. This publication is confessed by the criticisers to be of considerable interest to them. Your readers might surely have been trusted to arrive at that conclusion from the evidence through the letter, without the aid of this confession. Glen and Ross are makers of great standing and renown; deservedly so all will admit, for to the practical perfection of workmanship and eye-pleasing lines of their hammers it is recorded that they add bold defence of its distinctive features, and a watchfulness of its reputation equal to the watchfulness of a gaoler or income-tax gatherer. Old memories, they say, of the steam hammer are resuscitated by the description given, and, I have to add, their letter also brings up strange memories, which, however, are not quite in accord with those mentioned by Glen and Ross.

William Rigby, of Parkhead Forge, was a genuine pioneer in engineering, who hewed many roads through the trackless forests of his day, by which some owning smaller measures of genius and more stereotyped brains have been led in ease and pride to considerable fortunes. Rigby, like many other true inventors, as also many who are not inventors at all, had no profound knowledge of patents or the subtleties of claims under them. In fact, he cared little about such claims. It therefore came to be that at the alleged passing of the patent rights of the Rigby hammer into the possession of Messrs. Glen and Ross in 1856, that few or no rights existed save those alone which the public choose to generously accredit. I have a distinct recollection of the patent specification, No. 25, of 1854, and a clear impression of the hammer first made under it, the outline of which is reproduced with the letter in point. Therefore, to base a patent claim on the mere fact of the ram or hammer bar being made in a piece with the piston, or on the non-projection of its face past the ram sides, was far from my contemplation; and this may be said of the valve and other parts to which allusion is made.

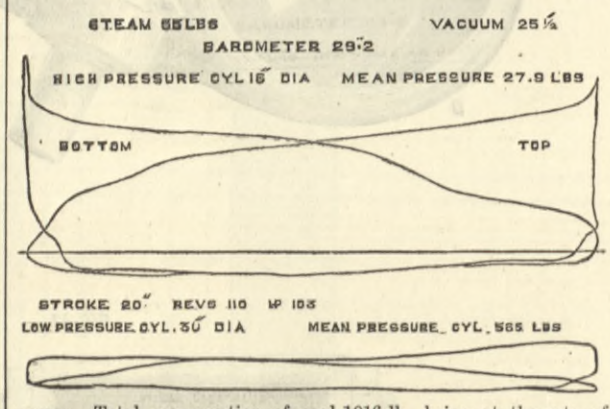
Messrs. Glen and Ross, in short, have missed the "facing points," and got shunted into a siding surrounded by fog, which peradventure their "considerable interest" in this matter if persevered in, may eventually see cleared away. Meanwhile I regard their query, "Where then is the patent?" as ill-timed and not *bonâ-fide*, and therefore have no direct answer to make to it. Suffice it to say that between the lines reproduced from Rigby's specification and those representing my hammer, there is a gulf of separation which the merest novice in patents may see to be sufficiently wide for accommodation of many patents. Patent rights, like poetry rights, are not, however, grasped by everyone. Some in these matters are born to colour blindness, just as some are to non-discrimination between certain of the rainbow's stripes. Thus it is that now and again even honest instances are met with in which loud cries of want of novelty, anticipation, and previous use are heard in connection with the most valued of our modern machines and discoveries. John Elder elaborated his famous compound engine, and by it brought steam navigation forward with a bound, yet after all the Britishers were told by cousin Jonathan that steamships had been a' working in 'Merica on that 'ere principle more'n thirty years. The multitude should always be excused in these matters, and very often many who lay claim to special knowledge, for in point of fact John Elder's patent compound engine, in a sense, may be said to be separated from Jonathan Hornblower's and other earlier patents by mere hair lines. Hair lines, however, often make a world's difference in the matter of efficiency; in fact, sometimes most value is added by the finest lines; and *apropos* of this it may be borne in mind that the hairs which divided compounding are again being subdivided in triple expansion in hopes of great results; and so on, one might go as to steam boilers, breech-loaders, steam hammers, sewing machines, telegraphs, and others without number. But again, and to conclude, patents are like poetry, and, for instance, "There is a beauty born of grace," that line by itself is poetry. My critics may, however, only see in it only plain prose, the words composing the line being all old and by themselves commonplace, just as the several parts of grand new machines often are.

GRAHAM STEVENSON.

Airdrie Engine Works, Airdrie, June 1st.

TRIAL OF A COMPOUND ENGINE.

SIR,—In your paper of November 7th, 1884, you published an illustration of our tandem compound engines. We now beg to hand you particulars of a trial of one of these engines, which took place on the 20th of May last. This engine has a 16in. high-pressure cylinder, 30in. low-pressure cylinder by 20in. stroke; and is driving the Wellington Cement Works of Messrs. Matteson and Chapman, of Sunderland. The work—which consists of millstones, wash mill, elevators, &c.—is very regular, and was not altered during the trial, which lasted four and a-quarter hours. At the commencement steam was raised to 60 lb., and only just sufficient fire left on the bars to start the fresh coal; the height of the water in the glass was noted; and at the conclusion of the trial, steam and water were exactly the same as at the commencement, and the fire in as nearly as possible the same condition. Twelve diagrams were taken during the trial, of which we beg to enclose herewith a sample. The mean of the whole is 103·2 horse



power. Total consumption of coal 1016 lb., being at the rate of 2·32 lb. per horse-power per hour. The coal was of the kind known in Lancashire as duff, and in this district as rough small, of very moderate quality, and towards the conclusion of the trial very wet. The boiler was a very fine one, 7ft. diameter by 30ft. long, by Messrs. Galloway and Sons, Manchester; but, like the engine, was much too large for the work, it being almost impossible to keep the steam from blowing off without sometimes letting the fire burn in holes. But the size of the engine and boiler was arranged with a view to extensive additions to the machinery driven being required at an early date. From the results of this trial we have no doubt but that when the engine is loaded to 180-horse power the consumption of small coal will not exceed 2 lb. per horse-power per hour. (For Worth, Mackenzie, and Co.)

R. TINKLER, Secretary.

Vulcan Engine Works, Stockton-on-Tees, June 2nd.

VACUUM BRAKES—JERKS IN TRAINS.

SIR,—The subject of "jerks in trains" is just now receiving very great attention in Leicester, in consequence of a well-known local town councillor having recently been charged before the magistrates with getting out of a train in motion. The facts of the case are very simple indeed. The 9.43 p.m. train from Trent to Leicester is always made up of an engine and tender fitted with the steam brake, a few carriages with the automatic vacuum leak-off two-minute brake, a large number of meat and milk vans not fitted with brakes, and a rear van with a hand brake only. The train stops at every station, and each time the continuous brake is applied to the leading portion of the train the unfitted meat vans push forward and compress the buffer springs. Just as the train is coming, or has actually come, to rest, the Clayton brake "leaks off," and the jerks and recoils which follow are very violent. Several passengers have been thrown down and couplings broken in such circumstances.

On the night of 17th April Mr. Councillor Green, of Leicester, was a passenger by the train in question, and on arrival at Humberstone Road he waited till the train came to rest, and was just getting out when the brake leaked off, and the recoil took place, throwing him down on the platform. The company charged him before the magistrates, but the case was dismissed. It has before been argued that the train must have been in motion or the passenger would not have been thrown down; but surely the bye-law refers to persons getting out of a train before it has stopped—not to a case of a rebound or jerk after the train has once come to a dead stand.

If the bye-law includes these "jerks," it would be well to put a notice in the carriages that passengers must stop not only till the train stops, but till the vacuum brake has leaked off and the recoil ceased. The attention of the chairman of the company has been directed to the case, and it is hoped in this district that the meat vans will be taken off the passenger train and worked in a separate train from Trent to Leicester, as they already are from Leicester to London. I can speak positively as to the risk to passengers, having only a few months ago narrowly escaped being thrown down at Leicester by the recoil of this same train.

CLEMENT E. STRETTON.

40, Saxe-Coburg-street, Leicester, May 23rd.

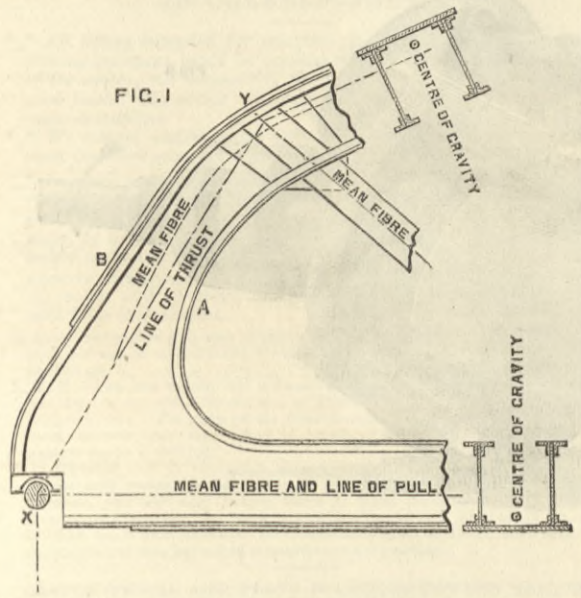
THE HOOGHLY BRIDGE.

SIR,—I desire to call attention to what I conceive to be a somewhat serious error in the design of the above bridge. It has long been the practice in bowstring or hog-backed girders to make the upper or compression boom in the form of a continuous circular curve. This practice is a perfectly correct one in the case of plate web girders where every point in the upper boom is tied down to the lower boom. In open webbed girders it is incorrect. Here the compression boom should be polygonal, consisting of a series of straight portions meeting at a slight angle at the points where the web members are attached. In most cases, however, the amount of curvature in each bay is so slight that no reasonable objection can be made to the popular arrangement, and this is true of at least three-fourths of the length of the Hooghly Bridge girders, as illustrated in THE ENGINEER of January 23rd and February 13th. But in the end bays of these girders we find a very different state of things. On the accompanying tracing, Fig. 1, taken from the illustrations in THE ENGINEER of February 13th, it will be seen that the "line of thrust" or line of action of the resultant compression, instead of coinciding with the "mean fibre" or line passing through the centre of gravity of each cross section, departs fully a foot from it towards the inner or weaker side of the compression boom. Now, it can be shown that in a simple rectangular section if the centre of pressure be moved from the centre of figure to a point one-sixth of the width toward one side, the compression per unit of area will be doubled on that side and be reduced to zero on the other; so at the Hooghly Bridge. The line of thrust passes more than one-sixth of the width of the boom below the centre of gravity of

the cross section, and consequently the stress on the light angle iron at A will be doubled in intensity, while the massive plate at B will be relieved from all stress. The loss of strength must, therefore, be most serious.

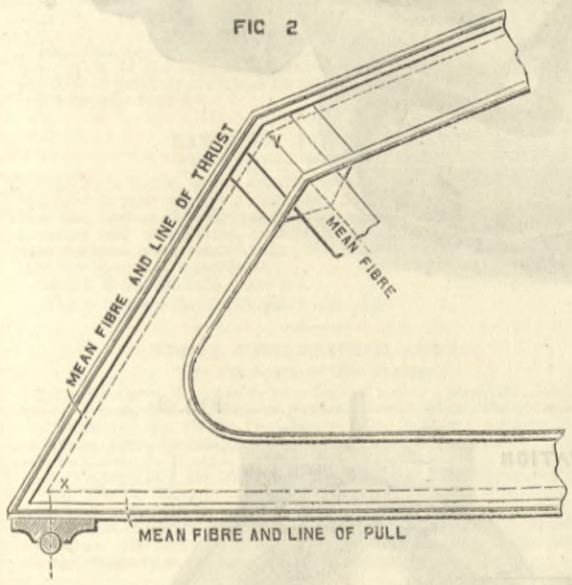
I fail to see any reason why the portion X Y of the girder should not have been made perfectly straight, with its mean fibre coincident with the line of thrust, as in Fig. 2. Then the thrust would have been evenly distributed over the whole cross section, and all the metal would have been fully utilised.

FIG. 1



I am well aware of the frequent and notable departures from theoretically correct forms that are to be found in existing structures. That these structures continue to stand proves, to my mind, but little, for, in the first place, bridges are usually designed to carry some possible, but highly improbable, load greatly exceeding their ordinary working load; and then, in the second place, ordinary factors of safety contain a large allowance ostensibly intended to cover contingencies in the direction of bad material or doubtful workmanship, but which in not a few instances has served to counteract errors in design.

FIG 2



We have in Melbourne a girder bridge in which the bottom boom endures a tension of 5 tons per square inch from the weight of the structure alone, 7 tons with a moderate or ordinary load, and 15 tons in the event of a dense crowd collecting. This bridge has stood for twenty years, and I have had the greatest difficulty in persuading the authorities to close it. No engineer, I feel sure, would argue from this instance that bridges should be designed with their tension members one-third of the size approved by the Board of Trade. A girder of 420ft. span is a very serious matter, and I should most earnestly deprecate any departure from theoretically accurate forms, even though such departures might appear to have been made with impunity in smaller structures.

University of Melbourne, W. C. KERNOT.
April 18th.

THE HEBERLEIN BRAKE

SIR,—In a letter of the 26th inst., published in last week's ENGINEER, Mr. Clement Stretton mentions that it was stated in your previous issue that the Heberlein brake on the Colne Valley Railway fulfils the well-known conditions of the Board of Trade, but that information received by him that day from that railway leads him to ask for some further details. As Mr. Stretton's letter would seem to convey the impression as if the above statement was made by your authority, whereas any responsibility for it rests solely on myself, may I be allowed to point out that, as shown by another letter from Mr. Stretton, which appeared in the *Railway Review* of the same date, that gentleman at the time he wrote was in possession of the following full details respecting the train in question, as published by me in the *Review* of the 22nd, and that it is therefore difficult to understand the object of his letter:—"The Colne Valley train consists of a van and two carriages with brakes, three carriages with cord guides for the continuous brake line, and an engine fitted with the reel by which the engine-driver controls the brake power. The engine is not fitted with the friction brake, because we never connect the driving wheel brake of a tank engine—nor, indeed, of any engine—with the continuous brake, as cases frequently occur where the automatic action of so powerful a brake in front of a disabled vehicle might create the very accident it is desirous to avoid. The control of the driving wheel brake is consequently given solely to the engine-driver, who is to avail himself of it or not, according to the circumstances of each special case. If the engine has a tender, the brake of the latter is treated as belonging to the continuous brake."

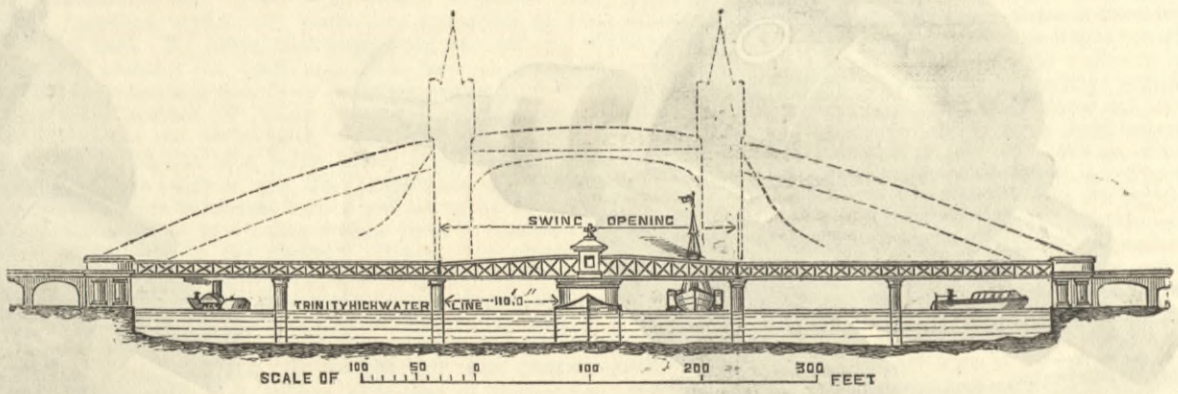
With regard to the requirements of the Board of Trade, it may, I think, be taken for granted that the Railway Department are the best as well as the only proper judges as to the proper interpretation of the wording of their own conditions, which also differs very materially from that given by Mr. Stretton in his letter. The circular says that the brakes are "to be instantaneously self-acting in case of accident," and that they should be "put on and taken off with facility on the engine and every vehicle of a train." There is not a word in the circular about their "remaining on even if the engine and every vehicle become separated." So we may probably understand this to be one of Mr. Stretton's usual side thrusts against the so-called two-minute brake on the Midland Railway, as it cannot possibly have any reference to the Heberlein, it being evident, in the nature of things, that these brakes, after application, will remain on until they drop to pieces from old age and corrosion, unless intentionally taken off.

Supposing us even to be wrong in our contention as to the inadvisability of connecting the driving wheel brake with the continuous tender, and train brakes—in which, however, we are supported by the resolution recently passed at the general assembly of all the railways of the German Railway Union, by which it was decided that the driving wheels of all engines should be braked, but that they should be kept independent of the continuous brake—it is only necessary to fit the same lifting gear to the engine brake as to the tender and carriage brakes in order to bring it at once under the control of the continuous brake line, and it was only after a careful inquiry into the facts of the case that the Board of Trade acknowledged that the present form of Heberlein brakes shall in future be entered in the first-class in the return.

June 3rd. C. FAIRHOLME.

THE TOWER BRIDGE.

SIR,—The question of communication between the banks of the Thames below London Bridge is receiving—and deservedly so—a deal of attention; and I think when it is seriously proposed by one scheme to erect two towers in the river, each 70ft. wide and nearly as high as St. Paul's, and by another scheme to throw an arch 850ft. span and 170ft. high over a river a few feet deep, any attempt to introduce common sense into the subject should be encouraged. Whatever form of bridge is erected, public opinion has decided it must fulfil two conditions: it must be a low level bridge, and it must offer no obstruction to the shipping. Both Mr. Horace Jones' design and that of Messrs. Ordish and Matheson, described in your issue of May 8th, 1885, fulfil these conditions. But what advantages do they offer over a bridge of ordinary construction? The traffic over the bridge will be of two kinds—vehicular and pedestrian—and in both schemes the former must be suspended while the bridge is open for passing vessels. Let us now see what each proposes with regard to the pedestrian traffic. In Mr. Jones' scheme it is proposed to raise the foot passengers in parties of thirty-six to a high-level platform, and lower them again by hydraulic lifts, each journey occupying, say, two and a-half minutes. A passing vessel will close the bridge for traffic for five minutes, so that after the first lot of passengers have been carried up and down, it is clear the next lot might as well wait the other two and a-half minutes as occupy that time in going up and down the lifts. Taking the worst case, where the bridge is closed for twenty minutes, 252 passengers could be accommodated by the lifts in each direction.



And this is all that is accomplished by this stupendous structure, with its towers 300ft. high. In the case of one ship passing through, 36 foot passengers each way are saved two and a-half minutes, and in the case of several vessels passing, 252 each way are saved an average of ten minutes. How do Messrs. Ordish and Matheson propose to deal with this traffic? By means of 300 steps! A good many of us would prefer waiting a minute or two—if it did not occupy the whole five minutes in going up and down—and I know some who would prefer to wait twenty minutes rather than attempt any such exhausting performance.

I send you sketch showing the type of bridge that I should recommend, on which, for the purposes of comparison, the other schemes are shown by dotted lines. It has one great fault I know—it lacks novelty; but it will only cost half as much as the others, and that, after all, is worthy of consideration. The working expenses will be very much less than in Mr. Jones' design, as it will not be necessary—without any wind-pressure—to raise 400 tons an average height of 50ft. every time the bridge is opened.

For the convenience of foot passengers, while the bridge is closed for traffic, let there be a wharf on each side of the river, adjoining to and communicating with the bridge, from which two small steamers could make frequent passages, the cost of which could be defrayed by a small charge, or it might be considered as part of the working expenses of the bridge.

From the description it is not quite clear whether the lifts in Mr. Jones' scheme will accommodate eighteen or thirty-six passengers for each journey. I have, however, taken the larger figure. J. SOMES STORY.

Derby, May 31st.

THE RATIO OF CONTRACTION OF AREA TO ELONGATION IN TESTED BARS.

SIR,—Professor Unwin has, in your last, taken considerable trouble to prove that the mathematical problem which he solves is supported by experiment. There can be no doubt that the solution is correct, but the experiments, instead of showing this, appear to me to prove what he has just before disproved. I have recalculated the table commencing with No. 943, and find the difference between theory and experiment to be 11·4 per cent. in 2in. lengths and 13·5 per cent. in 1in. lengths. If the contraction is compared with the elongation per original length, the differences are very much smaller, though theory says they should be larger. The mean differences are only $+\frac{1}{2}$ per cent. in 2in. lengths and $-4{\cdot}3$ per cent. in 1in. lengths. This matter is of great interest, and it is to be hoped that Professor Unwin will on an early occasion explain in what way the experiments must be read in order to agree with the theory. C. E. STROMEYER.

London, May 30th.

SIR,—I should be sorry if your readers suppose, as "R. H. G." seems to imply, that I asserted a stress strain curve to differ according as loads or strains are taken for abscissæ. I said it was more usual and more convenient to take strains for abscissæ. The letters of this sentence would have the same curves if written—as an engraver would write them—from right to left. But it is more usual and more convenient to write from left to right.

W. C. UNWIN.

THE FRICTION OF SLIDE VALVES.

SIR,—Your correspondent, Mr. Henry R. Leahy, will no doubt be surprised to hear that the form of relief ring and exhaust, illustrated in this week's number of your valued journal, was applied exactly thirty years ago—in 1854—to two locomotives built at Carlsruhe, in Baden, for the Frankfurt-Hanau Railway, and soon after abandoned, and new cylinders made with common D valves. MARINE ENGINEER.

16, Burney-street, Greenwich, May 29th.

DEEP WATER DOCKS, TILBURY.

SIR,—I am surprised that up to the present there has been no authoritative statement to put right, if need be, your correspondents "Forth," "Thames," and others. I consider with your correspondent "Thames" that it is questionable as to whether the slope of 6 to 1 will stand, especially at the entrance where shown on his sketch. I think there is no doubt that the flattening of the slopes has affected the design for the entrance; but whether it is economical to make the upper side of the entrance in the manner shown on your view remains to be seen. H. K.

June 3rd.

GAS ENGINE GOVERNORS.

SIR,—We notice in your issue of 29th ult. that you describe a pendulum governor fixed on a gas engine exhibited by Messrs. Tangye Brothers at the Inventions Exhibition. This is covered by our patent No. 370, of 1881, in the names of Holt and Crossley. You will see that it is only fair to us that this should be published, as our governor will shortly appear in the same Exhibition on a five-man engine which we are sending in a few days. Please insert this letter in your next issue. CROSSLEY BROS.

Openshaw, Manchester, June 1st.

INSTITUTION OF CIVIL ENGINEERS.

THE SIGNALLING OF THE LONDON AND NORTH-WESTERN RAILWAY.

AT the ordinary meeting on Tuesday, the 5th of May, Sir Frederick Bramwell, F.R.S., president, in the chair, the paper read was on "The Signalling of the London and North-western Railway," by Mr. Arthur Moore Thompson, Assoc. M. Inst. C.E.

In this paper the author first referred to the disadvantages arising from signal-work being left in the hands of district engineers, and he advocated its being carried out by an independent department and superintended by an engineer specially trained for the work. He traced the development of the system on the London and North-Western Railway since 1873. In that year the directors of the company, who had already spent more than £1,000,000 on the work, and in view of a further large outlay, instructed their chief mechanical engineer to prepare the necessary shops and machinery at Crewe for the manufacture of every appliance to carry on the signalling of the line. Large fitting and erecting shops, carpenters' shops and saw-mills, with special machinery were provided'; and arrangements mere made for the rolling of the Bessemer steel-point rod, locking-bar, and other iron, and the stamping of corrugated steel signal-arms; while plans were prepared of the locking-apparatus and other requisite appliances, a signal department was instituted, and an engineer appointed to superintend the work. A brief description of the growth of the locking-apparatus was then given, up to the date of the introduction of the frame now used by the company known as "lever-locking," the invention of Mr. F. W. Webb, M. Inst. C.E., so called to distinguish it from "catch-rod-locking." These two methods of locking, together with the signal-cabins, signals, signal-slots, adjusting apparatus, point-rod compensators, facing-point locks, detector-bars, and other kinds of apparatus, were described in detail. Attention was directed to a want of improvement in the grouping and general arrangement of the signals for four lines of railway and at important junctions; and after giving an account of a simple plan for cheaply interlocking unimportant roadside stations, adopted on the London and North-Western Railway at the suggestion of the author, statistics were introduced of the number of men employed, signal-cabins, signals, and the cost of maintenance. The appendix contained a copy of the company's rules for the sighting of signals, and for the general work of the department.

TENDERS.

NOTTINGHAM CORPORATION NEW CATTLE MARKET.

CONTRACT No. 1.—For abutments and approaches to bridge, general formation, sewering and levelling of market. Mr. Arthur Brown, Assoc. M. Inst. C.E., borough engineer.

	£
Foster and Barry, Nottingham—accepted	10,000
Hodson and Son, Nottingham	11,287
T. Smart	10,232
S. Thombs, Nottingham	10,789
R. Holmes, Shirland, near Alfreton	10,997
H. Vickers, Nottingham	11,150
Meats Brothers, Nottingham	11,500
J. and G. Tomlinson, Derby	12,700

CONTRACT No. 2.—For two entrance lodges, offices, refreshment rooms, unloading platform and cattle docks, pig sheds, cattle lairs, &c.

	£
G. Bell and Sons, Nottingham—accepted	7668
T. Guy, Nottingham	7400
Wheatley and Mank, Nottingham	7560
Bott and Wright, Nottingham	7659
J. J. Adams, Nottingham	7738
H. Vickers, Nottingham	7778
E. Hind, Nottingham	7877
Foster and Barry, Nottingham	7900
Hodson and Sons, Nottingham	8104
J. Hutchinson, Nottingham	8284
F. Wartnaby, Nottingham	8700

CONTRACT No. 3.—For ironwork to bridge, roof, pens, stalls railings, hurdles, &c.

	£
E. C. and J. Keay, West Bromwich—accepted	5020
G. R. Cowen and Co., Nottingham	6028
Newton, Chambers, and Co., Sheffield	5451
Handyside and Co., Derby	6675
Butterley and Co., near Alfreton	5896
G. Fletcher, Wolverhampton	5530
Braithwaite and Kirk, West Bromwich	6268
J. Tildesley, Willenhall, Staffs	5880
J. T. Marshall and Co., Sandion, Notts	6452
Goddard and Massey, Nottingham	5841
White and Son, Nottingham	6442
Abbott and Co., Newark	5860
Brookes and Co., Wolverhampton—tender not complete.	
Haynes and Co., Nottingham—tender withdrawn.	

The amount of the three accepted tenders is £22,688; the borough engineer's estimate was £25,425.

THE Admiralty contract for asbestos for use in the Navy has been awarded to the United Asbestos Company.

THE INVENTIONS EXHIBITION—THE FIELDING HIGH-SPEED ENGINE.

MESSRS. FIELDING AND PLATT, GLOUCESTER, ENGINEERS.

(*For description see page 437.*)

FIG. 1

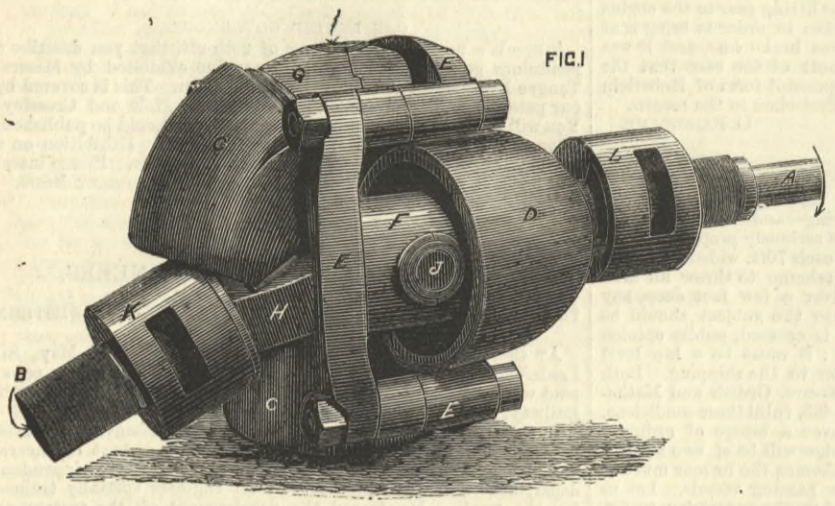


FIG 3

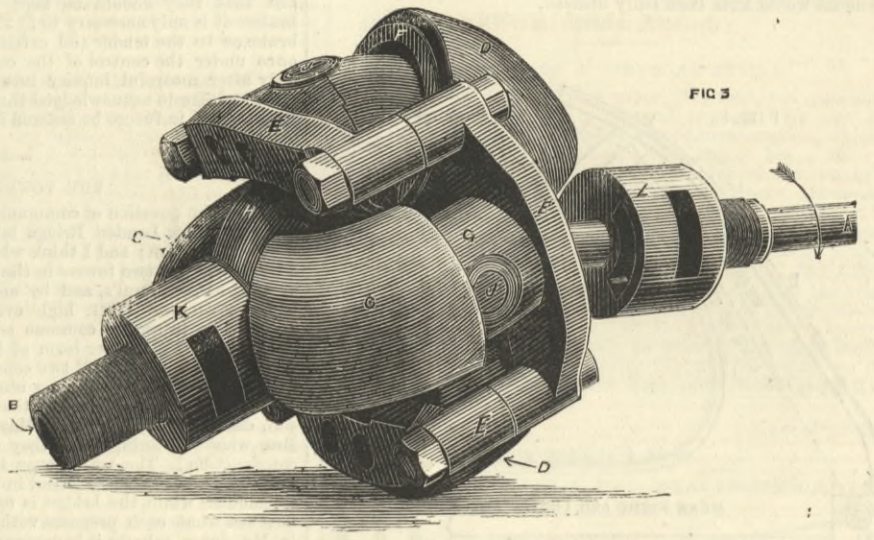


FIG 2

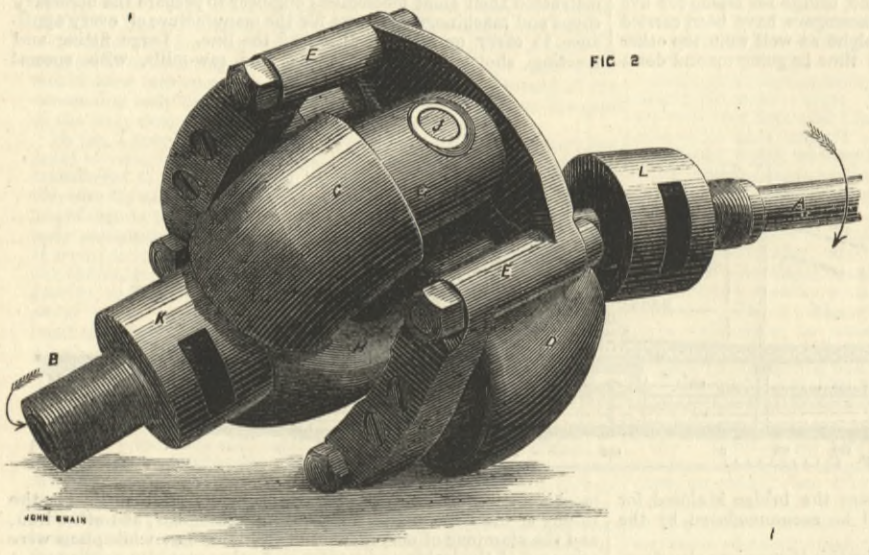


FIG. 4.

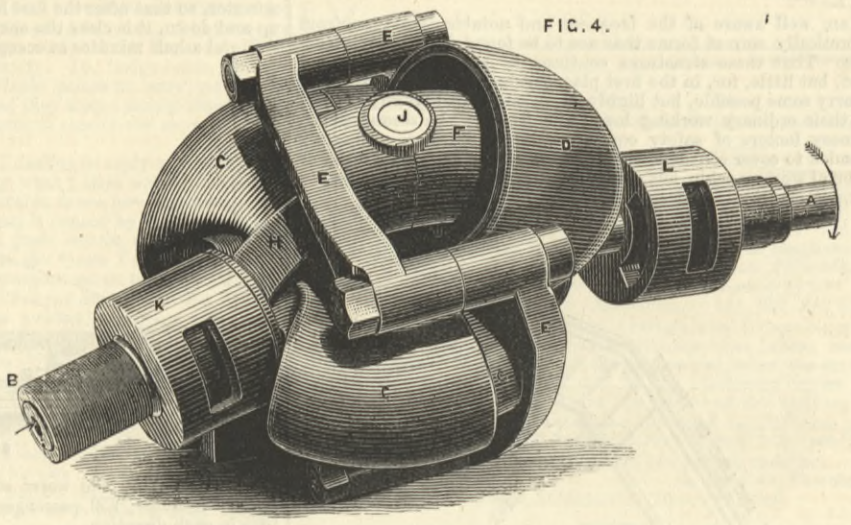


FIG 5

FRONT ELEVATION

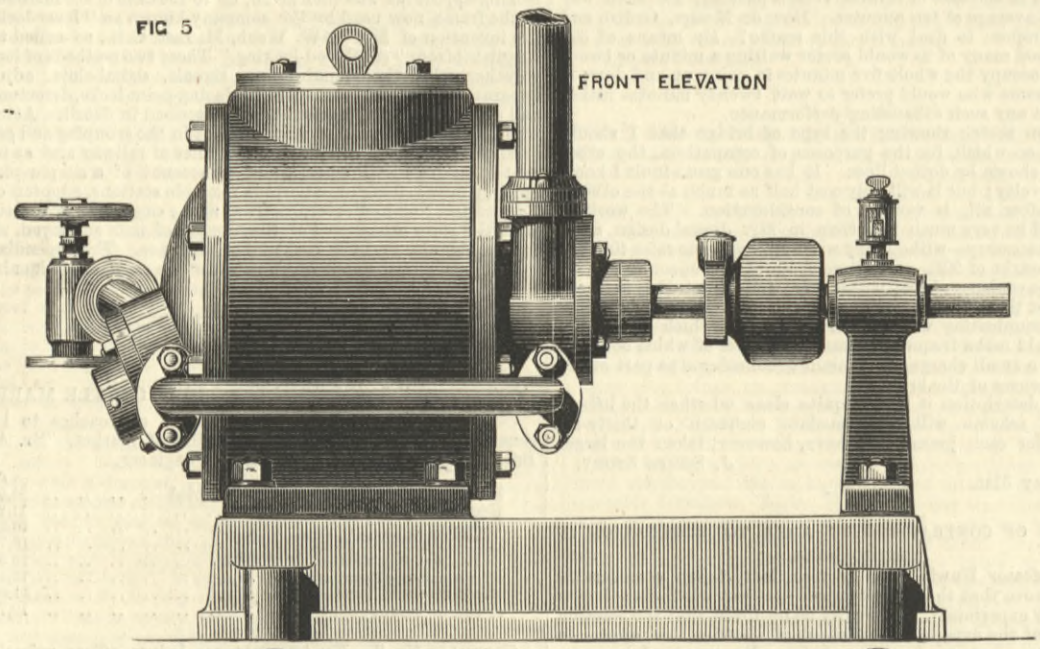


FIG. 6

END ELEVATION

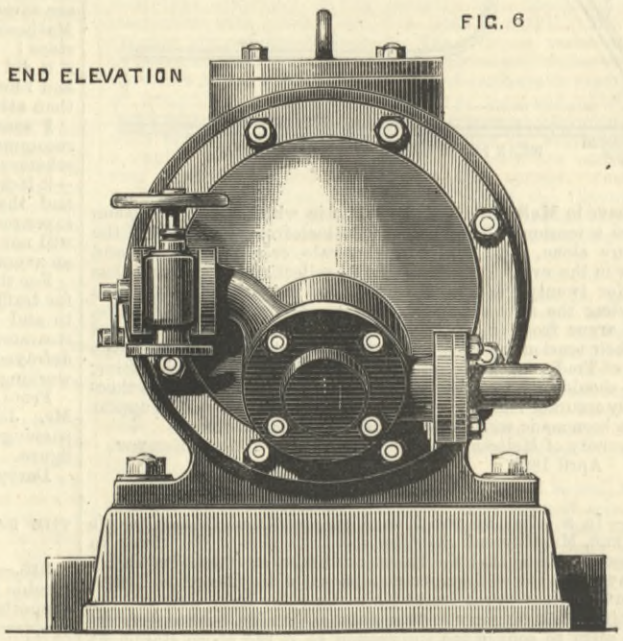
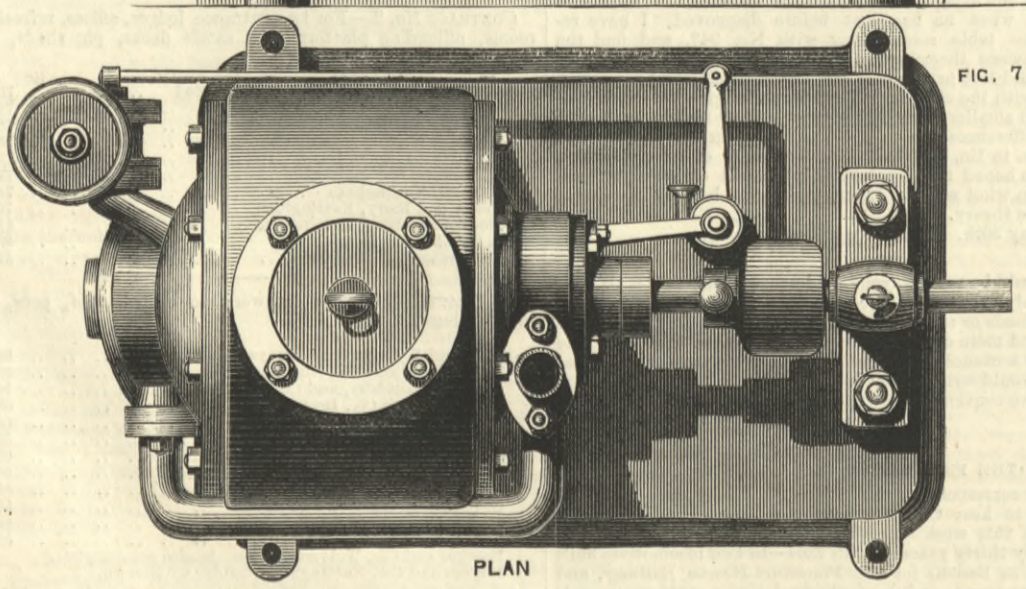


FIG. 7



PLAN

FIG. 8

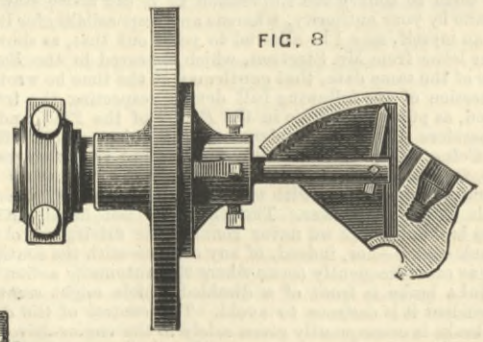
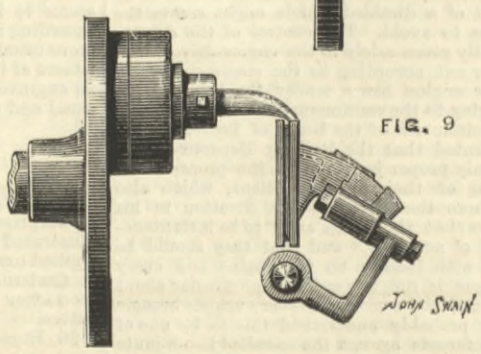


FIG. 9



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PARIS.—Madame BOYVEAU, *Rue de la Banque.*
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VIENNA.—Messrs. GEROLD and Co., *Booksellers.*
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NEW YORK.—THE WILLMER and ROGERS NEWS COMPANY, 31, *Beekman-street.*

TO CORRESPONDENTS.

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

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

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

R. D.—*Your engine will use a great deal more steam running at 75 revolutions per minute and driving the shop, than it will at* 150 *revolutions with no load on.*

X. Y. Z.—*You can obtain all printed specifications by sending the number and date to the office for the sale of Patent Specifications, Cursitor-street, Chancery-lane. The price varies from fourpence up. Not many specifications, however, cost more than a couple of shillings; by far the larger number under a shilling.*

J. D. (Bristol).—*It is impossible to say how much condensing water your engine will require because you do not give the indicated horse-power. However, you will need twenty times as much condensing water as feed water—that is to say, for every gallon you pump into your boiler, twenty gallons must pass through the condenser. This reply answers another correspondent who has asked a nearly similar question.*

CRAYON PENCIL AND PLATE POLISHING POWDER MAKERS.

(To the Editor of The Engineer.)

SIR,—Will any of your readers tell me of some good firms who are makers of crayon pencils and plate polishing powder? C. D. G.
Dover, June 1st.

CANE-SPLITTING MACHINE.

(To the Editor of The Engineer.)

SIR,—I shall be glad to know if in England any machinery is made for splitting reed or cane; also for making cane-bottom and basket work of reed or cane. S.
Hamburg, June 1st.

SUCTION TAKING-OFF APPARATUS.

(To the Editor of The Engineer.)

SIR,—Can any of your correspondents tell me where I can find a description of the suction apparatus that was, or may be still, used in envelope or printing machines for taking-off the envelopes or sheets?
Edinburgh, June 1st. T. R. J.

RAWORTH'S FRICTION GEAR.

(To the Editor of The Engineer.)

SIR,—In a notice of our exhibit at the Inventions Exhibition which appeared in your paper, we find that no mention was made of the fact that the friction driving gear for dynamos which you described was invented and brought out by Messrs. Siemens Bros. and Co., for which firm we have solely made them. We think it due to Messrs. Siemens that this should be mentioned. BROWETT, LINDLEY, AND Co.
Sandon Works, Salford, June 3rd.

[Why is it called Raworth's gear?—ED. E.]

MESSRS. FORD, STATHAN, AND CO.

(To the Editor of The Engineer.)

SIR,—We regret to notice in your issue of to-day a paragraph under the head of "Iron, Coal, and General Trades of Birmingham, Wolverhampton, and Districts," pp. 428, to the effect:—"The Darlaston concern known as Messrs. Ford, Stathan, and Co. (?) has changed hands, and in future will be known as Messrs. Timmins and Co." We beg to contradict your correspondent, and ask you to insert a notice to the following effect:—"That Messrs. Timmins and Pirrie, of 11 and 12, Clements-lane, E.C., have been appointed managing directors of the old-established and well-known firm of Carter, Ford, and Co. (Limited), James Bridge Ironworks, Darlaston. Beyond the change in the directorate, there has been no change whatever in the constitution of the company."
TIMMINS AND PIRRIE.
James Bridge Ironworks, Darlaston, May 29th.

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Remittance by Bill in London. — Austria, Buenos Ayres and Algeria, Greece, Ionian Islands, Norway, Panama, Peru, Russia, Spain, Sweden, Chili £1 16s. Borneo, Ceylon, Java, and Singapore, £2 0s. 6d. Manilla, Mauritius, Sandwich Isles, £2 5s.

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

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

MEETINGS NEXT WEEK.

ENGINEERING SOCIETY, KING'S COLLEGE, LONDON.—Thursday, June 11th, at 4 p.m.: Paper to be read by Mr. J. C. Fairholme "On the Different Forms of Flexible Wheel-bases for Railway Rolling Stock."

SOCIETY OF TELEGRAPH ENGINEERS AND ELECTRICIANS.—Thursday, June 13th, at 8 p.m.: "On the Calculation of Mains for the Distribution of Electricity," by Mr. W. H. Snell, Associate.

LONDON ASSOCIATION OF FOREMEN ENGINEERS AND DRAUGHTSMEN.—The next meeting will take place at the Cannon-street Hotel on Saturday, the 6th inst., at 8 p.m., when Mr. Thomas G. Holland, of Messrs. Singer and Co., will read a paper "On the Development and Manufacture of the Bicycle and Tricycle."

DEATH.

On the 23rd May, at his residence, 3, Rue d'Eauplet, Sotteville-les-Rouen, in his 76th year, M. JOHN WHALEY, formerly engineer Chemin de fer de l'Ouest.

THE ENGINEER.

JUNE 5, 1885.

AN UNCONSIDERED ASPECT OF MODERN STRIKES.

IT is announced that over 100,000 hands engaged in various departments of the iron trade have turned out in the United States. In this country the great colliers' strike has ended disastrously for the men. During the seven weeks the dispute lasted, it is estimated that 1,500,000 tons of coal have not been drawn which would have been brought to bank if the collieries had been at work. This quantity of coal represents about £250,000 in wages alone. To this has to be added the diminution in the consumption of stores, such as timber and other materials used in and about the pits, £120,000; while the coalowners have had to expend, without any return whatever, £55,000 at least in keeping the roadways in good condition, and the ventilation right with a view to the resumption of work. Nor is this all the injury that has been done. Contracts which would have been taken in the Yorkshire district have gone to the Durham and Northumberland coalowners. One coalowner alone lost the sale of 100,000 tons through his pits being laid idle. The export trade has suffered most severely, many vessels which usually load at Hull with Yorkshire coal having gone to the Tyne for cargoes. It is calculated that twelve months will elapse before the export trade recovers this loss; and now that the miners have returned to work they are finding that employment is much scarcer than when they went out. In not a few instances the pit owners state they are literally devoid of orders, and the men have not yet gone down. Thus history repeats itself. The Sunderland strike of engineers has brought misery to thousands of unoffending folk. There is no reason to believe that the American strike will prove any exception to the general rule. No lesson that experience can enforce, or political economy can teach, appears to have the smallest effect in preventing men from resorting to this crude and ineffective method of fixing the price to be paid for labour; and the philosopher regards with wonder the continual adoption of a policy which always ends badly for those who follow it up. The practical man will, however, find more to interest him in endeavouring to ascertain the means of preventing strikes than in speculating on human folly in the abstract. Indeed, the questions involved are of the greatest possible importance, and it is earnestly to be desired that some agency should be employed which would counteract, or at least tend to counteract, the baleful influences brought to bear on the working men of all countries. It is not for one moment to be supposed that strikes originate of themselves. The rank and file always want leaders before they will take action; and some dominant minds are invariably associated with strikes of any or, indeed, no importance. If it were practicable to enlist on the side of peace and order men who have both the will and the way to persuade the rank and file that there are much better methods of adjusting wages' disputes than strikes, good might be done, and we by no means hold employers of labour blameless in this matter. They hardly ever stir a finger or wag a tongue. They take no steps of any kind to teach sound doctrine on labour questions to those who labour. The demagogues have it all their own way, not only on the stump, but in the reading-room and the lecture hall. No attempt is made to teach the whole truth to men, who, imbibing a mixture of truth and falsehood, see but one way to cure all ills, and that is to strike. Why should not the masters have a literature of labour questions? Why is it that pamphlets, broad-sheets, books, speeches, do not abound, all having the same object—namely, to counteract doctrines which are pernicious. The working man never hears more than one side of the question. Whose fault is it that he does not hear both?

There is good reason, too, for believing that just now much good might be done by such a propaganda as that at which we hint. The working man sees things from a point of view not quite what it was twenty or even ten years ago. Although arbitration has failed to do good, the sliding scale has been more successful, and its greatest success lies in the circumstance that it has taught the working man much that he did not know before. So long as employers kept their books secret, so long did the workers believe any cock-and-bull story told them concerning profits, and the injustice with which capital treated labour. The regular publication of the selling price of iron has opened the eyes of iron makers to facts the existence of which they did not previously suspect. The result of this, and the spread of information in some other directions, has been that strikes are now seldom, ostensibly at least, directed against capital in the old and bitter fashion. In other words, when 40,000 colliers turn out in the North of England, they strike not against the colliery proprietors but against the consumer. They ask for more wages, or that wages shall not be reduced, according to circumstances. The masters reply that they cannot afford to comply with the men's request, because prices are too low. The men answer that this is quite possible, but that the masters ought to raise the prices, and to compel them to do this they strike. The working man is shrewd enough to see that when coal is sold for 7s. a ton the masters cannot pay as much wages as if coal was 10s. a ton. It is no longer strikes against capital with which we have to do, but strikes against the consumer. The colliers insist that the iron-maker shall pay more for his coal. The iron-maker insists that the shipbuilder and the railway company shall pay more for plates and rails. This would lead to larger expenditure on ships and railways, dearer freights, and higher fares. For these things the strikers care nothing at all. But the old parrot cry that capital is getting an undue share of profit is dying out. It is not yet dead, for such theories die hard; but it is moribund. The question is, Shall we be better off when it is gone? Is there anything encouraging about its decease? The answer must, we think, be in the affirmative. It is a hopeful sign that men admit that low prices are the cause of low wages. It is a great thing that even the leaders of trades unions concede that masters really do tell the truth when they say that they cannot work at a profit and comply with the demands of the men at the same time. It shows that the hard outer crust of self-deception has at last been penetrated, and it leads to the conclusion that, with a little more teaching, the working man might learn that his master—that is to say, the capitalist—is as powerless as the man to determine what the selling price of anything sold shall be. The most recent development of the strike policy is the desire to get the capitalist to make common cause with the workers against the consumer. If, for example, all the coalowners in Great Britain would constitute themselves a mighty ring, and say that no coal should be sold at less than a sovereign a ton, the colliers maintain that they would have good times of it again. No doubt they are in a certain sense right. The masters could afford to pay higher wages, and if the matter ended there all might be well; but it could not end there. We shall say nothing now about the effect produced on other industries depending on coal for their prosecution. We may narrow the circle of our vision and still find enough to prove that the expedient would prove inefficient—that is to say, the colliers would not be really the better for the establishment of the ring.

Let us suppose that the wages of the collier being now 5s. a day, the enforcement of the ring restriction would double them. The direct and instantaneous result would be that the number of men anxious to earn 10s. a day as colliers would be enormously augmented. The rise in the price of coal would at once reduce the demand, and very much less would be raised than is now the case; fewer colliers would be needed, and the number of applicants for work would be out of all proportion to the openings available. Scores of men would come forward willing to work for 7s. 6d. a day, and these in time would be underbid, so that in a very short time wages would go back to 5s., or to such other sum as would suffice to limit the supply of labour. The colliery proprietors would be the only gainers. Of course it may be pointed out that it would be impossible to get such a ring to hold together, but this is beside the present question. We are dealing now, not with the capitalist, but with the men. The true way to raise the wages of colliers is to limit the supply of colliers, but this the men are as powerless to do as the masters are to settle the price of coal. The number of men working in our mines is determined by the number of men willing to do this for a certain remuneration. Wages are regulated by this condition more than by any other, and, indeed, the men of all trades unions pretty fully understand this, and act upon it, by endeavouring to keep down the number of apprentices which the masters shall take. If there are plenty of fitters to be had at 26s. a week, it is quite hopeless to expect that men will get 28s. A strike is the full and complete embodiment of a policy dictated by and consistent with this truth. The men resolve not only to limit the supply of workers, but to stop it off altogether. If they could only partially limit it they would, and the practice of divided strikes is well understood, and used at one time to be carried out with some success, until, indeed, the masters put down their feet, and adopted the universal lock-out as the weapon with which to fight.

In writing as we have done we have gone, to some extent, over old ground, and it is impossible to avoid doing so. The new feature of the question, namely that strikes are now not only virtually but ostensibly directed against the consumer and not against the capitalist or employer, has not yet received the attention it deserves. It is an aspect of strikes which was not, a few years ago at least, contemplated by any political economist; and, as we have said, it is encouraging, because it shows that the working man can change his ground and shift his basis of operations. In other words, it proves that his mind is open to conviction even on trade questions; and it may not be impossible to prove to the next generation, if not to this, that strikes are a most defective means of attempting to secure a given end. We are not going to dispute the right of a man, or a body of men, to strike. We do not assert that it is not a tempting expedient. We will even admit that strikes have ere now done the working man some service, but we do assert that strikes cannot be divested of a great defect, which is that they are enormously expensive. They represent an intolerable outlay, and it is a disgrace to a civilised community that a cheaper and better method of determining what is the proper price to pay for a day's work cannot be devised. It would, we think, soon be devised if only the working man could be taught the whole truth; and we end this article, as we began it, with an exhortation to employers, in season and out of season, to work at the extension of education so that men may see that trades union leaders are not invariably infallible; and that, however possible it may be to crush a capitalist, no power on earth exists which will crush the consumer. The capitalist may be ground between the working man and the consumer like wheat between the upper and nether millstones, the consumer is certain to win in the end, and the only victory which the working man will achieve must be won in the character of a consumer.

TELEGRAPHY IN TIME OF WAR.

EVERY crisis in the history of a nation is bound to develope some question or other which has long slumbered; and even if its bearings have not been altogether overlooked in time of peace, they become prominent when consideration is forced upon nations by the alarm of possible warfare. As our material civilisation progresses, its elements become so diverse and extended as to entail upon us year by year new responsibilities under conditions which were altogether absent in the past; and the advance of science, which has done so much in increasing the blessings of a state of peace, has also done its utmost to neutralise them when that state is changed to one of warfare, actual or apprehended. No stronger exemplar of the

fact could be adduced than the alarm which has recently given rise to much discussion in the House of Commons as to the possible insecurity of the telegraphic communication we possess with our colonies in the event of war breaking out with Russia. How far international arrangements would protect submarine cables in the event of hostilities it is difficult to say. These arrangements are in themselves extremely complex; and even should they in theory afford sufficient protection, we fear that late events on the borders of Afghanistan prove to us that we may have to deal with a Power which is apt to override all and every consideration in its efforts to secure military advantages.

But apart from this conviction, leaving for the moment out of consideration how far international engagements are likely to bind a Power which can shield itself by repudiating of the acts of its agents, attention has been strongly called to the precariousness, to say the least, which would attend our telegraphic communication with our distant colonies while it is, as at present, so largely dependent upon the goodwill of or continuance of peaceful relations with those foreign countries through which much of it is carried on. The dangers to which that communication is exposed under existing conditions have not unnaturally given rise to much alarm in our important Eastern colonies—Hong Kong and the Straits Settlements. When attention was called to this matter in the House very recently, it was stated by Ministers that the telegraph lines through which messages are conveyed to those colonies are alternative; that they are in duplicate, and lie in two separate countries, it being argued therefrom that it is improbable that this country would be at war with both at the same time, and that therefore one communication would always be secure. We hold this to be a very insufficient basis upon which to rest content. As one member put it, it is an indeterminate question as to how far the restraints upon neutrals would justify them in permitting to pass over their telegraph lines messages affecting the direction of military or naval operations; and it might well be that in the event of this indeterminate question being decided adversely to the interests of England, we might find ourselves at any moment deprived of the only means at our disposal of either giving instruction to our commanders engaged in distant colonies or of receiving that rapid intelligence which is a necessity of all modern operations, whether warlike or pacific.

We have only very recently been experiencing such a disability with regard to Sir Charles Warren's proceedings in Bechuana Land, and it is made known that the breakdown of our telegraphic communication with South Africa has caused intense anxiety to our Government, in view of the differences existing between the officer referred to and the High Commissioner, Sir Hercules Robinson. It is certain that anxiety would be greatly increased if war with Russia should break out; and in the face of such existing experience, we fail to believe the wisdom of the ministerial utterance which has stated the view that the expense of an independent line of cable to Hong Kong would not be justified by any apparent advantage to be derived from it. Lord Carnarvon, we cannot but think, was right in stating that, considering the imperial interests involved, it is imprudent to base a refusal to provide independent accommodation on any commercial aspect of the question. It seems to us that the outlay for providing such an independent cable to Hong Kong and Singapore, as well as duplicating that now existing to South Africa, would be more than repaid by the security it would afford against a possible position which we cannot but contemplate with extreme alarm. The same point of expense was over and over again urged when it was endeavoured to persuade our authorities to give telegraphic communication to our colonies of Natal and at the Cape; and it required the stimulus of actual warfare to convince them that the position assumed upon it was untenable when the strain at last came. We may feel assured that, should war with Russia break out, the same necessities would then become apparent in dread of a crisis which might occur at any moment, and the haste, and consequent extra expense, which were observable with regard to the laying of the South African cable, would find its parallel in the emergency which would then have to be dealt with.

In this connection we may revert to the contingency alluded to in the beginning of this article, viz., the chances that an unscrupulous Power might override all international obligations, and either openly or by secret agency effect the destruction of one or more of our submarine cables. We may, perhaps, assume that the lines connecting England with France would be secure against grappling and cutting; but more, in such an instance, because of the hostility of France such an act would create than because any watchfulness on our part could absolutely prevent it. But there are numerous other points at which our oceanic telegraphic system would be vulnerable, and they might be attacked in shallow water by the most innocent looking craft, the appearance of which could give rise to no suspicion, and whose secret commission could be executed in such a way as almost to preclude for want of proof the possibility of calling a belligerent to account under any international provision. The science which has made it possible to lift and repair a cable readily has also made it possible for an enemy to secretly destroy it. Such an operation would be most easily performed in the near neighbourhood of a friendly or neutral coast. It might even be given the appearance of mere accident; but if our cables were laid, as it is contended the projected lines to the East should be, in the depths of the ocean, the appliances required would almost certainly ensure the detection of any vessel fitted out with such an object under the power of the right of search of neutral vessels.

THE U.S. DESPATCH BOAT DOLPHIN.

In our last impression we briefly noticed the failure of the engines of the United States despatch boat, Dolphin, to comply with the terms of the contract under which she was engined by Mr. John Roach. If our readers will turn to vol. lvi. of The Engineer they will find particulars of this ship, and of war ships to be built at the same time, and for convenience we reproduce our illustrations and description of the Dolphin on page 446. It will be remembered that we criticised the design of the engines of the war ships, and our criticism so strengthened the hands of those on the other side of the Atlantic who agreed with us, that the engines in question must prove inefficient, that radical changes were made in the constitution of the Naval Advisory Board appointed to report on the additions which the United States Navy required, and to assist the Naval Bureau. What has really taken place concerning these engines and ships it is very difficult to ascertain, because, for obvious reasons, those concerned have kept their own counsel very closely. It is impossible, however, to keep a trial trip a dead secret, and the trials of the Dolphin and the results obtained with her are now to some extent public property. As yet, however, nothing like the whole truth has come out, members of the press having been rigorously excluded, but this as a matter of course has only kept a portion of the truth in the background. The facts, as far as they can be ascertained, are that Mr. Roach bound himself to run the engines of the Dolphin at full speed for six hours, indicating not less than 2300-horse power. She has now made several attempts to comply with this demand without success. On the very first trial the screw shaft was broken; on all the subsequent trials the boilers have failed to make steam enough and the bearings have heated. The best trial lasted for something less than an hour, when the engines with picked coal and extra stokers, indicated 2180-horse power for a short time. The Government under the circumstances refuse to take her over, and Mr. Roach, it is stated, is determined to force her on the nation, and we are disposed to think that he has a great deal to urge in his favour.

In the United States there is an Institution, the Bureau of Steam Engineering, nothing analogous to which exists in this country. This Bureau has among its members one or two very good men, and all its members are well educated in theory. They have, however, no extended experience in designing or building engines, and they attach to theory a great deal too much importance; so much importance, indeed, that they do not shrink from undertaking work of considerable magnitude. Now, the theory of the steam engine is one thing, practical engine building is quite another thing. Very good engines, indeed, can be built by men who scarcely know what steam is; but Hirn or Clausius would scarcely be regarded as men competent to design and superintend the construction of the machinery for an Atlantic steamer. If the Bureau of Steam Engineering or the Naval Advisory Board felt it incumbent to prepare designs for the engines of a war ship, obviously the only sensible course which they could adopt would be to get hold of the drawings of some successful English engines, and copy these engines as closely as possible. Instead of doing this, however, the Bureau has rashly broken new ground, and amateurs have rushed in where engineers would fear to tread, and always with the same result—failure. Nor is this matter for wonder; indeed, it would be surprising if any other result could ensue. The Bureau possesses no practical experience of any kind in the building of engines, in the proper sense of the term. No doubt many of its members are good workmen; but much more than this is required. Nothing short of an everyday acquaintance with the steam engine can give that information concerning details in the absence of which failure is certain. On particular points the practical man simply laughs at theory. The great success which has attended the labours of English engineers has been secured by the great skill of, after all, a comparatively few men; and the wider has been any departure from received proportions and methods of arrangement, the greater has been the trouble incurred. We might cite, for example, the City of Rome, in which vessel more than one innovation was to be found which did not fulfil the expectations formed of it. We do not blame the Bureau of Steam Engineering for being incapable of designing a good marine engine; but we do blame it for atttempting to achieve what must be for it an impossibility, and for throwing away the last chance of success by rejecting as much as possible that which appeared to be derived from English practice.

Mr. Roach contends that the engines of the Dolphin were designed from first to last by the original Naval Advisory Board, and that they are responsible for the failure. We are not quite sure that this contention is entirely justified by the facts. If we are not mistaken, Mr. Roach only obtained from the Bureau certain dimensions, and was left to work out the details himself. But even with this limitation, it is clear that Mr. Roach had his hands very effectually tied. We cannot do better here than quote the New York *World*:—"Whether there will be another trial is extremely doubtful. Mr. Roach said it was a matter for the Secretary to decide; but his manner plainly showed that he didn't care much whether there was one or not. He will take the ground that the vessel, as it stands to-day, was made under the most minute supervision of the old Advisory Board, and that the Navy officers drew plans and specifications, directing the size and style of every bolt and pin in the entire vessel. If the horse-power is not shown with the boilers ordered by the Board, Mr. Roach will shrug his shoulders, and point to the specifications fixing length, height, and grate surface. If speed does not come, he will shrug again, and point to the propeller, and say it is of the Board's ordering. Mr. Roach is getting into fighting trim, and will soon have a battery of figures to fire at the department over the heads of the old Board. There is music ahead, and the old Board know it, and are keeping very quiet. Mr. Roach will claim that the breakdown on the first trial when the shaft snapped was one which could not be foreseen. That at the second trial the horse-power rose to 2180 in the required 2300, which is near enough for any reasonable man, and that the last two tests, when hot journals stopped the way, were tests to which no new machinery should be subjected. Meanwhile the worst hot journals in the whole matter, in the opinion of Mr. Roach, are such journals as the *World*, which have insisted that a contract is a contract, and should be lived up to." There can be little doubt that if the old Advisory Board, which may be termed a supplement to the Bureau of Steam Engineering, had been in power, Mr. Roach would have been helped through his difficulties for the sake of the Board's reputation. But the old Board was dismissed, and the new Board is by no means likely to favour its predecessors or Mr. Roach. If a lawsuit takes place, some very interesting matter is likely to come to light.

It is stated in the *World* that the officials on board representing the Government refused to permit water to be put on the crank shaft. If this is really the case, it shows remarkable ignorance on the part of the officials. They ought to have been familiar with the fact that screw engines, when working full power, almost always have water run on the crank shaft to keep it cool. A few engines fairly worked down to their bearings, and in splendid adjustment, may run now and then for some hours without water, but new engines never do. This is one of the practical peculiarities of marine engineering. Theoretically there is no reason because engines are in a in a ship that they should need what they would not require on land. A bushel of fact is, however, in this case worth a ton of theory not guided by practical experience.

RESTRICTION IN COKE PRODUCTION.

After failing in the iron trade, restriction is, it seems, to be applied to the coal and coke trades abroad. In the coal trade it is not a novelty, for the "regulation of the vend" in the North of England is a historic method, though one which can scarcely be said to have been a success. But as far as we are aware, in the coke trade it is a novelty; and in that manufacture there are some of the conditions—comparative fewness of competitors, for instance—which have made the attempt in some of the branches of the chemical trade a success. In the Dortmund district there is to be the attempt we have just referred to, and according to the best information we have, about three-fourths of the coke makers have decided to adopt a "sale syndicate," which is to begin operations when it has received a few more adherents. What are the objects of such organisations? Evidently to force up the price of the product; and thus, to the extent of the success of the attempt, the consumers will have to pay more for their coke. Hence those users should charge more for the iron they smelt, and thus it is that to the extent of its use, the restrictive process forces up the price, and makes the user pay more to the producer. It is possible that in the coke trade, especially in the centre we have named, there might be an inauguration of the method, but it is clear that it is only after a year or two's operation that the real results will be seen both in the increase or decrease of the profits of the makers of coke, and in the increase or decrease of the profit of the iron-master. We have referred to the apparent success of the attempt in one branch of the chemical trade, but it is to be remembered that though the price of the product may have moved upwards, yet that price is received for a diminished quantity on which the standing and part of the working charges remain the same. It is just as well that the true bearings of the attempt of the German coke makers should be pointed out, so that it should not have its success or otherwise determined by the mere movement of the price. That price, moreover, must be said to be too easily affected in the early part of such a movement by speculative sales, so that it will be needful to suspend judgment as to the results until we are able to state the general bearings of the movement, not for a month or two, but for a more prolonged period.

THE COLOMBO BREAKWATER.

This great work, which has occupied in its construction about twelve years, received the ceremonial finishing touch at the hands of its designer, Sir John Coode, on the 22nd April last. It is but fitting, as we have noticed this fresh triumph over one of the greatest forces in nature repeatedly throughout the course of the operations, that we should thus briefly announce its final completion. We hope that it may be within our power ere very long to furnish to our readers the very many interesting facts and figures which will illustrate the cost and method by which this result has been secured. The exposure to which a work of this kind is subjected during the long period required to complete it furnishes a sufficient guarantee that it is fitted to withstand any influence attacking it, and the colony of Ceylon and its engineer may be congratulated on the successful termination of a work likely to contribute so greatly to the progress of the island. The closing ceremony consisted simply in the laying, by Sir John Coode, of the last square of concrete capping; and Mr. Kyle, the resident engineer, whose services have contributed so greatly to a successful issue, has finally reported that "the whole of the work reclaiming the inner harbour foreshore, including jetties, sheds, &c., has now been completed, and all hands have been withdrawn and the account closed." The total cost incurred from the commencement of the operations in 1873 to their close has been 8,125,438 rupees, or in round figures about £812,500. There appears no reason to hope that for the present the local Government will entertain the carrying out of Sir John Coode's design in its entirety by undertaking the construction of a northern breakwater.

THE MANCHESTER SHIP CANAL.

On Tuesday the Liverpool Chamber of Commerce expressed in every strong terms its opinion of the Manchester Ship Canal, and showed that its recent quietness on the subject was very far from being due to a concurrence with the promoters of the project. The scheme was characterised as of the South Sea Bubble order, and statistics were quoted to show that the estimates of the projectors were enormously incorrect. The promoters for instance, expect that the traffic on the canal will reach 9,469,000 tons, and it was triumphantly shown at the meeting on Tuesday that the whole road, rail, and canal traffic, is only 9,864,000 tons, this and the arguments that followed being based, as so many opposition arguments are, upon things as they are or have been, and not as they will be when facilities for increased trade develope it. The pretended fear that the estuary would be so affected as to destroy Liverpool as a port was again paraded, and finally a motion was adopted empowering the council of the chamber to oppose the Bill in Parliament and call evidence. Liverpool is getting another fright about losing trade.

CUTLERY ARTISANS IN CANADA.

It has often been complained that emigrants who feel "lonesome" in the land of their adoption, send home glowing accounts of the new country with the view of getting old companions to come and join them. Sheffield artisans who have recently emigrated to the United States, Canada, and even Australia,

have not committed this serious error. Letters have been received from these various labour markets strongly dissuading other Sheffield operatives from following the footsteps of the writers. The last warning comes from Canada. A workman, writing from Montreal, cautions cutlers or grinders against going there in the hope of finding employment. "We are very short of work," he says, "and in addition we have been obliged to take a 20 per cent. reduction since last December, and have been short of work since that time." Finding that the masters wished to tide over "the bad time from December to May," the men offered to work for six months, and draw half their salaries, and the other half by instalments of so much per week at the end of six months, but these terms were refused, the employers offering the alternative of another 20 per cent. reduction, making 40 per cent. in all. The workman adds that they are already working below Sheffield prices without the 20 per cent. reduction, and the Canadian employer simply says, "Take these terms or git." These words of warning may save some industrious families a long voyage to find nothing but vexation of heart at the end of it.

LITERATURE.

The Works Manager's Handbook of Modern Rules, Tables, and Data for Civil and Mechanical Engineers, Millwrights, Boiler-makers, Tool-makers, Machinists, Metal-workers, Iron and Brassfounders, &c. By W. S. HUTTON, Civil and Mechanical Engineer. Second edition. London: Crosby Lockwood and Co. 1885.

THIS is the second edition of a book which has been well received, and deservedly so. It addresses those of every branch of engineering, and some of other industries. It is not like any of the recent books of its order, as it treats every subject from the point of view of one who has collected workshop notes for application in workshop practice, rather than from the theoretical or literary aspect, and contains a great deal of that kind of information which is gained only by practical experience, and is seldom written in books. It is all given in a form for ready application in the works or office, and every subject is treated without the use of algebra, but by rules. It is divided into six sections, which are—(1) stationary and locomotive steam engines and gas engines; (2) hydraulic memoranda, pipes, pumps, water power; (3) millwork, shafting, gearing, pulleys; (4) steam boilers, safety valves, factory chimneys; (5) heat, warming and ventilating, melting, cutting and finishing metals, alloys and casting, wheel-cutting and screw-cutting; (6) strength and weight of material, workshop data, &c. In dealing with steam engines, the author makes some remarks on range of expansion and lowest terminal pressure, which are evidently based more upon practical experience than on consideration of what ought to be from a thermodynamic point of view, and which will mislead no one with great expectation from the use of high ranges. A number of short rules for dimensions are given, which are generally safe rules; but it is hardly safe to make cylinder flanges only of the same thickness as the cylinder, and it is not possible to proportion the ports of a cylinder by dividing its area by 12, as the area of the ports should bear some relation to the speed at which the piston is to move, even if the pressure of the steam is not taken into account. Among these rules the outside lap of a slide valve is given as the width of the steam port multiplied by 0·62, a proportion which might be correct in one instance; this is, however, corrected by a rule given later on for the lap for given ranges of expansion.

On governors, some rules sufficient for general purposes are given, but more satisfactory information is required in some cases on the power of a governor of given proportions.

On locomotives, the information given is all of the practically required kind obtained by reference to modern examples; for instance, specifications of details by Mr. Barton Wright and by Mr. W. Kirtley, Mr. W. Stroudley, Mr. F. W. Webb, and Mr. S. W. Johnson, are given as examples. The information on gas engines is contributed by Mr. Robert Wilson. An extensive and useful lot of rules and hydraulic memoranda are given, including pumps, dimensions and capacity of power required, discharge of pipes, effect of bends, &c. The rules on the proportions, weight, and strength of gearing are followed by tables giving diameter, weight, and horse-power for different widths of face.

In dealing with steam boilers, and in a brief note on the effect of heat on water, the author speaks of heat in a new way. He says: "The particles of water expand and form themselves into bubbles of steam—that is, the heat becomes enclosed in films of water—and gradually ascend," &c. To this exception will, of course, be taken; but for the purpose of the author's explanations respecting the transference of heat to water, it answers his purpose, though, of course, he might have been more accurate with equal clearness. The book by Mr. Robert Wilson and the reports by Mr. Lavington Fletcher are largely drawn upon for the matter given on boilers. The rules given are all of the empiric kind, and no pretence to a scientific treatment of boiler construction or design is made. Several tables are given of the sizes and weights of boilers of various types. A good deal of information on mixing iron in the foundry for general and for chilled castings is given which is not elsewhere to be found in a handy form, and some of it not at all in books, though more information on chilling mixtures has been given in our columns. The notes on alloys are extensive and useful. There is a useful series of weights, measures, and multipliers, and a collection of often-required miscellaneous workshop and office data, which we can but mention. The book is provided with a good index, and will be found useful. Concerning the suppression of all formulæ and the substitution for these of written rules, we feel bound to say that there are very few men capable of acting as works' managers who would not much rather use a simple formula in preference to a worded rule. The latter is a clumsy method, as compared with a simple equation, which, at a glance, shows relations which are not gathered but with loss of time from a rule.

THE IRON AND COAL DISTRICTS OF ALABAMA.*

No. I.

IN leaving the Exhibition at New Orleans and travelling northward through forests and cotton country to the mineral lands of Northern Alabama, one is struck first by the vast extent of territory seeking development, and then by the vigour and enterprise with which one district after another is assailed. But at present the rate of progress is slow, the supply of skill and capital being much behind the demand, and entirely inadequate to the immense resources waiting exploitation. In attempting a brief description of the newly-developed iron districts of Alabama, and in comparing them with those which are better known and longer established in the Northern States, the bases of comparison are mainly—as they must ever be in discussing the commerce in iron—ore, fuel, and transport. The reasons why coal was mined and iron worked in Pennsylvania are not far to seek. The demand for iron came almost exclusively from the New England States, and even in the old colonial days, iron from the Cambria Valley east of Pittsburgh was brought by canal and road to Philadelphia and New York. Pittsburg was a natural centre for great industries; not for the iron she possesses, but because of the two other main conditions of success—exhaustless fields of coal and convenient transport. The coal is too well known to need description, and the coke from the Connelsville ovens is of a high class, equal to that of Durham, and at half the cost, the selling price at Pittsburg ranging from 5s. to 7s. per ton. Situated at the confluence of the Monongahela and the Ohio rivers, whence the double stream flows forward as the Ohio, there is cheap water navigation to the Mississippi, and thence to the sea at New Orleans, a distance of 2000 miles; while east and north and south the finest railways in the country supply abundant facilities for transport. Anyone who visits Pittsburgh with its vast iron, steel, and glass works, is struck by the signs of wealth and enterprise that abound on every side. But while the district afforded till recently greater advantages than were available in any other part of the Union, and with a tariff protection from European competition, had a monopoly of the trade and grew rich accordingly, it had not the advantages of our best English iron districts. Unlike our Cleveland in this respect, suitable coal and iron were not found together. There is no steel-making ore in the vicinity as at Barrow-in-Furness, and the river navigation is frozen up for four months in the year. Although much iron is found along the Allegheny slopes in Pennsylvania, and is used with other ores at Pittsburg, the best supply even for iron making comes 600 miles from the Lake Superior mines, which also supply non-phosphoric ores for steel making. The distance is so great that, even with rates of railway carriage lower than those in England, the cost of ore at the furnaces ranges from 7 dols. to 10 dols. per ton, and there has been a constant import of ore from Europe, though lately this latter, burdened as it is with sea freight and 3s. per ton duty, does not now find its way so far inland.

The above recapitulation of well-known facts is only given as a necessary preface to what follows about the Southern States because the question naturally arises, why, if the proclaimed advantages of the latter are so superior, have they not been developed before? The answer is a short and simple one. Fifty or sixty years ago, when blast furnaces and rolling mills were in prosperous operation in Pennsylvania, the Indians still roamed through Alabama and Kentucky, and when these States were opened out by emigration from Virginia and other of the older colonies, agriculture was the only pursuit. The rich cotton planters of Alabama, with their numerous slaves, possessed in common with the neighbouring Southern States a monopoly of the world, and they formed a rich and exclusive aristocracy who scorned any other industry. The Civil War impoverished the Southern States and killed off the best of the population; and when the strife finished, after Sherman's famous march to the sea, all that was left of the capitals of Georgia and Alabama were a few smoking ruins to show where these cities had once stood. For many years after the war there seemed no hope that prosperity could come again. The nominal owners of the land had lost their slaves and their money, and competing cotton from Egypt and India lowered prices of their product in Europe. The older lands were impoverished by bad farming, and, worst of all, the planters themselves found their habits and education were not adapted, even if they had the means, for mining enterprises and manufacturing trades; so that, notwithstanding the mineral wealth below their feet, nothing was done to develope it, and the iron trades of Pennsylvania advanced by leaps and bounds, undisturbed by fears of Southern competition. But, though dormant, the stores of coal and iron were not unknown. Indeed, the coal obtrudes too plainly from the hill sides in Northern Alabama to be ignored, and, ever since the white man came, has been mined to supply local needs. Iron, too, was smelted and forged in small quantities; and when during the Civil War the Southern States were shut out from the world, the native iron proved of great value. So rich was some of the ore, that by means of an ordinary Catalan hearth blacksmiths could forge horseshoes directly from it.

The great extent of the coal-fields of Alabama was noticed as far back as 1834. A writer in a magazine of that date, in describing them, says: "This State is very rich in bituminous coal of a most excellent quality. It is in every respect equal, if not superior, to the very best English coal. It is very heavy, burns with a good flame, and gives out much heat; it also yields carburetted hydrogen gas in immense quantity. The veins or formation of this coal are quite extensive. It is first seen in the bed of the Black Warrior river, near Tuscaloosa, and next appears on the surface of the ground to the north-east and east of the town. The magnificent deposit of coal known as the Warrior coal-field takes its name from the Warrior river, which, finding its source in the mountainous country bordering the coal measures of the State of Alabama on the north, runs directly through them, flowing into the Tombigbee river at Demopolis, Alabama, and thence onward into the Alabama river and the Gulf of Mexico at Mobile. "For convenience it has been divided into the Plateau or Table Land region, and the Warrior Basin, the plateaus sinking into the basin proper. In the first two basins, which may be designated respectively the Birmingham Basin and the Jasper Basin, there are not less, according to Professor Eugene A. Smith, State Geologist of Alabama, than 2600ft. of coal measures, including between thirty and thirty-five seams of coal, five of which have been extensively mined."

Mr. W. A. Gould, an intelligent miner who has been prospecting in this coalfield for twenty-seven years, and whose knowledge of it is extensive and accurate—he having opened many of the coal mines which are now in successful operation—asserts that he has exposed forty-two different seams of coal in the Warrior coalfield, and he knows the coal measures there to be over four thousand feet in depth. This is a remarkable statement, and shows an extraordinary development of the coal measures of Alabama as compared with others of the United States. In Pennsylvania, according to Professor Rogers, the thickness of the coal measures is 2089ft. In Ohio, according to Professor Newberry, there are 1455ft.; while Professor Worthen, State Geologist of Illinois, makes their thickness for that State about 600ft. The Missouri Basin is but little thicker. So, taking the lowest estimate—that of Professor Smith—it appears that the coal measures of the Warrior Basin have a greater thickness than those of any other field in the United States by over 500ft., and, according to Mr. Gould, of 1500ft. In 1846 Sir Charles Lyell visited Alabama, and made analyses of the coal of the Warrior Basin field, of which he said:—"The most western of the two coalfields has been found by Professor Brunsby to be no less than 90 miles long from north-east to south-west, with a breadth of from 10 to 30 miles, extending through the counties of Tuscaloosa, Walker, Jefferson, and Blount, on both sides of the Warrior river and its branches. The most eastern coalfield, or that of the Cahawba, is nearly of equal length and width." Alabama was also visited in 1875 by Mr. I. Lowthian Bell, whose opinion on the iron industries of the district will be referred to later on.

In examining the prospects of Alabama as a coal and iron country, a map showing the courses of the navigable rivers is necessary to a proper appreciation of the subject, and in that given for this purpose on page 444, only what is explanatory of the points in question is shown. The Alleghany mountain range, from whose slopes is extracted the mineral wealth of the States east of the Mississippi runs from north-east to south-west, and, to use a phrase often quoted in the new Birmingham of the South, it would seem as if nature, bountiful as she has been in distributing her minerals all along this range, has, when she passed south of the Ohio River, appeared weary of further distribution, and has emptied with lavish hand all her remaining store into the favoured State of Alabama. There, indeed, it needs no searching, it has long been displayed, and only calls for willing hands to get it. The leading features of the case will be most readily understood by describing the respective advantages of Birmingham, Tuscaloosa, and Sheffield, and to this the following remarks will be mainly directed.

Birmingham is situated near the southern limit of the coalfields, and was carefully selected as the best centre in regard to coal, iron, and transport for a new city. Three great railroads meet here; the Louisville and Nashville coming south from Louisville, the capital of Kentucky, where it joins the lines from Cincinnati, Pittsburgh in the east and Chicago and St. Louis in the north and west, and going south from Birmingham *viâ* Montgomery to the ports of Mobile and New Orleans. Then the Alabama Great Southern forming part of the so-called Queen and Crescent route from Cincinnatti to New Orleans, which passes through Birmingham and the heart of the coal and iron country, and thence south to the important railway centre of Meridian in the State of Missisippi. As a third system of railways, the Georgia Pacific line, which crosses the above lines at Birmingham, connects northwards with the Richmond and Danesville system to Washington and Baltimore, and south-west to Atlanta and the railways of Georgia; running also south-west of Birmingham to Meridian, and thence direct south to New Orleans. But valuable as are these railways to the exploitation of the new districts, water carriage is in the case of minerals of even greater importance, and an Englishman naturally examines with interest the possible outlets to the sea, especially when he hears on every side that the export coal trade of Great Britain to North and South America is soon to be superseded by that from Alabama.

The iron manufactured at Birmingham is taken from the Red Mountain mines in the vicinity of the town and operated by the Sloss, the Mary Pratt, the Hillman, and the Eureka companies. The following particulars are taken partly from a physical survey of the district by Professors J. L. Campbell and W. H. Ruffner, of Lexington, Virginia, and has been confirmed by personal investigations at the mines themelves:—The Silurian valley in which Birmingham is situated, and the Red Mountain ridges which border it in on both sides, constitute one of the great ore-fields of Alabama, and embrace two of the geological formations noted for the quantity and quality of the ores they yield. The Red Mountain is a striking feature in the topography as well as in the geology of this region. As a conspicuous ridge, rising several hundred feet above the adjacent country, it passes within about a mile of Birmingham, and forms the south-east boundary of the valley in which the city is situated. The Georgia Pacific Railway passes through Red Mountain at Red Gap, six miles north-east of Birmingham, where the ore-bearing rocks and fragments of ore are freely exposed. If they should prove to be productive at this point, mining and transportation will both be inexpensive. The quantity and quality of the ores along the Birmingham valley have been fully

* The series of papers of which this is the first, has been written by our special correspondent at the recent New Orleans Exhibition. They refer to facts very little known in this country, and we commend them to the special attention of those interested in the iron trade of this country.—ED. E.

demonstrated by their extensive and satisfactory use in a number of furnaces. Near Greenpond Station, on the Alabama Great Southern Railway, about twenty-five miles south-west of Birmingham, limonite ores have been mined on a large scale for use in the Oxmoor furnace, where they are employed in the admixture with fossil ores from Red Mountain. The Brown ores from the Alice furnace are obtained from the same region. Ores of the same class are mined for the Sloss furnaces in the valley about eight miles south-east of Birmingham. The Woodward Coal and Iron Company own a mine in the same neighbourhood, from which they supply their large furnace at Wheeling, between Birmingham and Jonesborough.

The red ores have been extensively mined about two miles north-west of Oxmoor furnace. The mines are on the crest and south-eastern slope of Red Mountain, in a half-ton of the limonite. This combination yields one ton of superior pig iron.

The following analysis of the two varieties of ore from the Sloss mine, furnished by Colonel Sloss, will serve to illustrate the composition of the Red Mountain ores generally, and may be regarded as representing two types of ore found at different points along the Clinton formation; the one abounding in carbonate of lime, the other containing very little or none.

Percentage composition.	No. 1.	No. 2.
Ferric oxide	74·98	58·30
(Corresponding to metallic iron	52·48	40·81
Carbonate of lime	0·00	22·42)
Silica (chiefly as sand)	14·56	9·04
Phosphoric acid (P_2O_5)	1·05	0·57
Equivalent in phosphorus	0·45	0·24

The red ore used at the Alice furnace is mined in the same ridge as those above mentioned and about nine miles

The light shading shows the Allegheny mountain mineral range. The dark shading indicates the Warrior coal field.

MAP SHOWING THE POSITICN OF THE MINERAL DISTRICTS OF ALABAMA.

remarkably well-defined bed 7½ft. thick between strata of hard ferruginous sandstones, which, with the ore bed, make an aggregate thickness of 30ft. The ore is sufficiently free from clay to be used without washing. It is carried down to the furnace by rail, and there mixed with one-third of its own weight of brown ore for use in the furnace. This combination yields 1 ton of pig iron to 2 tons of the ore, and requires for its reduction 1 ton of limestone with 1½ tons of coke.

For the Sloss furnace the red ore is obtained from a mine a few miles farther towards the south-west. From the outcrop near the crest of the ridge, the bed is worked downward on its south-eastern dip, and has a thickness of 14ft. of good ore. It is also approached by a tunnel on the north-western flank of the ridge, 250ft. below the outcrop. The ore brought out by the tunnel is remarkable for its large percentage of carbonate of lime. Both varieties—No. 1 from the outcrop and No. 2 from the tunnel—are employed at the same time, mixed with the limonite of the Quebec period—American nomenclature—in the proportion of one ton each of Nos. 1 and 2 and a south-west of Birmingham, near the Alabama Great Southern Railroad. It is worked in the furnace mixed with half its weight of limonite ore, the mixture yielding 52·81 per cent. of pig iron.

The analysis of the red ore of the Alice furnace mine, furnished by Captain Hillman, superintendent, is highly favourable—though unsuitable, because of the phosphorus for steel-making—showing 56·64 of metallic iron and 0·29 of phosphoric acid. The Red Mountain, too, still flanking the valley on both sides for a long distance in the same direction, carries with it out-croppings of its characteristic red fossil ores that point to extensive beds beneath. The increasing demand for these ores will soon give rise to new mining enterprises that will bring them into market as a source of wealth to the communities in which they are located and of traffic to the railroads. Black-band ore and clay ironstone have been found at several points in the coal regions, and some samples from the Warrior field have been tested in the furnaces and found to work well in admixture with more silicious ores. These are the leading ores in England, and have been very successfully worked in Pennsylvania and in West Virginia, so that their real value has been fully demonstrated. There is good reason, therefore, for making more thorough search for them in all of the Alabama coalfields.

The various mines, as above referred to, which supply the furnaces in the Birmingham district are being developed with considerable care and skill. The principal workings are entered by roads sloping into the mine from the sides of the hills, but there are also vertical shafts. The ore crops out to the surface, the best qualities being found at moderate depths, and the cost of getting is very low. At each of the mines there are complete settlements of well-built wood-framed houses, many of them with small garden plots attached. There is a large proportion of negroes employed, but these coloured men, as they are always euphonistically called, seem to be on friendly terms with their white brethren. The race supremacy of the latter is, however, well marked, and it is found that the negroes work best when stimulated by the example and leadership of the whites. There are large store houses of food and clothing, but there is no Truck Act in Alabama or in the United States generally, as in England, and much of the nominal wages of the miners is paid to them in kind, with considerable profit to their employers, who reduce greatly thereby the amount of ready money necessary for the weekly or monthly pay-day. Co-operative stores and trading, by which workmen find so much benefit in England, are not yet much developed here, and it will be some time before they are educated up to these economies. The transport of the ore is well managed, the small tip wagons from the mine emptying into the railway trucks arranged in sidings at the various exits from the mine. The railways are laid with steel rails well ballasted, and in these respects show well in comparison with the main lines with which they join in the town, the reason being that the mineral lines are private property, while the main lines are, like too many in the Southern States, impoverished by a long career of watered stock and other forms of plundering for which the Wall-street financiers in New York have shown such skill.

In regard to the coal supply, it will be sufficient to describe that obtained from the Pratt seam. This seam is most convenient to Birmingham and to the present lines of transportation, and is largely used for iron smelting and miscellaneous purposes. The daily output from the mines on this seam ranges from 1500 to 3000 tons, according to the demand. This may be deemed a considerable output when it is remembered that it is only four or five years since the seam was first tapped for systematic mining. The only mining so far has been done by the Pratt Coal and Coke Company, whose daily product is about five-sixths of the whole; and by the Milner Coal and Railroad Company, the latter property having been lately taken over by the Richmond and Danville Extension Company.

The Pratt Company's mines are on the east outcrop of the seam which runs nearly parallel to Sand Mountain, from one to two miles in its rear, and about five miles west of Birmingham. This company mines from one vertical shaft, two inclines or slopes from which go down the seam at a dip of perhaps 20 deg. for a few hundred feet, and then after a short level, at the rate of 6 deg., which is the usual dip of the seam on this side of the basin. A drift has also been opened in a hollow and enters on the flank of the seam, thus giving a main entry nearly on a level. The mining appliances are of the most modern description and on the largest scale, and the practical mining is, in every particular, done in the best manner. There has been no trouble from water, bad air, or bad roof. The screenings are coked at the mines. The company owns its railroad and rolling stock, by means of which it delivers coal and coke to the Birmingham furnaces and mills, and to the two railroads passing through that city. The cost of mining is stated at 85c—3s. 6d.—per ton, delivered in cars at the mouth of the mine.

The mining operations here present many points of interest to an English visitor. The mines are situated in a primæval forest whose lofty trees and undergrowth have been cleared away only where necessary for the buildings, railways, and coal depôts. The buildings are almost entirely of wood, there being houses, stores, and workshops as at the Red Mountain iron mines previously alluded to. Each workman can have as much land as he chooses to clear and cultivate, but there does not seem to be much advantage taken of this. The winding engines and other pit equipment appear to be well arranged, and one is not surprised to find that the best of the miners and mechanics employed are emigrants from South Wales and Newcastle, and these men, as trade developes, are likely to do well. Coloured men are employed in considerable numbers, but the strangest sight of all are the negro convicts. Each State being free to make its own laws in this respect, Alabama not only chooses to employ its worst convicts in the mines, but lets out their labour to contractors. There are about 500 convicts so employed here, most of whom are negroes, the white men, about fifty in number, being sent here as an extra punishment. This system of contract labour is open to abuse, and complaints are not wanting of unfair treatment. The barred gates in the galleries of the mine and the armed guards suggest to the visitor the Siberian mines of Russia.

The Milner Company's mine is an opening on Five Mile Creek, eight miles from Birmingham, where this bold creek has cut across the basin at a level below the horizon of the Pratt seam. The company selected for their operations the lowest line of the synclinal depression, where the outcrops created by the excavations of the creek are scarcely above high water. Numerous openings have been made, and in March this year three entries were being driven on the north side of the creek, and one on the south. A few weeks after commencing operations the daily product reached 300 tons, and was soon increased. The appliances for mining are on the same plan as those of the Pratt Company, but are as yet incomplete. The company owns a railroad, ten miles long, to Birmingham.

The Pratt seam, taking the whole field, averages about 4ft. in thickness, the extremes being about 3ft. and 5ft.

THE NORTH OF ENGLAND.

(From our own Correspondent.)

THE outlook of the Cleveland pig iron trade is gloomier than ever. At the market held at Middlesbrough on Tuesday last, merchants were offering No. 3 g.m.b. at 32s. 6d. per ton for prompt delivery, which is 3d. per ton less than they were willing to accept a week ago. Nevertheless buyers hold back from purchasing even at that figure, and scarcely any sales have recently been made for immediate delivery. Certain consumers show a disposition to buy forward as far as to the end of the year, and to such merchants are selling at 33s. per ton. Makers are not, as a rule, in urgent need of orders, and therefore maintain their prices. For No. 3 g.m.b. they still quote 33s. 6d. to 34s. per ton. Forge iron is not quite so scarce as it was. Merchants ask the same as for No. 3, viz., 32s. 6d. per ton. Makers ask 3d. to 6d. per ton more.

Finished ironworks are fairly well employed, but fresh orders are not so numerous as they were, and prices are easier than before the holidays. Ship plates are £4 17s. 6d. to £5 2s. 6d. per ton on trucks at makers' works. Angles are £4 12s. 6d. to £4 15s., and common bars, £4 15s. to £5., payment cash 10th, and less 2½ per cent. discount. In the steel trade also a quieter feeling prevails, and prices are slightly weaker. Steel plates are now offered at £7 2s. 6d. per ton at works and angles at £6 15s.

There has been no change in the stock of pig iron in Messrs. Connal and Co.'s Middlesbrough store for some time. The quantity now held is 50,242 tons, being a reduction during May of 580 tons. At Glasgow their stock is 597,673 tons, being an increase of 2676 tons in the same month.

One of the most unpleasant features as regards the Cleveland pig iron trade is the diminution recently of exports to foreign ports. The shipments coastwise are up to the average, but during May only half the usual quantity was sent abroad. The chief export items were as follows:—To Scotland, 25,872 tons; to Germany, 11,755 tons; to Wales, 4851 tons; to Holland, 5715 tons; and to Norway and Sweden, 3511 tons. During the first five months of the year 330,920 tons of pig iron were shipped from the Tees, being about 53,000 tons less than in the corresponding period of 1884.

Current orders for new vessels are being quickly worked off at the Tees shipyards, and in some workmen are paid off weekly, as fresh orders are not forthcoming. Messrs. Raylton Dixon and Co. launched a vessel on Monday last, and have now only one ship and four fishing smacks in hand. They have in their employment only 200 hands, as against 1000 a month ago. Three years ago 2300 men were employed at this yard.

Will the great strike, or lock-out, or whatever may be the proper name for what has just occurred in America, affect the trade of the North of England? That is the question which is at present in the mouths of all manufacturers and merchants, and which no one seems able to answer. Certain it is that for long not much beyond Scotch pig iron has been permitted to enter the United States from the North of England. Yet, notwithstanding prohibitive duties, American trade appears to be as little prosperous as is that of their Transatlantic competitors. If the strike were to last several months, it is just possible that prices would rise so high as to enable British iron to flow westward once again. But this is scarcely likely. The differences between employers and employed will surely be adjusted before it comes to that. And meanwhile American consumers of iron, being forced to wait for many things till the conclusion of the strike, will probably elect to postpone constructive enterprises altogether and wait for all. Should the employers prevail and establish the much lower rates of wages they seek, it will give them an enormous advantage in cheapening production. English ironmasters will be compelled in self-defence to follow suit, and once again lower wages all round.

The trade between the North of England and St. Petersburg is suffering serious disadvantage from the new regulations compelling vessels to use the canal just completed instead of the port of Cronstadt. The approach is so narrow that it is only with difficulty that two vessels can pass in it. There are only about twenty-five loading berths, if room be allowed for lighters. There are no facilities for mooring; and if anchors are let go, the water being shallow, there is great risk that the projecting flukes will find their way through the bottom of a neighbouring vessel. No houses or barracks for labourers having been built, the latter have to come by train from St. Petersburg or Cronstadt, which causes the loss of an hour or two daily in loading and unloading. In consequence of these and other defective arrangements, shipowners must now reckon on double cost and nearly double detention as compared with what they have been accustomed to at Cronstadt. There is also considerable risk of grounding for want of water. A week or two since the Emperor's yacht, drawing only 17ft., stuck on the bottom and blocked the whole canal. No less than thirty tugs were pulling at her, and although they finally succeeded in getting her off, it was only with the loss of her rudder. In time many of these troubles will no doubt be removed, but meanwhile shipowners would do well to avoid the port altogether.

NOTES FROM SCOTLAND.

(From our own Correspondent.)

THE iron market was much depressed at the end of last week, in consequence of some holders having determined to get rid of their warrants. When the market opened on Monday, warrants were quoted at 41s. 4d. cash, but there was more animation, and a slight improvement on some following days. The week's shipments of pigs were reported at 11,413 tons as compared with 9130 in the preceding week, and 12,107 in the corresponding week of 1884. A large shipment was made to Italy, and a fair amount to Germany, but the quantities sent elsewhere were comparatively small. In the course of the week a furnace has gone out of blast at Eglinton, but as an additional one was lighted at Glengarnock, the total number in operation remains at ninety-two, against ninety-five twelve months ago. The week's addition to the stock of Scotch pigs in Messrs. Connal and Co.'s Glasgow stores is about 900 tons.

Business was done in the warrant market on Friday at 41s. 5d. cash, and on Monday the quotations were 41s. 4d. to 41s. 5½d., a further improvement taking place on Tuesday to 41s. 6½d. On Wednesday the market declined from 41s. 6d. to 41s. 3½d. cash. To-day—Thursday—there was an improvement to 41s. 5d. cash.

The current values of makers' iron are:—Gartsherrie, f.o.b. at Glasgow, per ton, No. 1, 49s. 6d.; No. 3, 45s. 6d.; Coltness and Langloan, each 50s. 6d. and 49s. 6d.; Summerlee, 49s. 6d. and 45s. 6d.; Calder, 52s. and 45s. 6d.; Carnbroe, 47s. 6d. and 45s. 6d.; Clyde, 46s. 6d. and 42s. 6d.; Monkland, 42s. and 40s.; Quarter, 41s. 6d. and 39s. 6d.; Govan, at Broomielaw, 42s. and 40s.; Shotts, at Leith, 50s. and 49s. 6d.; Carron, at Grangemouth, 52s. 6d. and 47s.; Kinneil, at Bo'ness, 43s. 6d. and 42s. 6d.; Glengarnock, at Ardrossan, 47s. 6d. and 46s. 6d.; Eglinton, 42s. 3d. and 39s.; Dalmellington, 44s. 9d. and 41s. 6d.

The past week's shipments of iron and steel manufactures from Glasgow included five locomotives for Bombay, valued at £12,500; machinery worth £3500; sewing machines, £1000; steel goods, £7500; and general iron manufactures, £20,100.

For rough coals the inquiry is not at all good. The fine weather is reducing the inquiry for household sorts of all descriptions. Fine steam coals are in steady demand at firm rates, upon which, however, no improvement can be quoted. The week's shipment of coals embraced, besides some other quantities of less importance, 19,099 tons at Glasgow General Terminus, and 8909 at the Queen's Docks, 1493 at Greenock, 1784 at Irvine, 7672 at Troon, 7675 at Ayr, and 15,141 at Grangemouth. During the past month the shipments at Burntisland have been the largest on record, amounting to 77,374 tons, as compared with 62,336 in the corresponding month of last year. The prices in Fife have remained without alteration in May, ranging from 6s. 3d. to 6s. 9d. f.o.b. at Burntisland, 9d. more at Tayport, and 3d. less at Charleston. All the collieries are now working full time, there being a very good continental trade, and especially with the Russian ports. The large stocks at the collieries, which accumulated while trade was dull, are now being much reduced.

The miners in Fife are agitating, in common with those of the west-country, for an advance of wages. The amount of business being done is certainly an apparent justification of the demand, but the great difficulty with the employers is that they have not been able to raise the prices of coals. Great efforts at organisation are being made by the leaders of the men in the different mining districts, but they will not likely have much effect so long as coals are so plentiful as at present.

The Mining Institute of Scotland held a meeting a few evenings ago in Glasgow, when Mr. J. S. Dixon, the president, intimated that an appeal made to the Scotch coal and ironmasters for a guarantee fund for a proposed exhibition of mining machinery and appliances had met with a gratifying measure of success.

In the course of the past month twenty-three vessels with an aggregate tonnage of 18,927 were launched from the Clyde shipyards, as compared with twenty-eight vessels and 28,570 tons in May, 1884. The new tonnage placed in the water during the first five months of the year has been 78,440 tons, against 116,070 in the same period of last year, and 149,969 up till the end of May, 1883. The proportion of sailing vessels being built to steamers has been largely on the increase, and the average size of the new ships is very much less than it was a year ago. The tonnage presently in hand is not much over half what it was at the beginning of June last year. There are, however, a few inquiries being made for additional tonnage for abroad, and it is hoped that some of it may come to the Clyde.

WALES & ADJOINING COUNTIES.

(From our own Correspondent.)

THE coal trade is in a satisfactory condition, and if the Whitsuntide holidays had not interfered with output and despatch, I should have been able to record even a more favourable condition, and a total output little inferior to the high one of a fortnight ago.

As it is, Cardiff last week sent away 130,000 tons, though many offices were closed up to Wednesday; Swansea, 37,834 tons, and Newport, Mon., 36,432 tons. The clearances of patent fuel from the district were quite up to the average, Cardiff alone sending away 2500 tons.

Prices are well maintained for all classes of coal, small steam, perhaps, being a little easier than it has been, and coalowners are not quite so fixed to the 5s. per ton quotation which has existed so long. This is due to the largely increased output of coal, and in consequence more small is thrown on the market.

I noted last week the enormous coal trains at the Roath sidings and their rapid clearance. In striking comparison with this is a case at Wrexham where a coal train from the Frwd remained so long on the siding that a starling built a nest in the coal, and this with its young freight was discovered when the train eventually reached Liverpool. Wheels scarcely cool with us from pit to docks, and the prospect of a still busier trade, in steam coals at least, is assured.

In the imports of pig iron Swansea shows well, nearly 5000 tons having come to hand last week. Swansea trade generally is good, and if the Harbour Trust continue its energetic action this port will show even a more prosperous figure than it has done. Critics who are well conversant with their business say that the chief thing now wanted is a good backwater for the Prince of Wales Dock.

A portion of the Rhondda and Swansea Bay Railway, from Port Talbot to Pontrhydyfen, has just been inspected by Colonel Rich, and as soon as the certificate is issued this port will be opened for goods and passengers. The rolling stock is ready, and will well compare with the best in the district. The passenger carriages are built by Brown, Marshall, and Co., of Birmingham; locomotive engines by Beyer, Peacock, and Co., Manchester; and the goods wagons and trucks by the Swansea Wagon Company. I am glad to hear that the land is now secured for the long tunnel which will connect this line with the Rhondda. The tunnel under the Neath river may possibly be delayed a while.

I note that the well-known steam coal collieries, Tyla Coch and Nantderris, with plant, will go to the hammer in a few days; also the plant of the Rhondda Mountain Colliery. I shall expect good bidding for the Tyla Coch, as it is so well situated on the Taff, and is only twenty miles from Cardiff. The Aberghorki vein is in good repute for locomotives.

The iron world is still rather quiet. A moderate business is being done with Canada and India. About 6000 tons of rails were shipped last week, the principal destinations being Canada and Africa. The leading works, Cyfarthfa, Dowlais, Rhymney, Tredegar, Ebbw Vale, and Blaenavon are doing better of late, and in the Swansea district the iron trade is regarded as sound and promising. Steel rails are now quoted as low as they can be made with any regard to worth, and generally the Welsh steel rail, plate, and bar can hold their own either in price or quality.

Some failures are prognosticated in the tinplate trade, and one or two small works are closing if not actually closed.

Pontnewydd and Avondale are closed temporarily—only, I hope—and 350 hands are idle.

Makers have been lessening make of late, and the result has given more firmness to prices. It is thought that any change the next few weeks will be for the better. Wasters, which are well sought after, are much firmer, and high-class plates are quoted at better figures. 1300 tons of plates went to Baltimore last week, and a small cargo for Bilbao. The men of Rhiwderin are now out, and the Monmouthshire workmen have agreed to pay 1s. per man and 6d. per boy during the strike.

The demand upon the Dowlais Iron Company for coal has been so great of late that strenuous efforts have been necessitated to increase output. Mr. H. Martin has been equal to the occasion, and I am glad to hear that Bedlinog is now doing its work. The up-cast is also utilised, and the four-feet seam at length turns out well.

The future of the Bute Docks is just now on the carpet. I shall note it fully in a short time.

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.

26th May, 1885.

6377. GUARDS for WINDING MACHINES, W. J. Gamble, Belfast.
6378. WATER-CLOSETS, H. W. Buchan, Edinburgh.
6379. SHEDDING MOTIONS, &c., for LOOMS, C. Catlow, Halifax.
6380. STEAM GENERATOR and BRICK ARCH SUBSTITUTE, A. Johnstone, Edinburgh
6381. CONTROLLING the FLOW of LIQUIDS in REFRIGERATING MACHINES, F. N. Mackay, Liverpool.
6382. CUTTING or SLICING BREAD, &c., J. Twyerould, Manchester.
6383. MACHINES for CUTTING GRASS, &c., G. Tankard, Halifax.
6384. INTERNALLY STOPPERED BOTTLES, D. Rylands, near Barnsley.
6385. ADMIXING FERRO-MANGANESE with STEEL, &c., J. Riley, Glasgow.
6386. LIGHTING, &c., GAS LAMPS AUTOMATICALLY, J. J. Butcher and J. H. Wüster, Newcastle-on-Tyne.
6387. STEAM BOILERS, I. Pimblott, Liverpool.
6388. MEASURING GRAIN, F. Frazier and A. Arnault, Paris.
6389. ROSE TURNING and SHAPING, G. W. Budd, London.
6390. SIZING, &c., WARPS, W. G. Bywater and T. B. Beanland, Leeds.
6391. SCORING at LAWN TENNIS, &c., H. J. H. Thomas, London.
6392. DYNAMO-ELECTRIC MACHINES, G. C. Fricker, Putney.
6393. WEAVING LOOMS, R. Blake, Glasgow.
6394. PNEUMATIC DRYING MACHINES, J. Dick, Glasgow.
6395. FOLDING WIRE MATTRESSES, H. J. Allison.—(*C. H. Hard, U.S.*)
6396. SUPPLYING BOILERS with WATER, H. J. Allison.—(*W. H. Rushforth, U.S.*)
6397. CASH and PARCEL TRANSMISSION APPARATUS for SHOPS, H. J. Allison.—(*I. A. Watson, G. W. Fifield, J. W. Currier, J. P. Cook, C. Hazeltine, and W. H. Gilman, U.S.*)
6398. CONSECUTIVE NUMBERING MACHINE, H. J. Allison.—(*J. H. Reinhardt and G. Schmalzried, U.S.*)
6399. SHAFT LEVEL and ALIGNERS, H. J. Allison.—(*C. Espenschied, U.S.*)
6400. VELOCIPEDES, H. J. Allison.—(*H. C. Willis and N. W. Stearns, U.S.*)
6401. BUTTON-HOLE ATTACHMENTS for SEWING MACHINES, J. K. Harris, London.
6402. VALVE MECHANISM for DUPLEX STEAM PUMPS, J. R. Maxwell, London.
6403. BOTTLE STOPPERS, C. B. Peacock and C. Hamilton, London.
6404. OBTAINING SULPHUR from FURNACE GASES, E. Hänisch and M. Schroeder, London.
6405. OBTAINING LIQUID ANHYDROUS SULPHUROUS ACID from FURNACE GASES, E. Hänisch and M. Schroeder, London.
6406. MOTORS for TRAM-CARS, &c., T. Charlton and J. Wright, London.
6407. PORTABLE HEATING APPARATUS, &c., T. Sutton, London.
6408. STEAM ENGINE GOVERNORS, &c., M. R. Moore, London.
6409. DRIVING GEAR, J. Snelling, London.
6410. CANDLESTICKS, W. H. Bulpitt, Birmingham.
6411. LOCKING NUTS on SCREW BOLTS, G. B. Smith, Birmingham.
6412. WEATHER GUARDS for DOORS, &c., H. Whiteley, Halifax.
6413. FEED PUMPS for STEAM BOILERS, A. F. Link.—(*G. Mennesson, France.*)
6414. POROUS BODIES for FILTERING, &c., A. Breuer, London.
6415. ORNAMENTING WARP MACHINE MADE LACE with FROSTED TINSEL THREADS, A. L. Caporn and H. Smithurst, London.
6416. DREDGING APPARATUS, A. B. Bowers, London.
6417. MACHINES for OPERATING SCREW-THREADED TAPS, A. W. L. Reddle.—(*C. H. De Lamater and Co., U.S.*)
6418. RING-SPINNING MACHINERY, P., R., and J. Eadie, Manchester.
6419. SUPERHEATERS, K. R. Smith, London.
6420. SHUTTLE-BOX OPERATING MECHANISM for LOOMS, J. Brownlee, Glasgow.
6421. EXTINCTEURS, J. Small, Glasgow.
6422. COMPOUND ENGINES, W. Y. Fleming and P. Ferguson, Glasgow.
6423. MACHINES for CLEANING SHIPS' BOTTOMS, H. Arentz, London.
6424. WIND and WEATHER INDICATORS, E. H. Harling, London.
6425. RENDERING INCORRUPTIBLE any ORGANIC, &c., SUBSTANCES, C. L. Bachelerie, London.
6426. BIB and BALL COCKS, E. Knight, London.
6427. CASH REGISTERS, H. J. Haddan.—(*C. H. Maltby, United States.*)
6428. CASH REGISTERS, H. J. Haddan.—(*J. Ritty, United States.*)
6429. IRON SPONGE, &c., W. R. Lake.—(*C. J. Eames, United States.*)
6430. IRON SPONGE, &c., W. R. Lake.—(*C. J. Eames, United States.*)
6431. IRON SPONGE, &c., W. R. Lake.—(*C. J. Eames, United States.*)
6432. SUGAR, W. R. Lake.—(*F. O. Matthiessen, United States.*)
6433. CUTTING OUT the SOLES of BOOTS, &c., W. R. Lake.—(*J. J. Breach, United States.*)
6434. GOVERNING STEAM, &c., ENGINES, R. Rackham, London.
6435. STEAM STEERING, &c., GEAR, A. J. Maginnis London.
6436. WATER LAID ROPES, &c., H. W. Hall, London.
6437. PENWIPERS, R. C. Annand, London.
6438. HYDRAULIC PRESSES, S. Pitt.—(*D. C. Mayo, Canada.*)
6439. METAL RIB, J. Ellis, London.
6440. HANGER for GARMENTS, A. R. Smith, London.

27th May, 1885.

6441. PAVING of STREETS, C. F. Foster, London.
6442. GAS MOTOR ENGINES, J. P. Lea, Hockley.
6443. TEA and COFFEE POTS, M. Boyd, London.
6444. ROLLING MILLS, I. Hayward, Birmingham.
6445. APPLYING ELECTRIC CURRENTS to RIDERS of VELOCIPEDES, S. Moody, Birmingham.
6446. PUMPS, J. Grantham, Blyth.
6447. EDUCATIONAL APPLIANCES, J. F. Wilson, Liscard.
6448. GAS ENGINES, J. E. Rogers, Smethwick.
6449. ROTARY ENGINES, &c., J. and D. Paterson, Edinburgh.
6450. EXTINGUISHING LAMPS, &c., J. Rayner, New Sharlston.
6451. SPRINGS, E. de Pass.—(*La Société anonyme d'Etudes Mecaniques, France.*)
6452. TYPE WRITER, F. N. Cookson, London.
6453. TREATING and DRYING EXCRETA, W. Grimshaw, London.
6454. TRICYCLE, G. J. Hills, London.
6455. STEAM ENGINES, A. S. Hamand, London.
6456. LAWN TENNIS and such-like RACKETS, A. Foster, London.
6457. HYDRAULIC ENGINES, J. F. Blennerhasset, London.
6458. BURETTE for REGULATING, &c., the FLOW of LIQUIDS, L. A. Groth.—(*J. Wallensteiner, Germany.*)
6459. PURIFYING WATER, &c., F. R. Conder, London.
6460. ORCHID CHARCOAL, W. Griffith, East Dulwich.
6461. BAILS used in the GAME of CRICKET, E. Altman, London.
6462. FEEDING STEAM ENGINES, F. Carré, London.
6463. MOULDS, J. G. Sowerby, London.
6464. RAILWAY CHAIRS and SLEEPERS, W. J. Chant, London.
6465. VENTILATING APPARATUS, G. H. Haywood and G. Williams, London.
6466. FURNACES, H. J. Haddan.—(*J. W. Brightman, United States.*)
6467. SHIRT, H. J. Haddan.—(*W. M. Spence, U.S.*)
6468. FASTENINGS or LIDS for PURSES, &c., F. Stein, London.
6469. LOOMS, J. Roberts, London.
6470. HOLDING ELECTRIC INCANDESCENT LAMPS, O. March, London.
6471. DYEING COTTON in HANKS, A. M. Clark.—(*J. F. E. Berrubé, France.*)
6472. SLEEVE PROTECTORS, R. G. Turner, Massachusetts, U.S.
6473. GENERATING MOTIVE POWER, H. H. Lake.—(*E. Friedrich, Austria.*)
6474. STUFFING-BOXES, &c., G. W. Manuel and R. Marshall, London.
6475. CAPS for ASH, DUST, &c., SHOOTS, J. Attridge, London.

28th May, 1885.

6476. REGISTERING NUMBER of PASSENGERS, P. Ogden, Manchester.
6477. INFANTS' FEEDING BOTTLES, H. A. Costerton, Brighton
6478. GAS-BURNERS for HEATING, &c., J. Wainwright, Manchester.
6479. CARDING FIBRES, G. Goldthorp, Halifax.
6480. VALVE MOTION, A. Taylor, London.
6481. HAMMERLESS, &c., GUNS, E. C. Green, Cheltenham.
6482. SUBSTITUTES for PASTE WAFERS, E. Mansfield, Manchester.
6483. DRIVING BELTS, M. Booth, Hyde.
6484. CUTTING, &c., HOLES in LEATHER, &c., C. H. and F. J. Dale, Leicester.
6485. RAISING, &c., TELEGRAPH CABLES, A. Jamieson, Glasgow.
6486. ROLLS for ROLLING COLLIERY RAILROAD, &c., RAILS or BARS, F. J. P. Cheesbrough.—(*H. Diekmann, Germany.*)
6487. TELEPHONES, W. P. Thompson.—(*K. S. Dembinski, Belgium.*)—*14th March*, 1885.
6488. INDUCTION COILS, W. P. Thompson.—(*K. S. Dembinski, Belgium.*)—*14th March*, 1885.
6489. SPRING for VELOCIPEDES, A. Peddie, London.
6490. MEAT DISHES, E. Faram, Stoke-on-Trent.
6491. ELASTIC SPRING WHEEL and COUPLING-BOX, J. Greenhalgh, Hyde.
6492. PRESSURE GAUGES, &c., T. Thorp, Whitefield.
6493. DRYING MALT, &c., J. Milne, Glasgow.
6494. WHEELS for BICYCLES, TRICYCLES, &c., E. Nunan, London.
6495. EXTRACTING OIL, &c., from FISH, T. F. Veasey, London.
6496. RUDDERS for BOATS, J. S. Waite, Twickenham.
6497. CONVEYANCE, &c., of HEAT and COLD, W. Hutchinson, London.
6498. SURFACE CONDENSERS, W. and G. Lawrence, London.
6499. STEAM ENGINES, W. Schmidt, London.
6500. PETROLEUM STOVES, J. C. Mewburn.—(*J. A. Vagner, France.*)
6501. SCARF-HOLDER, J. H. Baseley, London.
6502. STUD for COLLARS, CUFFS, &c., A. G. de Tejada, London.
6503. SCRATCH BRUSHES for JEWELLERS, J. Masters, London.
6504. LINING for HATS, M. A. Ripperger.—(*—. Hulfols, U.S.*)
6505. WATER FILTERS, R. R. Kelly and A. C. L. Weigel, London.
6506. LINK MOTION, A. D. Bryce-Douglas, London.
6507. SAFETY DOOR BOLT, A. Fongeadoire, London.
6508. VARYING, &c., the ACTION of GAS GOVERNORS, W. E. Price, London.
6509. WATERPROOFING, &c., LINEN and other FABRICS, ROPES, HOSE, &c., H. H. Lake.—(*A. Sandron, Belgium.*)
6510. DECORATED GLASS, J. Y. Johnson.—(*W. Hirsch, Germany.*)
6511. INTERNAL STOPPERING of BOTTLES, G. J. Chambers, London.
6512. CARTRIDGE CASES, A. Parkes, London.

29th May, 1885.

6513. TORPEDO, A. P. Sharp, Dublin.
6514. BOOTS and SHOES, W. H. Stevens and J. Underwood, Leicester.
6515. PERAMBULATORS, C. W. Parker, Starcross.
6516. COMPRESSED FERRULES, S. Allcock, Redditch.
6517. EXPLOSIVE PROJECTILES, W. Kennish, Halifax.
6518. DRIVING the CYLINDERS of CARDING ENGINES, J. Sykes, Halifax.
6519. BURNING TAR, &c., for HEATING PURPOSES, J. Taylor and A. and C. Stewart, Glasgow.
6520. WHEEL BRAKE, J. Taylor and J. Brookwell, Wigan.
6521. LOCK BRICKS, T. Street, London.
6522. STEAM BOILERS, A. H. B. Sharpe, Gainsborough.
6523. DATING RAILWAY TICKETS, J. McEdward, Aberdeen.
6524. HYDRO-PNEUMATIC MOTORS, R. C. Sayer, Newport, Mon.
6525. EYELET for LABELS, &c., H. Ryland, Birmingham.
6526. TOBACCO POUCHES, H. J. Bovill, Chiswick, and J. A. Broder, London.
6527. BASTING MEAT, W. J. Fowler, Reading.
6528. WASHING MACHINES, S. A. Sismey, London.
6529. ELECTRIC TIMEPIECES, W. P. Thompson.—(*F. Baumann, Switzerland.*)—14*th April*, 1885.
6530. SPINNING TOBACCO, J. Garside and F. Evans, Liverpool.
6531. DISH and TUREEN COVERS, B. T. Norton, Chiswick.
6532. PULLEYS for TRANSMITTING POWER, B. C. Tilghman and G. Richards, London.
6533. SHAFT COUPLINGS, B. C. Tilghman, London.
6534. SELF-ACTING REPEATING MAGAZINE GUNS, B. Burton, London.
6535. DRAWING CORKS from WINE BOTTLES, W. Gardner, Tynemouth.
6536. BOTTLES and STOPPERS, W. Heatley and G. Hutchins, London.
6537. FLUID REGULATOR, W. A. Cumby and W. J. Sawyer, London.
6538. FASTENING for SOLITAIRES, &c., L. Schneider, London.
6539. TEA-ROLLING MACHINERY, J. C. Kinmond and J. Richardson, London.
6540. CARPET-CLEANING APPARATUS, J. P. and A. Diggles, London.
6541. MOTTLED YARNS for WORSTED COATINGS, &c., J. Dawson, London.
6542. CIGAR and ASH TRAY PAN, W. Buttery, London.
6543. ESCAPEMENT MOVEMENTS for CLOCKS, &c., E. P. Alexander.—(*Japy, Bros., and Co., France.*)
6544. FASTENERS for GLOVES, BOOTS, &c., H. G. Carew, London.
6545. PRODUCING NITRATE of AMMONIA, A. Favier, Paris.
6546. PENCIL-SHARPENING MACHINES, A. J. Boult.—(*W. H. Lamson, U.S.*)
6547. RAIL JOINTS, J. Kellow, London.
6548. BOX for CONSECUTIVELY NUMBERED TICKETS, J. M. Black, London.
6549. EMBROIDERING MACHINE, H. J. Haddan.—(*F. A. Gräf, Saxony.*)
6550. BEARINGS, L. Budini, London.
6551. CRIBS, J. Batley, London.
6552. SIGHT ELEVATORS for FIRE-ARMS, H. P. Miller, London.
6553. LOOMS, M. A. Furbush, C. H. Knowlton, and B. F. Meyer, London.
6554. TELEPHONIC CIRCUITS, S. P. Thompson, London.
6555. VOLTAIC BATTERIES, T. J. Jones, London.
6556. PENHOLDERS, E. C. Burrows, Brooklyn, U.S.
6557. SUSPENDING DEVICES, H. H. Lake.—(*C. T. Root, United States.*)
6558. BEDSTEADS and BEDDING, H. H. Lake.—(*G. Assimon, France.*)
6559. DRYING WASTE ANIMAL, FISH, or other MATTER, J. S. and J. Edwards, London.
6560. CUTTING SOAP, J. A. Cross, London.
6561. CARTRIDGE CASES, F. Bolton, London.
6562. DISSOCIATING NEUTRAL FATTY BODIES by HEAT, C. D. Abel.—(*L. Hugues, France.*)

30th May, 1885.

6563. PORTABLE NAVAL TELEGRAPHS, J. G. Lorrain, London.
6564. PAPER BOX MACHINERY, J. W. Gill, Birmingham.
6565. GAS MOTOR ENGINES, G. W. Weatherhogg, Swinderby.
6566. AUTOMATIC COUPLINGS, H. S. Stewart, Westminster.
6567. FASTENINGS for STAY-BUSKS, F. R. Baker, Birmingham.
6568. ROTARY BRUSHES, A. Macfarlane and D. Craig, Glasgow.
6569. WINDOW BLIND CORD, &c., W. H. St. Aubin, Bloxwich.
6570. GAS LAMPS, R. H. Best, Birmingham.
6571. CLAY BATS, W. E. Maddock, Wolstanton.
6572. SLIDING FIRE-GRATE for MARINE BOILERS, &c., H. Montgomerie, Hendon, Sunderland.
6573. STEAM BOILERS, T. Tomlinson, Sunderland.
6574. CABLES for SUPPRESSING TELEGRAPHIC INDUCTION, &c., R. Tamine, Liverpool.
6575. ATTACHING RAILS to METALLIC SLEEPERS, W. P. Thompson.—(*L. Delettrez, France.*)
6576. PRIME MOVERS, G. E. Montagnon, London.
6577. LOCKING and UNLOCKING COMBINATION, M. A. Dalton, London.
6578. NICOTINE CONSUMING PIPE, G. H. H. Fuller and E. G. Salt, Liverpool.
6579. DOUBLE LOCK TILES for WALLS, &c., J. D. Denny, Newbridge, Ruabon.
6580. HEAT HASTENERS or ROASTING SCREENS, J. Perry, London.
6581. STEAM EXCAVATORS, J. Billingham, London.
6582. DETECTING COUNTERFEIT COIN, A. Harris, London.
6583. TRIPOD STANDS for PHOTOGRAPHIC, &c., PURPOSES, J. W. Ramsden, Leeds.
6584. MECHANICALLY-ACTUATED PIANOS, F. E. P. Ehrlich, London.
6585. MECHANICAL MUSICAL INSTRUMENTS, F. E. P. Ehrlich, London.
6586. SPRING SCALES, E. Ubrig, London.
6587. SEPARATING LIQUIDS from SOLID MATTERS, W. Macnab, London.
6588. FLEXIBLE SHAFTS, H. Walley and T. Gare, Manchester.
6589. ROASTING COFFEE, &c., H. Faulder, London.
6590. SHAWLS, &c., J. T. Apperly, London.
6591. GUNS and EXPLOSIVE PROJECTILES, H. S. Maxim, London.
6592. ACTUATING SHUTTLE GUARDS, F. Waterhouse, London.
6593. TREATING FIBRES, YARNS, &c., C. D. Abel.—(*J. O. Obermaier, Germany.*)
6594. TREATING FIBRES for SPINNING, C. D. Abel.—(*J. O. Obermaier, Germany.*)
6595. CIGARS and CHEROOTS, A. G. Goodes, London.
6596. MAKING STEEL by the BESSEMER PROCESS, A. Davy, London.
6597. COUNTING the REVOLUTIONS of WHEELS, &c., F. J. Rooker, London.
6598. SIFTING CINDERS, J. H. Barry, London.
6599. REAPERS and SELF-BINDING MACHINES, G. E. Jeffery, London.
6600. PERMANENT WAY of RAILWAYS, F. Service, London.
6601. PIPE and other WRENCHES, H. H. Lake.—(*J. F. Guthrie, United States.*)
6602. SWEEPING BRUSHES, J. H. Simpson, London.
6603. EMBOSSING PAPER, &c., W. Napier, London.
6604. STOP-BAILS for MILK CANS, &c., W. Jordan, London.
6605. AUTOMATIC FEED APPARATUS for STEAM BOILERS, A. M. Clark.—(*S. Haigh, Canada.*)
6606. STRETCHERS of UMBRELLAS, &c., W. A. Bindley, W. J. Gell, and A. F. Boham, London.
6607. LOOMS, M. A. Furbush, C. H. Knowlton, and B. F. Meyer, London.

1st June, 1885.

6608. ELECTRICAL INDICATOR, E. W. Lancaster, East Dulwich.
6609. SHUTTLE TONGUES, J. Waddington and J. Wilkinson, Bradford.
6610. COMPOUND STEAM ENGINES, W. Brock, Glasgow.
6611. SLUICE VALVES, E. Hunt.—(*C. Giebeler, Prussia.*)
6612. BUNDLE CARRIERS for GRAIN BINDERS, W. P. Thompson.—(*C. H. M'Cormick, jun., U.S.*)
6613. WINDOW BLINDS, W. P. Thompson.—(*O. Sörlie, Norway.*)
6614. DISCHARGING PROJECTILES A. Dexter, London.
6615. PERPETUAL FERRULE, V. D. de Stains, London.
6616. SCARF PIN FASTENER, A. Harris, London.
6617. DEPOLARISING ELECTRIC BATTERIES, A. C. Henderson.—(*E. Bazin, France.*)
6618. TRICYCLES, A. Collingridge, London.
6619. PROPELLERS, R. J. Rae, London.
6620. FASTENINGS for WEARING APPAREL, J. P. Bayly, London.
6621. TOBACCO PIPES, E. de Pass.—(*G. F. Eich. II., Germany.*)
6622. SHIFTING GEAR for CARRIAGES, R. Pink, jun., Bishopstoke.
6623. BATHS, H. H. Statham, London.
6624. SAFETY LOCKS, B. J. B. Mills.—(*J. E. Patin and M. Le Marchand, France.*)
6625. FIRE-BOXES, R. A. Hardcastle, London.
6626. SWEET COMPOUND, J. Y. Johnson.—(*C. Fahlberg, United States, and A. List, Germany.*)
6627. UTILISING WASTE HEAT, R. Wyllie, London.
6628. BAR for CORSETS, R. C. Gardner.—(*A. Rammoser, Germany.*)
6629. DISINFECTING APPARATUS, H. H. Lake.—(*A. H. Kidney and H. D. Watts, United States.*)
6630. GRINDING CORN, J. Schweitzer, London.
6631. BRAKE APPARATUS, S. L. Norris, London.
6632. STARTING, &c., TRAM-CARS, S. L. Norris, London.
6633. WORKING OPEN HEARTH FURNACES, F. Siemens, London
6634. PROPELLING VESSELS, O. G. Bolitho, London.
6635. TREADLES, T. E. Pearce and W. Higgitt, London.
6636. DRIVING BELTS, J. C. Mewburn.—(*J. A. Magnin, France.*)
6637. FILTER TAPS, G. Teideman, London.
6638. STEEL ARMOUR PLATES, T. Hampton, London.
6639. MAKING BRICKS, &c., F. M. Lyte, London.
6640. PRINTING MACHINES, A. M. Clark.—(*P. Jackson, United States.*)
6641. WELL REAMERS, A. M. Clark.—(*W. D. Braden and W. H. Wells, United States.*)
6642. DRIVING BELT, P. Adie, London.
6643. KITCHEN RANGES, R. Hunter and J. Turnbull, Glasgow.
6644. OBTAINING CARBONATE OF POTASH, H. Trecht, London.

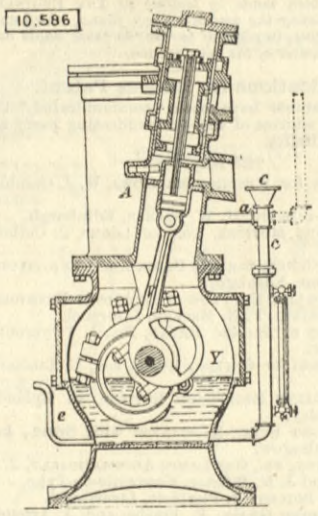
SELECTED AMERICAN PATENTS.

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

10,586. STEAM ENGINE LUBRICATING ATTACHMENT, *H. Herman Westinghouse, New York, N.Y.—Filed March 25th*, 1885.

Claim.—(1) As an improvement in the class of engines in which lubrication of the moving parts is effected wholly or in part by the splashing of the oil effected by the piston and valve stem connections, the combination of a close oil vat and a vent pipe leading therefrom, substantially as set forth. (2) As an improvement in the class of engines in which lubrication of the moving parts is effected wholly or in part by the splashing of the oil effected by the piston and

10.586

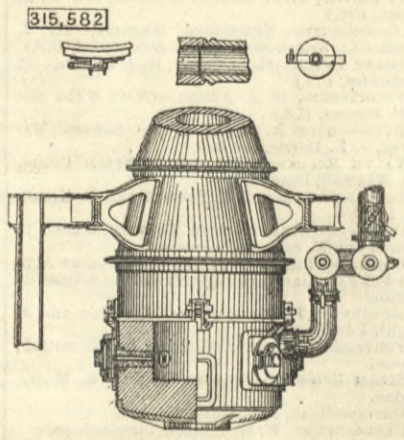


valve stem connections, the combination of a close oil vat and a vent and return drip pipe, substantially as set forth. (3) In combination with a close oil vat Y, of a steam engine, a vent pipe *a*, escape opening or funnel *c*, and drip pipe c^1, substantially as set forth. (4) In combination with close oil vat Y, and the cylinders and valve chambers A V, a water escape pipe *c*, entering a vat at or near the bottom and rising to the normal oil level of the vat, substantially as set forth.

315,582. METHOD OF OPERATING CONVERTERS, *John F. Wilcox, Pittsburgh, Pa.—Filed February 7th*, 1885.

Claim.—In operating a Bessemer converter, the method of keeping the tuyeres clear of metal, which consists in maintaining a sufficient minimum pressure

315,582

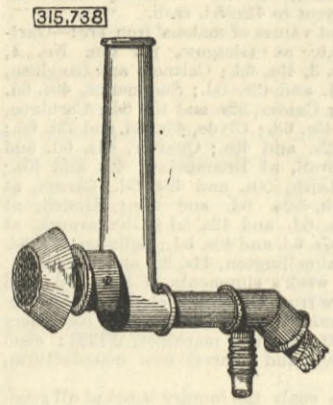


in the blast pipe and tuyeres during the time the metal is not under blow, to counterbalance the pressure of the column of metal in the converter, substantially as and for the purposes described.

315,738. FLUE CLEANER FOR STEAM BOILERS, *Wm. H. Cooper, Quincy, Ill.—Filed December 18th*, 1884.

Claim.—(1) The apparatus for cleaning flues, consisting of a hollow cylinder provided with an axially located jet pipe, and means, substantially as shown, for connecting the same with a steam supply, and a branch pipe or nozzle which extends laterally outward from said body, and is adapted at its outer end to fit within the end of a flue, so as to connect such flue with the interior of said body, substantially as specified. (2) In combination with the body provided with the axially located steam jet pipe, and the laterally arranged branch pipe, the nozzle adapted at its outer end to fit within the end of a flue, and at its inner end to fit into said branch pipe, and means whereby the latter and said nozzle may be secured together, substantially as and for the purpose shown. (3) The apparatus described for cleaning flues, consist-

315,738



ing of the cylindrical body having an open upper end, and provided with the horizontal diaphragm and axially arranged jet pipe, and with the laterally projecting branch pipes, the nozzle adapted at one end to fit within a flue, and at its opposite end to fit within the upper branch pipe, the L-shaped fitting adapted to receive a handle, and to have connected therewith a flexible hose, and the pipe extending between and operating to connect said fitting with the lower branch pipe of said body, substantially as and for the purpose set forth.

315,805. METALLIC WHEEL, *Justice W. Marshall, Cazenovia, N.Y.—Filed November 28th*, 1884.

Claim.—(1) In combination with the felly and axle, spokes formed in pairs of a continuous rod lapped at its centre around the axle and screw-threaded at both

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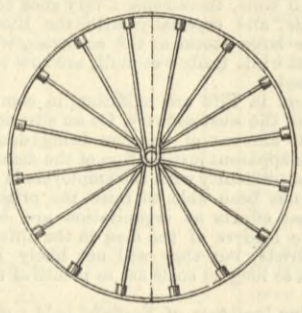
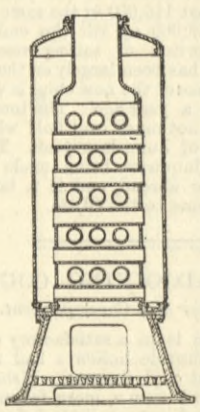


ends, and two screw-threaded thimbles pivotted in the felly and screwed on to the two ends of the aforesaid rod, substantially as described and shown.

316,214. STEAM BOILER, *Louis Zeller, Massillon, Ohio.—Filed September 15th*, 1884.

Claim.—In a steam boiler, the combination, with an inner casing provided at its lower end with an outwardly-projecting flange and an outer casing provided with inwardly-projecting flange adapted to rest on the outwardly-projecting flange of the inner cas-

316,214



ing, of a fire-box provided at its upper end with a flange which forms a seat for the outwardly-projecting flange of the inner casing, the said casings and fire-box being secured together by a single row of bolts, substantially as set forth.

316,302. FILAMENT FOR INCANDESCENT ELECTRIC LAMPS, *William Stanley, jun., Englewood, N.J.—Filed September 4th*, 1884.

Claim.—A carbon filament for incandescent lamps bent into the form of two outwardly-inclined lateral

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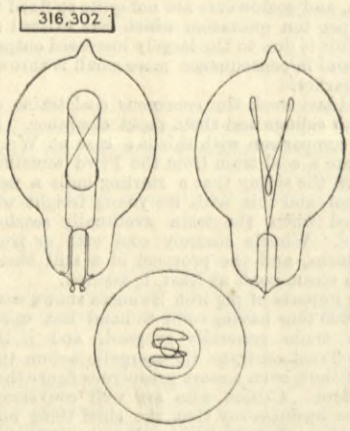
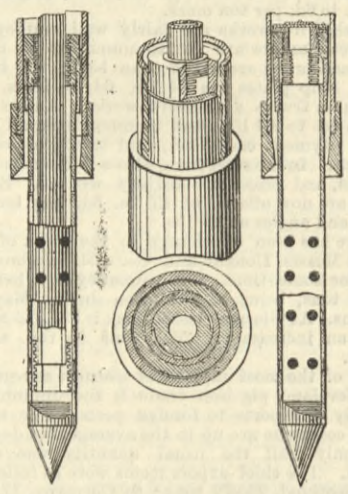


members having loops at two adjacent ends and two oppositely-inclined return bends extending in reverse direction to said lateral members, and connecting the loops thereof with an intermediate loop, substantially as set forth.

316,318. WELL TUBE FOR DRIVE WELLS, *Willett C. Wells, Tiffin, Ohio.—Filed February 19th*, 1885.

Claim.—(1) The combination, with the well tube having the shoe at its lower end, having the tapering bore, of the strainer having the tapering sleeve secured at its upper end corresponding in taper to the bore of the shoe, as and for the purpose shown and set forth. (2) The combination of the strainer having the sleeve at its upper end, formed with alternating threaded and smooth portions at its inner side, with the delivery pipe provided at its lower end with the sleeve having alternating smooth and screw-threaded portions upon its outside, the said smooth and threaded portions corresponding in width to each other, as and for the purpose shown and set forth. (3) The combination of the strainer, having the drive point and the concussion block at its lower end, with the tubular drive rod having the upwardly-opening delivery valve within its lower end, as and for the purpose shown and set forth. (4) In a well tube, the combination of the well tube, the strainer having means for preventing it from slipping out of the lower end of the well tube, and having the sleeve at its upper end formed with alternating smooth and screw-threaded portions upon its inner side, and the

316,318

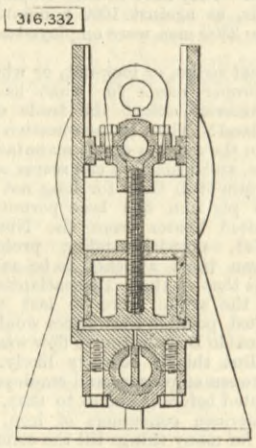


delivery pipe having the sleeve at its lower end provided with alternating smooth and screw-threaded portions upon its outer side, and formed with an internal valve seat provided with an upwardly-opening valve, as and for the purpose shown and set forth.

316,332. STEAM ENGINE, *James Clark, Medina, N.Y.—Filed January 3rd*, 1885.

Claim.—(1) The combination of the frame having the cylindrical steam chest with the shaft, the crank, the piston and rod, and the cylinder having a closed end that is pivotted upon the steam chest, said cylinder having a single central port in its closed end, and said steam chest being provided with an inlet and an exhaust port with which the cylinder port

316,332



registers alternately when the engine is in operation, substantially as described. (2) The combination of the frame having the cylindrical steam chest with the shaft, the crank, the piston and rod, and cross-head, and the cylinder having a closed end that is pivotted upon the steam chest and having guideways for the cross-head, substantially as described.

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