TRIAL OF A GRUSON CHILLED IRON SHIELD AT BUCKAU.

An experiment was conducted on the ground of Messrs. Gruson, at Buckau, on October 22nd, 1883, against a chilled iron shield in connection with a supply of armour for Holland. Any results of experiments against chilled iron are important to us in England, as we have never carried out such trials ourselves. Chilled iron blocks were indeed once fired at at Shoeburyness, but many years ago, and in so crude and elementary a way that the value of the result obtained was very limited indeed.

The gun employed was a Krupp 30·5 cm. (12in.) piece, 25 calibres long, mounted on a Gruson carriage. It fired a steel projectile of Krupp's, 3·5 calibres long, empty or blind, weighing 445 kilogs. (981 lb.), the charge being 120 kilogs. (264½ lb.). The velocity was 445 metres (1460ft.), and the striking energy or *vis viva* 4490 metre-tons (14,498 foot-tons). The shield consisted of five pieces of chilled iron forming half a tower—Fig. 1. The rear or open part was supported by means of masonry piers to which it was connected—Fig. 1. The entire weight of the shield was 47·5 tons. The first round struck a spot 4 cm. to the right of the centre of the shield, and 90 cm. from the bottom—Figs. 3 and 4. The shot struck the plate in a normal direction at the point marked I on Fig 4, forming a crack *a* running 125 cm. to the left and 91 cm. to the right of the point of impact. To the left of the point of impact a chipping off, or bruise of 30 to 40 cm. long and 3 cm. wide. Round the point of impact a chipping or bruise of a maximum depth of 35 mm., a horizontal breadth of 48 cm., and a vertical breadth or length of 52 cm. The point of the shot itself was flattened out into a disc with a centre core which stuck to the shield. On the interior the crack *a* was visible as a hair crack, running from a point 45 cm. from the left edge to about 22 cm. of the right edge—Fig. 2—in which, however, the crack is shown as completed by subsequent firing. Other effects of a slight nature were visible.

The second round was fired with a steel projectile weighing 446·3 kilogs. (983·9 lb.). It struck a point on the centre vertical line of the shield 100 cm. over the first point of impact—II. in Figs. 3 and 4—the axis of the shot having a striking angle of 51 deg. A long curved crack "*c*" was found running up to within 50 cm. of the top edge of the shield, and 17 cm. of the left edge—Fig. 4—also another crack *c* running to the right in a sharper curve nearly to the plate edge. A vertical crack *d* connected points of impact I. and II. together. It could not be traced beyond I. There were also four other hair cracks about 20 cm. long. A long chipping-off also was made of 70 mm. maximum depth, 48 cm. long, and 12 cm. width—Fig. 4. The entire bruise at the point of impact was about 55 cm. wide.

In the interior, the crack *a* was completed and opened to a width of about 1 mm. The cracks *c* and *d* were not visible in the interior. The horizontal plate was slightly moved back.

The third round had a projectile of 443·8 kilogs. (978·4 lb.) in weight. This struck a point 135 cm. from the bottom, 71 cm. from the right edge—see III., Fig. 4. This point is 86 cm. from shot I and 90 cm. from shot II. Striking angle, 72 deg. Eight cracks were formed, radiating from the point of impact—Fig. 4—one marked *e* united III. and I.; another, *f*, ran parallel to *b* for a short distance. Crack *c* opened about 7 mm. The chipping-off or bruise at the point of impact was about 50 mm. deep. Inside cracks connecting the *a* and *b* were developed in the manner shown in Fig. 2, below the point of impact III. A certain amount of general disturbance of parts also was effected.

The fourth round was with a shot weighing 444·6 kilogs. (980·2 lb). The striking angle was about 75 deg. The point of impact was 65 cm. from the bottom edge and 84 cm. from I (*vide* Fig. 4). This projectile, striking a fragment which was already detached from the rest of the shield, bodily moved it back, and to a certain extent dislodged and disarranged the entire structure.

The shield received three blows, having together a total *vis viva* or energy of 13,470 metre-tons (43,495 foot-tons), or 283·8 metre-tons (916 foot-tons) per ton of metal in the shield without the fragments of the shield being dislodged or the protection to the interior being lost. After the third round there were cracks extending entirely across the plate and through the whole thickness forming large fragments, but these fragments remained *in situ*. The surface of the metal was chipped off round the points of impact, but in no case had any of the point of the shot entered. After the fourth shot the pieces might still have held in their places had the supporting structure stood better; but as it was, the whole of the energy of the fourth shot was available for the removal of the detached fragment which it struck.

FIG. I
ENTIRE STRUCTURE
FIRED AT

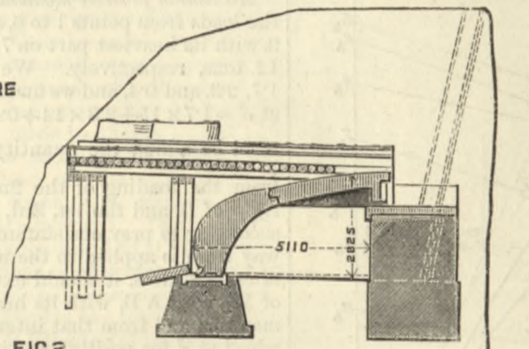
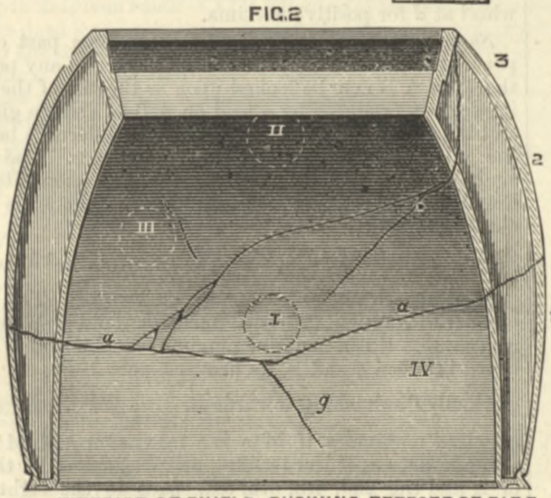


FIG. 2



INTERIOR OF SHIELD SHOWING EFFECTS OF FIRE

FIG. 3
SECTION OF SHIELD
SHOWING DIMENSIONS

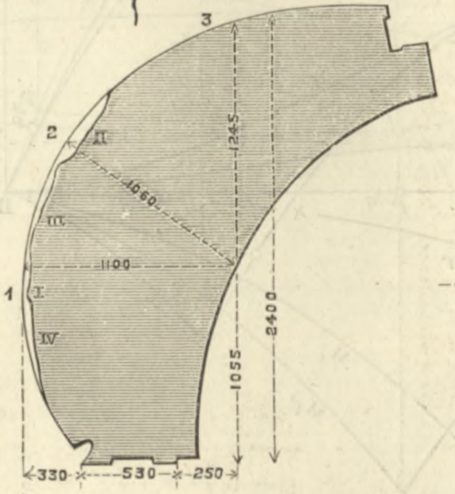
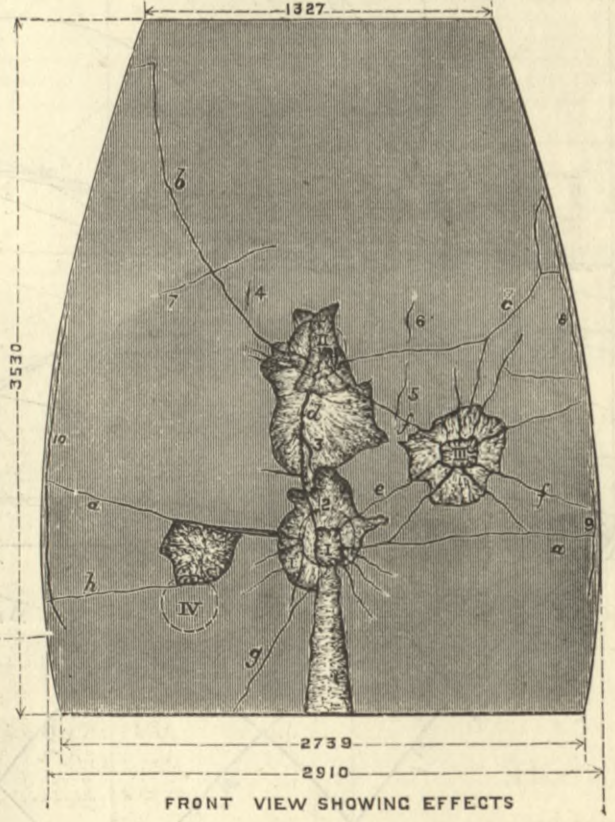


FIG. 4



FRONT VIEW SHOWING EFFECTS

GRUSEN CHILLED IRON SHIELD.

THE CALCULATION OF CONTINUOUS GIRDERS.

By Max am Ende, M.I.C.E.

No. IV.

If continuous girders are used for the support of stationary loads, as would often be the case in buildings, the moments over the supports for the one position of the load is ascertained according to the previous example are sufficient for the determination of all other moments and shearing forces by an elementary graphical or algebraical process, which need not here be described. But in cases of bridges where certain positions of the moving load produce maximum positive and negative moments or shearing forces at given points, further applications of the formulæ are necessary for the purpose of determining the positions of the load which produce and determine those maxima.

Fixed points.—If we consider the girder, vol. lvi. p. 479, to have no weight of its own, and if we act upon the first span from the left, either by means of a load or by raising or lowering the first support a distance e, then equation (20a) in the one case will be—

$$y_1 E = {}^{l}\Sigma \frac{m\,x\,\Delta\,x}{J} + 0{\cdot}815\,M_1,$$

l indicating that the direction of measurement according to Fig. 12 is from the *left*, and m the positive moments at the distance x; and in the other case—

$$(y_1 \mp e)\,E = 0{\cdot}815\,M_1, \text{ or } y_1\,E = \pm\,e\,E + 0{\cdot}815\,M_1.$$

The constants in the equations (20b) . . . (20k) are all $= o$. Working out, we obtain the following results:—

$$\left.\begin{aligned} M_1 &= 0{\cdot}613\,{}^{l}\Sigma \frac{m\,x\,\Delta\,x}{J}, \text{ or } M_1 = \mp\,0{\cdot}613\,e\,E \\ M_2 &= -\,0{\cdot}588\,M_1 \\ M_3 &= +\,0{\cdot}33\,M_2 \\ M_4 &= -\,0{\cdot}505\,M_3 \\ M_5 &= +\,0{\cdot}338\,M_4 \\ M_6 &= -\,0{\cdot}34\,M_5 \\ M_7 &= -\tfrac{1}{2}\,(M_2 - M_3) \\ M_8 &= -\tfrac{1}{2}\,(M_5 - M_4) \end{aligned}\right\} \quad (21)$$

From these results can be seen that, beginning at the left, the moments over the piers are alternately positive and negative, and that they bear a proportion to each other entirely independent of the amount of loading of the first span or the raising of the first support, and dependent only upon the form of the girder in its entirety. There is therefore in each succeeding span a point at which no moment is produced by the action upon the first span, whatever its magnitude may be. These points are called fixed points. If the first span, beginning at the right, is acted upon in a similar manner, there are other points in all the following spans which are also fixed points for the same reasons. The two end supports are also fixed points if, as in this case, the girder is free to turn upon them. As the present structure is symmetrical, the position of the two sets of fixed points is also symmetrical with regard to its centre line. (See Fig. 14, vol lvi., p. 479.) Thus there are two fixed points in every intermediate span of a continuous girder. In one of these, f, an existing moment is *not altered* by any action upon any spans to the right of the span, while in the other, f^1, it is *not altered* by any action upon any spans to its left. The end spans, including the two piers, have only one fixed point each. Any point between two supports may become a point at which the moment is *nil*—point of contrary flexure—but only two points—or one point in each end spans—can be fixed points in the sense of the above explanation.

Points of influence are those points where a load P must be placed to have its greatest influence on the moments over the adjoining supports. In a previous part of this paper it was shown how, for a girder of uniform section, these points can be determined analytically. In the present case the only way is to calculate the moments M for a series of positions of the single load P, and to determine the points of influence by interpolation or by drawing the curves of influence. The results of this calculation are given in Fig. 15. The ordinates of the curves M_1, M_2, &c., indicate the moments over the supports for the corresponding positions of P. The curves here shown are therefore the curves of influence of the load P upon the moments over the supports, and where they reach their highest points, viz., at points i, there are the points of influence for these moments. The position of the points of influence is like that of the fixed points, independent of the loading of the other spans. The calculation for the first span is the same as that for the fixed points. Substituting for $\Sigma \frac{m\,x\,\Delta\,x}{J}$ successively six values, according to the six assumed positions of the load, into the equation—

$$M_1 = 0{\cdot}613\,{}^{r}\Sigma \frac{m\,x\,\Delta\,x}{J},$$

m being each time the positive moment at the successive points from the load P for one of its positions, we obtain the values for the ordinates which have been plotted. Drawing the curve by hand, we find approximately the point of influence in the first span for the moment M_1 to be at i'_1, Fig. 15. If the load P is placed here, not only M_1 is a maximum, but M_4, M_5, $M_4 - M_5$ and M_8 are also maxima, and M_2, M_3, $M_7 - M_3$, and M_7 are minima. This follows from the equations (21) or from the diagram Fig. 14. The other positions of the load P in the first span also correspond to an increase of M_1, and therefore its real maximum will occur when a load is distributed over the whole span and when its heaviest part lies at point i'_1. The abscissa may be regarded as the curve of influence for the moment over the first support, which is always $= o$. The second span has two points of influence, one for M_1 and the other for M_2. For their calculation we put in equations (20b) and (20c), the values of $\Sigma \frac{m\,x\,\Delta\,x}{J}$ for a single load P, in analogy to the table, Fig. 12, vol. lvi., p. 479, taking for (20b) these values by measuring from the right, and for (20c) those by measuring from the left. Working out we find—

$$\left.\begin{aligned} M_1 &= 0{\cdot}985\,\frac{60}{85}\,{}^{r}\Sigma \frac{m\,x\,\Delta\,x}{J} - 0{\cdot}681\,M_2 \\ M_2 &= \frac{1}{2{\cdot}734}\left(2{\cdot}037\,{}^{l}\Sigma \frac{m\,x\,\Delta\,x}{J} - 0{\cdot}985\,\frac{60}{85}\,{}^{r}\Sigma \frac{m\,x\,\Delta\,x}{J}\right) \\ M_3 &= 0{\cdot}338\,M_2 \\ M_4 &= -\,0{\cdot}505\,M_3 \\ M_5 &= 0{\cdot}338\,M_4 \\ M_6 &= -\,0{\cdot}34\,M_5 \\ M_7 &= -\tfrac{1}{2}\,(M_2 - M_3) \\ M_8 &= -\tfrac{1}{2}\,(M_5 - M_4) \end{aligned}\right\} \quad (22)$$

Substituting for each of the two sums successively nine values according to the assumed nine positions of the load P, we obtain the two curves of influence for M_1 and M_2, and determine approximately the points of influence i_1 and $i_2{}^1$. Point $i_2{}^1$ is the point of influence, not only for M_2, but, so far as the load on the second span is concerned, also for the moments over all the supports to the right, making them alternately minima and maxima, in accordance with (22). The central span has also two points of influence. Equations (20*d*) and (20*f*) will now contain the sums, and working out we have—

$$\left.\begin{aligned}
M_1 &= -0{\cdot}34\,M_2\\
M_2 &= 0{\cdot}338\,M_3\\
M_3 &= 0{\cdot}726\,\frac{85}{110}\,{}^{r}\!\sum\frac{mx\,\Delta x}{J} - 0{\cdot}283\,{}^{l}\!\sum\frac{mx\,\Delta x}{J}\\
M_4 &= 0{\cdot}418\,{}^{l}\!\sum\frac{mx\,\Delta x}{J} - 0{\cdot}504\,M_3\\
M_5 &= 0{\cdot}338\,M_4\\
M_6 &= -0{\cdot}34\,M_5\\
M_7 &= -\tfrac{1}{2}(M_2 - M_3)\\
M_8 &= -\tfrac{1}{2}(M_3 - M_4)
\end{aligned}\right\}\ (23)$$

Substituting for each of the two sums successively twelve values, we obtain the two curves M_3 and M_4, and the points of influence i_3 and $i_3{}^1$. i_3 is the point of influence for M_3 and for the moments over all the supports to the left, in the sense as explained for the second span, and $i_4{}^1$ is that for M_4, and for the moments to the right. The calculation for the fourth and fifth spans is identical with that for the second and first, on account of the symmetry of the structure.

From equations (21, 22, 23) now follows (1) that M_1 becomes a maximum if the moving load is distributed over spans 1, 2, 4, with its heaviest parts arranged near the points of influence $i^1{}_1$, i_2, i_4; (2) that M_2 and M_3 become maxima if the load is distributed over spans 2, 3, 5, with its heaviest parts arranged near $i^1{}_2$, i_3, i_5, or, still more to the purpose, if it is so distributed that its intensity is as nearly as possible in proportion to the ordinates of the curves of influence; (3) that the maxima of M_4, M_5, and M_6, are equal to those of M_3, M_2, and M_1. In continuous girders of an indefinite number of spans the negative moment over any support becomes a maximum if the first, third, fifth, &c., spans to the right and left are loaded, and if the heaviest parts of the load are arranged in the spans to the right near points i, and in those to the left near points i^1. The positive moment between two supports becomes a maximum if the span itself, and among the other—outer—spans, the second, fourth, sixth, &c., spans to the right and left are loaded, and, as before, the heaviest parts of the load are arranged in the spans to the right near point i, and in those to the left near points i^1. In this case the moments over the adjoining supports from the loading of the outer spans are minima.

Moment at a given point.—It is convenient to consider the moment at a given point of the span A B—Fig. 16—as the sum of the moments produced by the loads on the outer spans, and by the load on the span itself. We let A B represent the second span of the girder in example 5, because the fixed points and the curves of influence for the moments over the supports are already calculated; but speaking of the outer spans, we may also be allowed to consider it as belonging to a girder of an indefinite number of spans. The moment at a point at the distance x from A by the loading of the outer spans is $M_A\,\frac{(l-x)}{l} + M_B\,\frac{x}{l}$. This is a maximum if M_A as well as M_B are maxima, and a minimum if both are minima. The conditions on which this takes place are given above, and, therefore, this part of the sum may be considered determined. The other part, viz., the maximum moment from the load on the span itself depends on its positions, and to determine these we have to take some further steps. In all cases it is advisable not to solve equations (20) at all with regard to any given load, moving or fixed, but to derive from them directly the equations (21, 22, 23), and to determine by means of these the fixed points and curves of influence for the supports, according to Figs. 14 and 15. Having got these, it is quite easy to draw other curves of influence for any given points. This process is then no longer dependent upon the outer spans. We will describe it for point *d*, Fig. 16, at a distance of 69·5ft. from A. First, we transfer the ordinates of the curves M_A and M_B to the ordinates over points A and B respectively, and draw the closing lines $1_a - 1_b$, $2_a - 2_b$, $3_a - 3$, &c. These lines intersect the corresponding ordinates in points 1_{ab} . . . 4_{ab}, 5_{ab} . . . through which a curve is drawn indicating the negative moments for a moving load P at the points where the load occurs. The curve terminates at A and B. Next we draw the curves of the positive moments for a load P (= 1) in different positions between A and B. These curves are the triangles A P_1 B, A P_2 B, &c., the apices of which lie in a parabola, because mom. $= P\frac{(l-x)\,x}{l}$. The sides A P and B P of these triangles intersect each corresponding closing line in two points, 1, 1; 2, 2; &c., which are points of *contrary flexure*. In Fig. 16 these points are connected by two curves, which may be called the *curves of the points of contrary flexure*. A peculiarity in these curves is that, starting from A and B, they terminate in the *fixed points* f and f^1, and that no part of them lies in the space between these points. We now draw an ordinate at point *d*, terminating at the parabola in point P_d. The ordinate intersects the curve of the points of contrary flexure between 6 and 7, and this signifies that a load P, lying at that point between P_6 and P_7, would produce no moment in point *d*; all loads P_7 to P_9 produce positive moments, and all loads P_6 to P_1 produce negative moments. These moments can be determined. We take, for example, P_4. The line P_4 B intersects the ordinate *d* in point 4_d; the vertical distance from 4_d *upwards* to the closing ling $4_a - 4_b$ is the *negative* moment for P_4 in point *d*. In the same way the vertical distance from 8_d *downwards* to $8_a - 8_b$ is the *positive* moment for P_8 in point *d*. If we plot these distances upon the verticals in which the loads act, measuring from the abscissa A B, we obtain the curve M_d, which is the curve of influence for point *d*. For the distance at point *d* itself, we have only to take the ordinate between P_d and the curve of negative moments A E B. The curve M_d reaches its highest point at i_d, and this is therefore its *point of influence.* Its lowest point is at *d*—*i.e.*, the greatest positive moment at *d* is produced if the load lies at that point. This is so not only with regard to *d*, but also to any other point between A and B. In the same way any number of curves of influence can quickly be drawn. In Fig. 16 curves of influence are drawn not only for points A, *d*, and B, but also for a point *c* between 1 and 2 for the two fixed points f and f^1, and for a point *e*, where the positive moment is an absolute maximum. This point lies where the vertical distance between the parabola and the curve of negative moments A E B is greatest; it can easily be found by moving a diagram of the parabola vertically downwards till it is tangent to the curve. E is the point of contact. It can be seen that the curves of influence for any point between A and f and between B and f^1 have negative as well as positive branches, and that those for points between f and f^1 have only positive branches. The use of these curves—for example, of the curve M_d—is to determine the greatest positive or negative moment at the point in question.

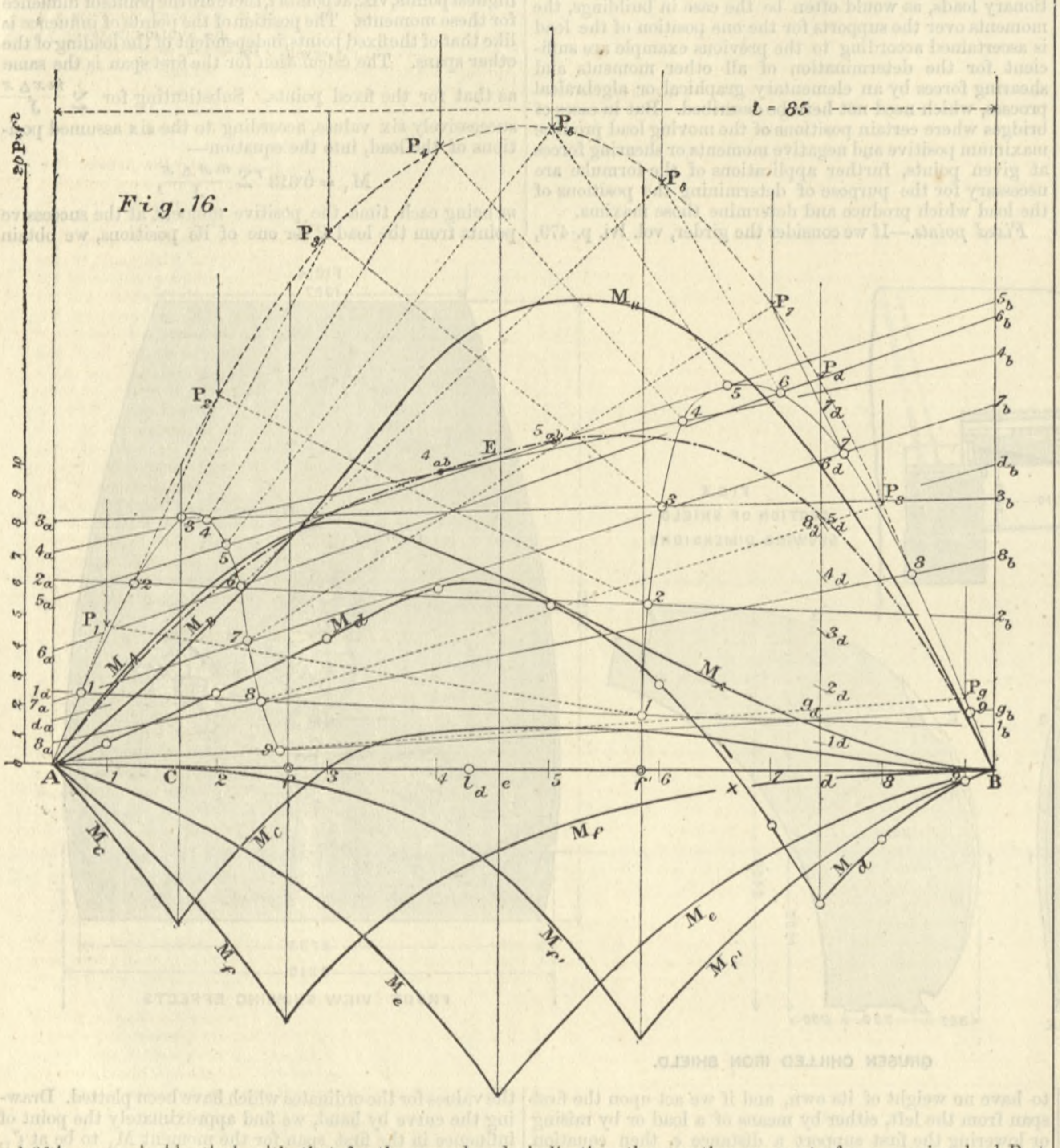


Fig. 16.

Maximum negative moment at point d.—Assuming that the loads P can be ascertained so as to correspond to the irregular load of a railway train—for example, when the cross girders of the bridge are at 1, 2, 3, &c.—then in order to get a maximum negative moment at *d* we place the loads at points 1, 2, 3, 4, 5, 6—for example, 8, 8, 12, 15, 14, and 10 tons respectively, the heaviest being near the point of influence i_d; and we remove all loads from points 7, 8, and 9 because there they would produce positive moments. We may now use the curve M_d immediately, as follows:—The six ordinates of the curve are, according to scale, 0·7, 2·4, 4·3, 5·9, 5·4, 2·8; multiplying these figures with the corresponding loads, and adding, we have—

$$0{\cdot}7\times8+2{\cdot}4\times8+4{\cdot}3\times12\ .\ .\ .\ .\ .=268{\cdot}5 \text{ foot-tons,}$$

the required maximum negative moment at point *d*. To this must be added the quantity $M'_A\frac{l-x}{l}+M'_B\frac{x}{l}$ derived from the loading of the 1st, 3rd, 5th, &c., spans to the right of B, and the 2nd, 4th, &c., spans to the left of A, according to previous statements.

Maximum positive moment at point d.—We remove all the loads from points 1 to 6, and place the load on points 7, 8, 9, with its heaviest part on 7 and 8; for example, 14, 15, and 12 tons, respectively. We measure the three ordinates 1·7, 2·3, and 0·4, and we find the maximum positive moment at $d = 1{\cdot}7\times15+2{\cdot}3\times14+0{\cdot}4\times10=61{\cdot}7$ foot-tons. To this must be added the quantity $M'_A\frac{l-x}{l}+M'_B\frac{x}{l}$ derived from the loading of the 2nd, 4th, 6th, &c., spans to the right of B, and the 1st, 3rd, 5th, &c., spans to the left of A according to previous statements. If the load of the railway train is applied to the main girders without the means of cross girders, it should extend from A to the intersection of M_d with A B, with its heaviest wheel at i_d for negative maxima, and from that intersection to B with its heaviest wheel at *d* for positive maxima.

Shearing force at point d.—In a previous part of this paper it was stated that the shearing force in any point of the span A B may be looked upon as the sum of the shearing force S, produced by a load on A B as a single girder S, and the shearing force produced by the difference between the moments over the adjoining supports. The latter again is composed of the difference of the moments from the load on A B, $M_B - M_A$, and that from the loads on the outer spans, $M'_B - M'_A$, we have therefore:—

$$\text{Shearing force} = S + \frac{1}{l}\,(M_B - M_A) + \frac{1}{l}\,(M'_B - M'_A)\quad(24)$$

Maximum negative shearing force at point d.—This would occur if in equation (24) each member could be a negative maximum. S is a negative maximum if the load is distributed between *d* and B, its heaviest part being at *d* and gradually diminishing towards B. $\frac{1}{l}\,(M'_B - M'_A)$ is a negative maximum, if M'_A is a maximum and M'_B a minimum, *i.e.*, if the 1st, 3rd, 5th, &c., spans to the left of A and the 2nd, 4th, 6th, &c., spans to the right of B are loaded in the manner already specified. $\frac{1}{l}\,(M_B - M_A)$, however, is positive for loads between *d* and B, as can be seen from the position of the two curves in Fig. 16; if it ever could be > S for any load between *d* and B, then the load which makes S a negative maximum would not make the total shearing force a negative maximum. But $\frac{1}{l}\,(M_B - M_A)$ is always < S; for even its greatest possible value would only be = S, that is, when the moment of inertia of the sections of the girder or its rigidity is ∞ between *d* and B and between B and the next support. Assuming loads 13, 12, and 11 tons at points *d*, 8, 9, and using the scale in Fig. 16, we have according to (24):—Maximum negative shearing force in *d* =

$$-\frac{15{\cdot}5\times13+10\times12+2{\cdot}5\times11}{85}+\frac{8{\cdot}7\times13+6{\cdot}3\times12+1{\cdot}7\times11}{85}+\frac{1}{85}\,(M'_B - M'_A) = \frac{-141{\cdot}6+(M'_B - M'_A)}{85}$$

where M'_B and M'_A have to be ascertained as previously stated.

Maximum positive shearing force at point d.—The conditions are here reversed. The load must be distributed between A and *d*, with its heaviest part at *d*; M'_B must be a maximum and M'_A a minimum; $M_B - M^A$ is still > *o* from *d* to a point near f, where it is = *o*, after that it is < *o*. Assuming loads 8, 8, 9, 12, 13 tons at points 1, 2, 4, 7, *d*, we have:—Max. pos. shear. force in *d* =

$$\frac{5\times8+25\times8+35\times9+65\times12+69{\cdot}5\times13}{85}+\frac{-1{\cdot}0\times8-1{\cdot}15\times8+6{\cdot}3\times9+10{\cdot}0\times12+8{\cdot}7\times13}{85}+\frac{1}{85}\,(M'_B - M'_A)=\frac{1511{\cdot}1+(M'_B - M'_A)}{85}.$$

As the effects of the loading of each outer span upon the moments M' are already known from the calculation of moments in any point, all the requisite shearing forces can very quickly be calculated from equation (24), above.

The results for the maximum negative and positive moments, and for the maximum negative and positive shearing forces, may then be put on record by means of curves in a diagram.

Recapitulating the operations required for the calculation of a continuous girder, as explained in the previous pages, we have:—(I.) An approximate determination of the moments of inertia of the girder at the various points stated to begin with relatively to an assumed unit. (II.) Making a sketch of the curves of moments according to Fig. 11, or according to Fig. 8, showing the positive moments of a single load. (III.) Making a sketch of the elastic line and its tangents at the supports, according to Fig. 13. (IV.) Statement of equations (20). Equations referring to loaded spans to have members $\Sigma \frac{m\,x \bigtriangleup x}{J}$, m being the moment of a single load P at a given point. In the case of a girder with uniform section, $a\,(2\,l - a)\,(l - a)\,P$ and $a\,(l - a)\,(l + a)\,P$ to be put in place of ${}^{r}\Sigma \frac{m\,x \bigtriangleup x}{J}$ and ${}^{l}\Sigma \frac{m\,x \bigtriangleup x}{J}$ respectively. Likewise $l^2\,(2\,M_1 + M_2)$ and $l^2\,(M_1 + 2\,M_2)$ to be put in place of the two members for negative moments into the same equations respectively—*vide* equations (17). (V.) Statement of equations (21, 22, 23). (VI.) Calculation of the fixed points according to equations (21). (VII.) Calculation of the curves of influence for the moments over the supports, according to equations (21, 22, 23). (VIII.) Drawing of diagrams analogous to Figs. 14 and 15. (IX.) Drawing of diagrams of each span separately, analogous to Fig. 16 on an enlarged scale, or completing Fig. 14 if its scale is large enough.—So far the knowledge of the moving or dead loads is not required.—(X.) Arrangement of the moving load—railway train—on each span separately, so as to be as much as possible in proportion to the ordinates of the curves of influence in Fig. 14. These arrangements are required for the determination of the maximum moments over the piers and of the effects of the loading of the outer spans upon the other moments and upon the shearing forces. The number of these arrangements is the same as the number of curves, viz., two in each intermediate span and one in each end span. (XI.) Calculation of the effect of each arrangement upon each moment over a support simply by multiplying each single load with the corresponding ordinate of the curve and adding the products together; record of results to be made in a table. (XII.) Calculation of maxima of positive and negative moments and shearing forces from the load on the span itself without regard to the outer spans, the number of points depending upon the accuracy required. The curves of influence, Fig. 16, to be used as explained. (XIII.) Record of results, sub (XII.), on two diagrams, one for moments and one for shearing forces, by means of ordinates; supplementing these diagrams by results recorded in the table sub XI. according to the given rules. (XIV.) Revisal of the calculation of the dead load by utilising the results hitherto found, and fixing the unit sub I. (XV.) Calculation of moments over supports for dead load only, by means of the curves of influence; elementary calculation—graphical or algebraical—of the moments and shearing forces at the intermediate points, and completion of diagram sub XIII. (XVI.) Calculation of strains and sectional areas.

In the previous pages it was assumed that the change of form of a girder under the load could be regarded as a function of the moments of inertia of its sections, but this is only the case if the web is either solid or made of dense lattice. The majority of modern bridges are made of systems of bars arranged in triangles, and these systems are either simple or compound. The simple systems are those which may be cut in two at any given bar without there being more than three bars cut at a time. They then consist of *necessary* bars only, and are *statically determined*. The compound systems are those which cannot everywhere be cut through in three bars; they then consist of *necessary* and *supernumerary* bars, and are *statically undetermined*. The continuous girder even of the simple "Warren" type belongs to this class, inasmuch as the intermediate supports may be regarded as supernumerary bars. Professor Mohr's method of calculating the strains in these systems* excludes the use of the moments of inertia, and is based upon the following principle:—If a system of elastic bars, acted upon by forces from without, is in equilibrium, the sum of the products of the forces acting in the bars into their alterations of length must be *nil*. That is the principle of work. The method may be applied to single girders with supernumerary bars and to triangulated arches with less than three hinges, with or without supernumerary bars, as well as to continuous girders. A somewhat similar method established about the same time by Professor Fränkel† is based upon the theory of the instantaneous axis.

THE ENGINE MAKERS' SOCIETY.

THE report of the Steam Engine Makers' Society, which is generally the earliest of the annual reports issued by the trades union organisations connected with the engineering branches of industry, was sent out to the members last week, and, notwithstanding the fluctuations of trade during the past year, the secretary is able to report a successful working of the association. The fact, however, is not disguised that the results have not been so beneficial as the executive council anticipated or expected twelve months ago, but, all things considered, the financial position of the Society might be regarded as satisfactory. At the end of 1882 the Society had a balance of £10,068; during the past year the income had amounted to £9870, and the expenditure on benefits and management had amounted to £8797, leaving a surplus of £1072, which increased the total balance in favour of the Society at the close of the year to £11,141. The number of members had risen from 4591 last year to 4762 this year, showing an increase over deaths and exclusions of 171. The expenditure for the past year had been £856 in excess of that of 1882, and there had been an increase in every benefit advance, except that of superannuation. The payment of unemployed members showed an increase of £404, but the average working expenses showed a decrease, and amounted to only 6s. 2½d. per member, which was the lowest rate the Society had ever had before. Turning to the question of trade in 1883, the following extracts from the report will be of interest as showing the view taken from the workmen's side. The report states:—"We must repeat that it has not realised what was anticipated at the commencement. We were led to hope that employment would be plentiful, owing to the great depression that had previously existed, and, as a consequence, it would find plenty of work to counterbalance the very low production in the period of stagnation in trade. This has not been the case, for, although the year opened with good prospects, as time went on confidence seemed to be wanting, and before the summer was over complaints began to be made that resulted in depression before its close. This decline has not been confined to our own country, but has manifested itself in every commercial community on the face of the globe. True, it has not been a depression that has brought about gigantic failures, but has shown itself in every country as being caused by one circumstance, and that was the inability of producers to dispose of their manufactures, or, in other words, over-production. This has shown itself in all our staple industries, and scarcely a business can be mentioned but there is the same complaint—no markets for their manufactured goods. It is anticipated by some that we may soon see a revival; but, whether this be so or not, we as workmen should look at it from our own point of view, and consider whether means cannot be adopted to better our condition." After commenting on bad trade, the report goes on:—"To our minds this is not to be wondered at when we consider the few inventions that have lately been made and the opposition shown to some improvements that help to create work for the engineer; and this is sure to be felt all the more when we take into consideration the many means that are adopted to dispense with the services of the skilled artisan. Last year we alluded to the telling effect that labour-saving machinery was having on the requirements of firms to manipulate their work in place of hand labour. In addition to this, all possible means are taken to strengthen parts of engines and machinery by introducing steel where iron was formerly used. This can be done at little extra cost for material; yet the risks of breakages or replacements are reduced to the lowest limits, and all with the one object of reducing cost, which means loss to the workman. Whilst, however, all this dispensing with labour is taking place, we see that a far greater percentage of work is being completed. To define a remedy for these grievances would be to solve a social problem that is occupying the attention of many people at present; but, as an important factor, we believe the production would be best reduced by a general reduction in the hours of labour. Our forefathers gained for us the ten hours' limit; we reduced the hours to fifty-four twelve years ago; and if we are combined and united in our opinions we can assist to further alleviate the struggles of our class, and to hand down to our children that which they will appreciate in all its beneficial effects."

THE WIGAN JUNCTION RAILWAY.

THIS line of railway was recently inspected by Major-General Hutchinson, R.E., one of the inspectors of the Railway Department of the Board of Trade. The inspector was accompanied by Mr. Charles Sacré, the engineer-in-chief of the Manchester, Sheffield, and Lincolnshire Railway; Mr. Charles H. Beloe, the engineer of the Wigan Junction Railway; Mr. Bradley, superintendent of the Manchester, Sheffield, and Lincolnshire Railway; Mr. Hamilton, who will take charge of the traffic arrangements of the Wigan Junction Railway; Mr. Scatcherd, superintendent of the signalling department; Mr. Stone, the contractor; Mr. Lambert, his agent; Mr. Symons, the resident engineer; Mr. Edwards, the manager of the Railway Signalling Company, and other officials. The inspector made a careful examination of the whole of the works, and tested all the bridges under the railway with four of the heaviest goods locomotives, and expressed himself thoroughly satisfied with the manner in which the works have been executed, and it is expected that the certificate authorising the opening of the line for passenger traffic will be received from the Board of Trade in a few days.

The new railway has been constructed by the Wigan Junction Railway Company, of which Mr. Nathaniel Eckersley, M.P. for Wigan, is the chairman. The scheme was projected in the year 1873, and parliamentary powers for its construction were obtained in the sessions 1874 and 1875. Its objects are to provide additional railway accommodation for Wigan and the neighbourhood, and especially to open out and develope the southern section of the Wigan coalfield in the neighbourhood of Platt Bridge, Abram, Bickershaw, and West Leigh. Several very large collieries have been opened in the vicinity of the new line. Another object is to connect the town and district of Wigan with the Cheshire lines, and through them with the Midland, Manchester, Sheffield, and Lincolcolnshire, and Great Northern railway systems, Wigan being at present entirely unconnected with those important railways.

Last year an Act of Parliament was obtained authorising an extension of this railway to join the West Lancashire Railway near Preston, and a Bill is now before Parliament for a branch from the main line to the important towns of Leigh and Bedford. The main line commences by a junction with the Manchester and Liverpool Railway of the Cheshire Lines Committee near Glazebrook station, about six miles east of Warrington. It proceeds across the Glazebrook Moss, where very great difficulties were encountered in excavating for the railway, the Moss having to be removed to a considerable depth below the rail level to ensure a good foundation for the works, and very extensive drainage works had to be constructed to keep this portion of the line free from water. The first station is at Culcheth, three and one-third miles from Glazebrook, where a convenient passenger station, goods yard, and sidings have been erected for the accommodation of Culcheth, New Church, &c. The next station is at Lowton, St. Mary's, five and one-third miles from Glazebrook, where similar passenger and goods accommodation is provided. This will serve for the populous districts of Lowton Common, Golborne, &c. The next station is at Plank-lane, nearly seven miles from Glazebrook, where similar accommodation has been provided, and will accommodate a very important district. At this point a short line connects the Wigan Junction Railway with the Bickershaw Colliery Railway, and this places it in direct communication with the extensive collieries of Messrs. Ackers, Whitley, and Co., the Abram Colliery Company, and the Bickershaw Colliery Company. A little further on is a junction with the new collieries now coming into operation belonging to the Wigan Junction Colliery Company. At Bickershaw-lane, eight and one-third miles from Glazebrook, a small passenger station is provided for the accommodation of the rising township of Abram, and a connection is made with the important collieries belonging to the Moss Hall Company, on land belonging to the trustees of the Duke of Bridgewater. At Strangeways, nine and a-quarter miles from Glazebrook, a passenger and goods station is provided, which will serve for the districts of Hindley, Strangeways, and Platt Bridge. Two short lines connect the Wigan Junction Railway at this point with the main line of the Lancashire Union Railway, and enable the traffic from the Wigan Coal and Iron Company, and from Messrs. Crompton and Shallcross's colliery, to be put upon the railway. At Lower Ince, ten and three-quarter miles from Glazebrook, a passenger station is provided for the town of Ince; and at Wigan, eleven and a-quarter miles from Glazebrook, a commodious temporary passenger station, goods yard, and warehouse have been constructed in Darlington-street East. The permanent station will be near the centre of the town on the extension to Preston, the works of which will shortly be commenced.

The works on the Wigan Junction Railway are of an exceedingly heavy nature. The total length of line to its present termination in Darlington-street East is eleven and a quarter miles, and on this length there are no less than forty bridges; five railways, two canals, four colliery railways, ten public roads, nineteen occupation roads, and eight footpaths having to be carried over or under the railway, in addition to a large number of small streams, many of which have to be carried through cast iron syphons; Ince Brook in particular being conveyed under the railway by means of three cast iron syphon pipes, each 3ft. 9in. in diameter. Owing to the subsidence of the ground by the colliery workings near Springs Branch, it has been found necessary to construct a reservoir to receive the drainage from the railway, and pump the same into the Ince Brook by means of two centrifugal pumps—a very unusual proceeding in railway engineering. The bridge under Springs Branch Railway is a very heavy work, the length of one of the abutments being no less than 212ft., and thirty-seven girders are required to carry the Springs Branch Railway and the sidings in connection therewith over the Wigan Junction Railway, and this had to be executed without interfering with the traffic. At Ince a commodious engine shed, with the necessary coaling stage, water tank, &c., have been constructed.

The parliamentary plans were prepared, and the Acts of Parliament authorising the construction of the line were obtained, under the supervision of the late Mr. R. S. Norris, M. Inst. C.E., whose great experience and local knowledge obtained through his long connection with the London and North-Western Railway in this neighbourhood was of great advantage to the works. Mr. Norris's health failing, the company entrusted the preparation of the contract plans and the superintendence of the works to Mr. Charles H. Beloe, M. Inst. C.E., of Liverpool, Mr. Sacré, the engineer-in-chief of the Manchester, Sheffield, and Lincolnshire Railway, who owns a large interest in the Wigan Junction Railway, acting as consulting engineer, and the works have been successfully carried out under the directions of those gentlemen by Messrs. T. and R. Stone, contractors, of Newton-le-Willows, and under the immediate superintendence of their agent, Mr. James Lambert. The contract for the signalling arrangements, which are now of an exceedingly complicated character, in order to comply with the requirements of the Board of Trade, was executed by the Railway Signal Company, of Fazakerley, near Liverpool. A considerable portion of the line was opened for mineral traffic on July 21st, 1879, and it is expected that the line will be opened for passenger and goods traffic throughout on March 1st. The line will be worked entirely by the Manchester, Sheffield, and Lincolnshire Railway Company.

NEW RAILWAYS IN PRUSSIA.

IF Prussia has been somewhat tardy in giving to the construction of secondary railway lines that attention which the subject has received in other countries, the energy with which the matter was taken up has already produced results of a satisfactory character. The following table shows the progress realised as indicated by the annual parliamentary votes for railway construction of a secondary character:—

Year.	Number of lines.	Total length miles.	Cost.
			£
1880	8	234	1,100,000
1881	10	296	1,850,000
1882	13	326	2,350,000
1883	17	250	2,100,000

In addition to these amounts large contributions were made by private persons under special circumstances, so that a total sum of about £8,000,000 to £8,500,000 has been spent for the purpose indicated during a period of four years.

For the present session of the Prussian Landtag a vote of £2,900,000 has been proposed; this amount representing a length of 490 miles, which, it will be seen, is in excess of any former annual project. The largest proportion of the new lines falls to the share of the Eastern provinces. Next in importance come the lines projected for Westphalia and Prussian Saxony. The following are the principal railways which it is proposed to construct:—(1) Labian-Tilsit, 43 miles; a continuation of the Königsberg-Labian line decided upon in 1882. (2) Allenstein-Soldo-Illowo, 62 miles; a junction will probably be effected at one point with the Marienburg-Mlawka line. (3) Jablonowo-Soldau, 50 miles, completing an existing line. (4) Simersdorf, or Marienburg-Tiegenhof, 13 miles, opening up a district rich in agriculture. (5) Posen-Wreschen is a continuation in an easterly direction of the Mark-Posen line. The starting point of the railway is not quite decided. Length, 30 miles. (6) Lissa-Jarotschin, uniting Lissa on the Breslau-Posen line with Jarotschin, a junction of the Kreuzburg-Posen and Oels-Gnesen lines. The prolongation of the line coming from Halle is thus effected. Length, 43 miles. (7) Lissa-Ostrowo, 59 miles, uniting Lissa with Ostrowo on the Posen-Kreuzburg line. (8) Bentschen-Wollstein, 16 miles. (9) Bitterfeld-Stumsdorf, 12½ miles, placing a rich and fertile district in direct connection with the Berlin-Anhalt line. (10) Cönnern-Bernburg-Calbe, A.S. This line runs for 8 miles through Anhalt, and for the remaining 7 miles through Prussian territory, the expense being divided. (11) Merseburg-Mücheln, 10 miles, opening up the Thuringian district called the Geiselthal. (12) Naumburg-St. Artern, 35 miles, uniting the Thuringian Railway, with the Sangerhausen-Erfurt line. (13) Dahlerau-Langerfeld, 7 miles long, completing the junction between the Lennep and Langerfeld—Rittershausen-Remscheid line. (14) Ründeroth-Derschlag, 9 miles; a continuation of the Siegburg-Ründeroth line now in progress. (15) St. Vith-Landesgrenze, 11 miles. (16) Brentzenheim-Simmern, 25 miles. (17) Treves-Hermeskeil, 32½ miles. In addition to the above the financial help of the State is projected in the construction of a line which is being started by private enterprise. It will run along the west coast of Holstein from Heide to Ribe, being a prolongation of the existing Holstein line. It will have a length of 82 miles, and will cost £725,000. The scheme includes a bridge over the Eider at Friedrichstadt, which will cost £75,000.

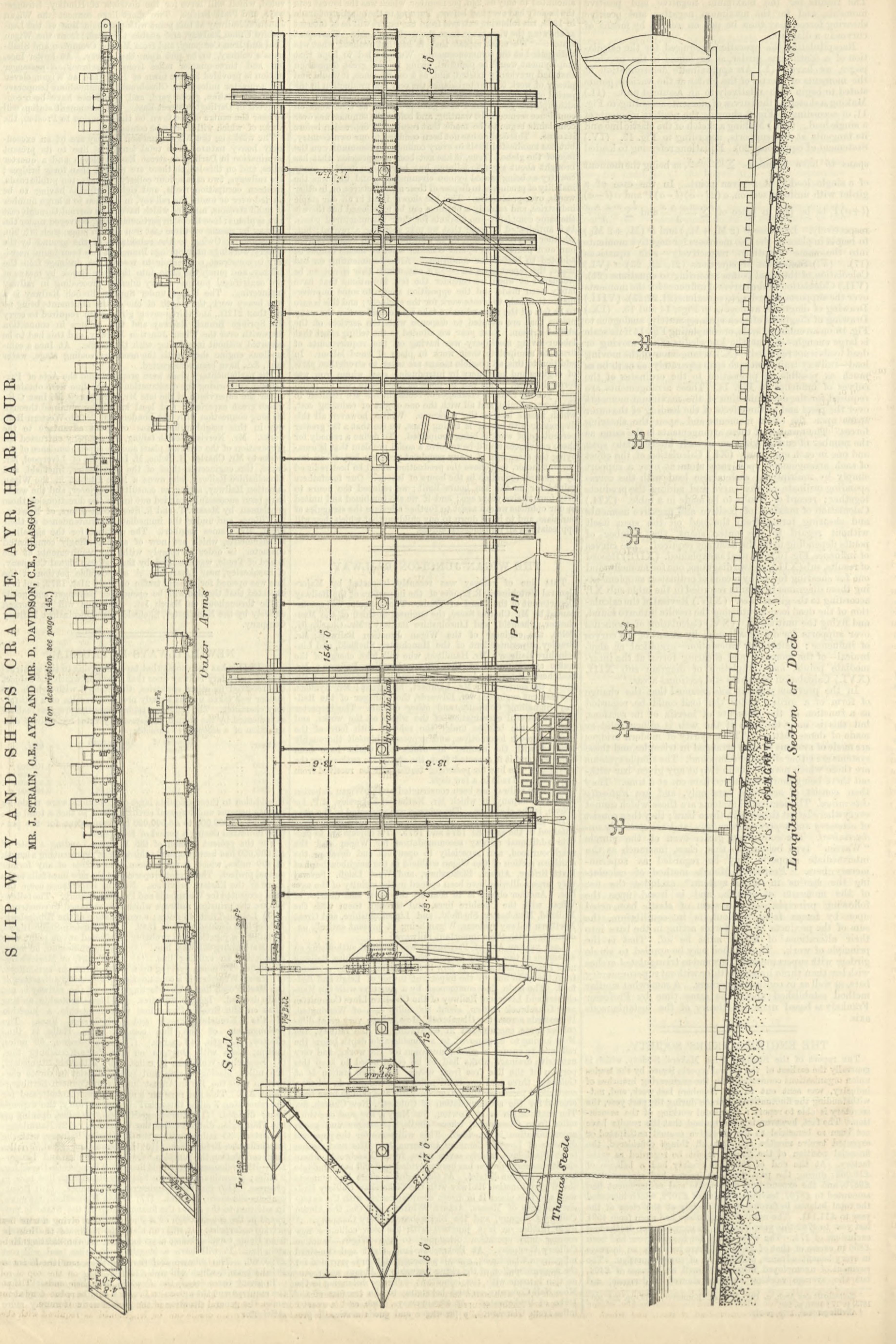
In giving these details the *Deutsche Bauzeitung* remarks that the employment thus given to Prussian engineers has tended to make the general situation of the profession in Germany more satisfactory.

* Zeitschrift des Arch. u. Ing. Ver. zu. Hannover, 1874, pp. 223, 509; 1875, p. 17; 1881, p. 243.
† Civilingenieur, 1875, p. 515.

SLIP WAY AND SHIP'S CRADLE, AYR HARBOUR.

MR. J. STRAIN, C.E., AYR, AND MR. D. DAVIDSON, C.E., GLASGOW.

(For description see page 145.)

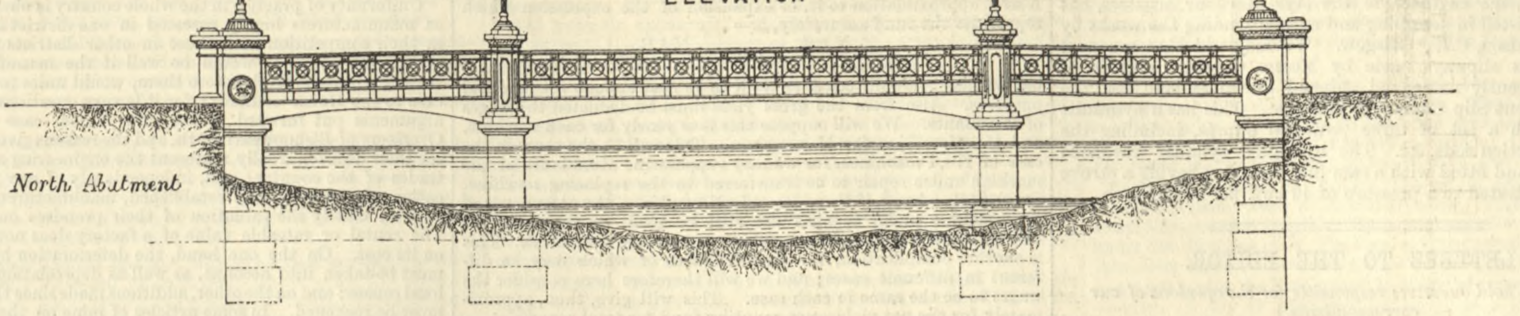


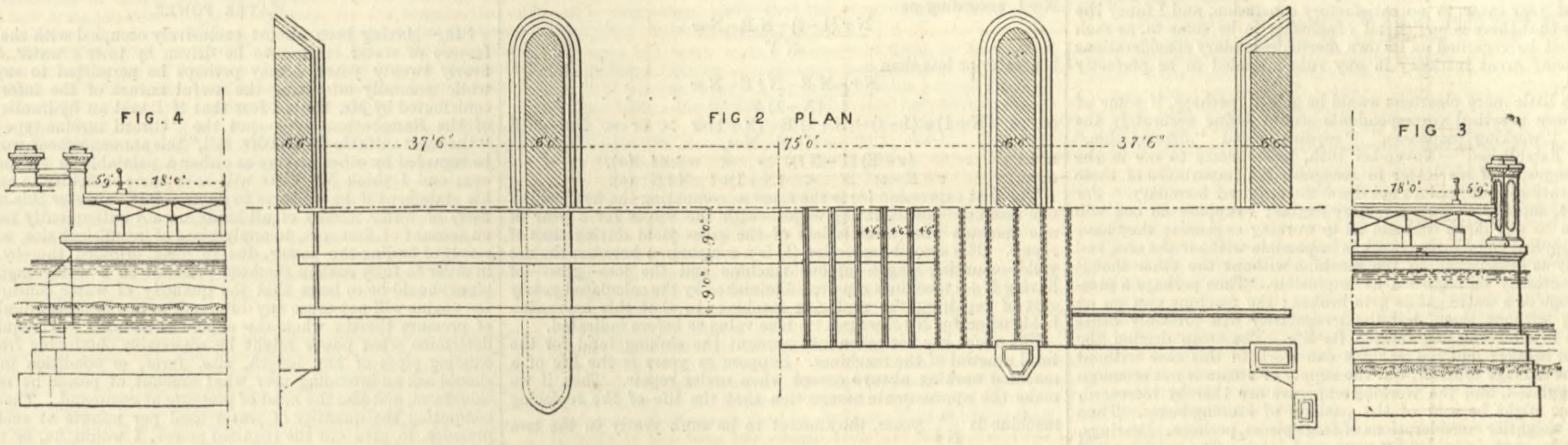
COLEMAN BRIDGE, SINGAPORE.

MR. T. CARGILL, M.I.C.E., ENGINEER

FIG. I.

ELEVATION





THIS bridge, which carries the principal thoroughfare of Singapore over the river, consists of one central and two side spans. It was designed for the municipality of Singapore by Mr. Thomas Cargill, M.I.C.E., and replaces an old worn-out wooden structure upon the same site. As frequently occurs, there was a difficulty in reconciling the level of the necessary headway for the navigation beneath with that of the road approaches above. In order to effect this to the best advantage, the lower flanges or soffit of the girders are curved, and the whole roadway of the bridge has a gentle rise from the springings to the crown, as shown in the general elevation in Fig. 1.

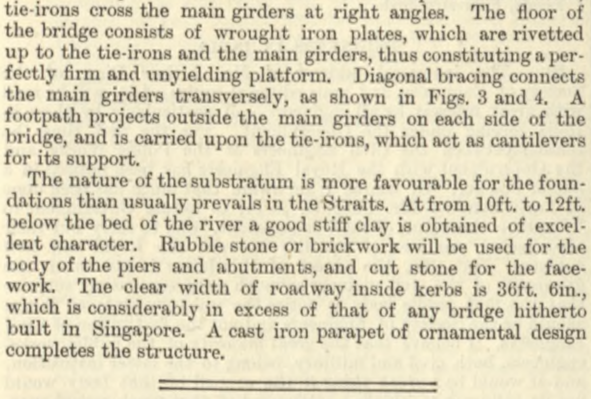
The main girders, which are continuous throughout the whole of the three spans, are wrought iron plate girders, of the usual double-flanged pattern, with upper and lower plates, angle irons, and plate web—see Figs. 3 and 4. They are five in number, and spaced 9ft. apart. At distances of 4ft. 6in. apart from centres, tie-irons cross the main girders at right angles. The floor of the bridge consists of wrought iron plates, which are rivetted up to the tie-irons and the main girders, thus constituting a perfectly firm and unyielding platform. Diagonal bracing connects the main girders transversely, as shown in Figs. 3 and 4. A footpath projects outside the main girders on each side of the bridge, and is carried upon the tie-irons, which act as cantilevers for its support.

The nature of the substratum is more favourable for the foundations than usually prevails in the Straits. At from 10ft. to 12ft. below the bed of the river a good stiff clay is obtained of excellent character. Rubble stone or brickwork will be used for the body of the piers and abutments, and cut stone for the facework. The clear width of roadway inside kerbs is 36ft. 6in., which is considerably in excess of that of any bridge hitherto built in Singapore. A cast iron parapet of ornamental design completes the structure.

COMPOUND ENGINE AND CENTRIFUGAL PUMP.

WE illustrate on page 148 a large centrifugal pump and compound engine, lately erected by Messrs. Hathorn, Davey, and Co., of Leeds, for draining the Burnt Fen, comprising about 33,000 acres of land, lying about 12ft. below the normal level of the river Lark, into which the water is pumped.

The contract was for a pump capable of raising 100 tons per minute 13ft. high; and the assumed discharges at varying heights were the following:—9ft. high, 121 tons per minute; 10ft. high, 115 tons per minute; 11ft. high, 109 tons per minute; 12ft. high, 104 tons per minute; 13ft. high, 100 tons per minute; 14ft. high, 96 tons per minute; 15ft. high, 92 tons per minute; 16ft. high, 89 tons per minute.

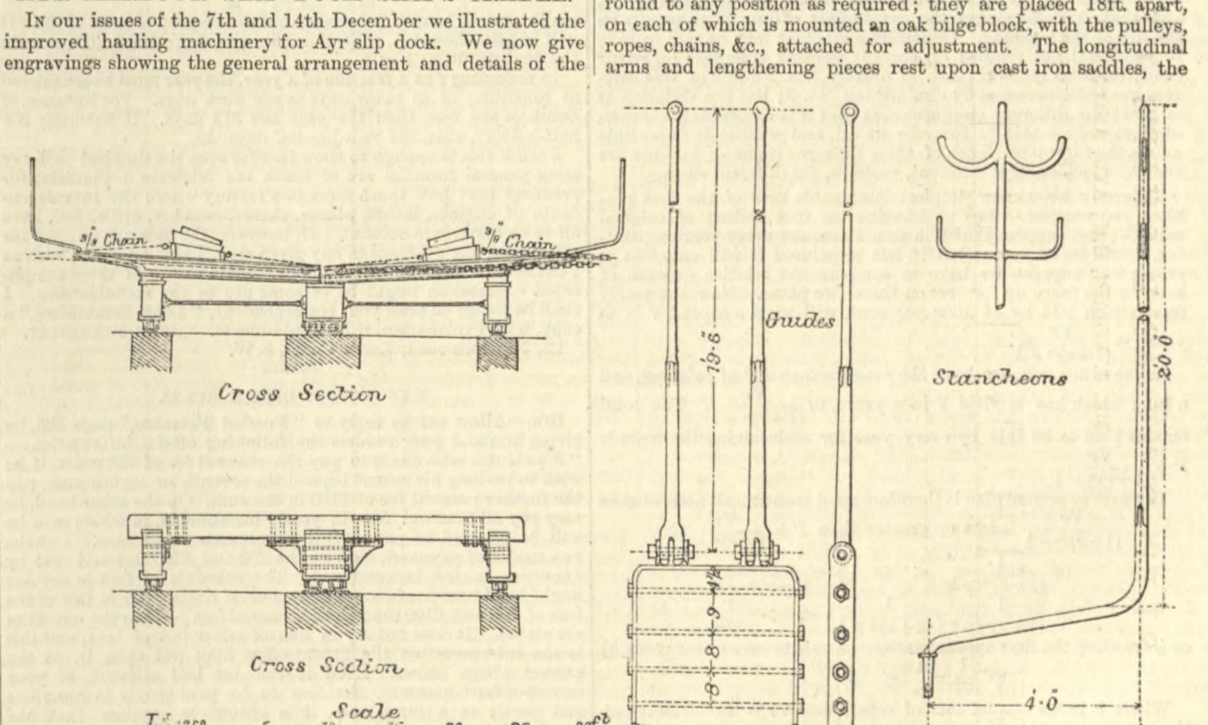


The pump has, however, proved itself capable of exceeding the above quantities by nearly 50 per cent., and has given an efficiency of 64 per cent. under ordinary conditions of working. This is an excellent result, but Messrs. Hathorn, Davey, and Co. propose to make a further trial, and hope to reach 70 per cent. The pump is 6ft. 6in. diameter, and is geared to the engine by means of bevel gearing constructed of steel, and which runs almost noiselessly. The engine has cylinders 18in. and 30in. diameter, by 3ft. stroke, and is provided with a variable expansion valve working on the back of the high-pressure valve. There are three Lancashire boilers, each 20ft. by 7ft.

The remainder of the information which the engravings convey will be readily gathered from them without further description. A section of the pump is given in the engraving below.

AYR HARBOUR SLIP DOCK SHIP'S CRADLE.

IN our issues of the 7th and 14th December we illustrated the improved hauling machinery for Ayr slip dock. We now give engravings showing the general arrangement and details of the ship's cradle as constructed by Messrs. J. Copeland and Co., Pulteney-street Engine Works, Glasgow. The engravings are sufficiently clear to require little explanation. The main cradle is 154ft. long, consisting of a centre and two outer longitudinal arms, which are made of American oak; the latter are 18in. square. The centre arm is made up of two logs planed true and laid side by side, giving a breadth of 3ft.; they are dowelled to each other with round turned timber dowels 4in. diameter. The logs are further secured with 1¼in. bolts placed 2ft. apart horizontally and vertically; at the upper end the sword is secured in a somewhat similar manner. The longitudinal arms are firmly braced to each other by two transverse arms or logs 20in. and 18in. square placed about 13½ft. apart, and firmly secured with malleable iron knees and brackets; they are, however, further strengthened with malleable iron rods fitted with pins to brackets bolted to the arms. These rods can be removed when a vessel has been blocked and the cradle required to be removed from underneath. The cross arms for supporting bilge blocks are made of malleable iron and rest upon the outer and centre longitudinal arms; they can be easily removed or turned round to any position as required; they are placed 18ft. apart, on each of which is mounted an oak bilge block, with the pulleys, ropes, chains, &c., attached for adjustment. The longitudinal arms and lengthening pieces rest upon cast iron saddles, the



journals of which have been chilled, thus giving a true bearing surface for the spindles, and the hard skin of the iron is not broken. The rolling wheels have also been chilled on their outer surfaces.

We are rather surprised that slip dock builders do not make the main cradle ride upon beds resting on the top of rollers instead of on bearings in journals at their ends. The power required to haul a vessel this way would be reduced by about 35 per cent., and the arrangement would not cost more.

The main cradle can be lengthened as required with ekes or lengthening pieces, three of which have been supplied. The first lengthening piece is made entirely of malleable iron to save head room, the other two are made in the form of sandwich beams. The cradle is fitted with hydraulic rams and piping connected to a set of two portable hydraulic pumps mounted on wheels. The rams are made of cast steel, and have been tested by hydraulic pressure to nearly four tons on the square inch. The cradle with lengthening pieces has been designed to accommodate vessels 220ft. long and 1200 tons dead weight.

Mr. Strain, the engineer to the Ayr Harbour trustees, has been ably assisted in designing and superintending the works by Mr. D. Davidson, C.E., Glasgow. We may add that amongst the numerous slipways made by Messrs. Copeland and Co. is one they recently made and shipped to Queensland for the Brisbane Patent Slip Company, Brisbane. This has a hydraulic purchase with a set of three powerful pumps, including the necessary traction rods, &c. The hydraulic cylinder was made in one piece, and fitted with a ram 8in. diameter having a stroke of 15ft., and tested to a pressure of 40 cwt. per square inch.

LETTERS TO THE EDITOR.

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

THE WEAR AND TEAR OF PLANT.

SIR,—Since you have opened the subject of the depreciation of plant in your columns, may I be allowed to offer a few ideas on the subject? You complain that your correspondents on this subject last year came to no satisfactory conclusion, and I fancy the truth is that there is no general conclusion to be come to, as each case must be regarded on its own merits, secondary considerations introducing great intricacy in any rule intended to be perfectly general.

But a little more clearness would be gained, perhaps, if some of your more practical correspondents would define accurately the terms, "working expenses," "repairs," and "depreciation." "Long Established"—November 16th, 1883—seems to me in the last paragraph of his letter to recognise the importance of these considerations, but he does not draw the required boundary. For instance, suppose we have a factory engine; I suppose no one will hesitate to put down fuel and oil to working expenses; they have to be supplied constantly—work is impossible without the one, and probably so destructive to the machine without the other that it may practically be regarded as impossible. Then perhaps a pressure gauge or a water gauge gets broken; the machine can go on working without them, but the irregularity will probably cause damage to the boiler and shorten its life. The strap driving the governor breaks; and the machine can work in this case without apparent damage to itself, but the supply of steam is not economically regulated, and the working expenses are thereby increased. The same might be said of the packing of stuffing-boxes. Then come in weightier considerations of large pieces, perhaps. Bearings, crossheads, or their guides get worn and loose. The machine will work, but is knocking itself to pieces. And so on, through many stages of required repair of defects, some of which affect directly the life of the machine, while others increase only the working expenses by diminishing the economy of working, until we arrive at a stage where no repairing that can be done to make the machine still work is repaid by the work it will subsequently do. This is the death of the machine.

It will readily be understood that the attempt to formulate all these considerations in a general rule introduces complications too intricate for ordinary use. There is also no determination of the law of depreciation proper, and besides this there is the difficulty of fixing exactly the value of the work turned out by the machine, and that of determining the exact effect of any given repairs on the life of the machine. Generally a machine may be said to have to yield—(1) net profits; (2) current working expenses; (3) repair fund; (4) total renewal fund. Probably Nos. 2 and 3 of this category are both increased by diminishing No. 3; but the variation is so great for different circumstances that it is exceedingly cumbersome to reduce this to formulæ at all, and practically impossible unless the interdependence of these different items of expense are known, which itself is different, perhaps, for different cases.

Take now about the simplest imaginable case of the first problem you suggest. Let us imagine an iron railing of original value V, and suppose that if a sum P is spent every year on painting, it will last n years; but if left unpainted it will only last m years; and suppose we have to compare the relative expense of keeping the fence up for ever on these two plans. Now, the yearly fund which laid by at $100r$ per cent. will yield a capital V in m years is $\frac{Vr}{(1+r)^m-1}$.

In the other case, we have the yearly expense P of painting, and a fund which has to yield V in n years, or $\frac{Vr}{(1+r)^n-1}$. The total on this plan to be laid by every year for maintaining the fence is $P+\frac{Vr}{(1+r)^n-1}$.

The first or second plan is therefore most economical, according as

$$\frac{Vr}{(1+r)^m-1} \text{ is less or greater than } P+\frac{Vr}{(1+r)^n-1},$$

$$\text{or } \frac{1}{(1+r)^m-1} < > \frac{P}{V_7}+\frac{1}{(1+r)^n-1},$$

$$\text{or } \frac{1}{(1+r)^m-1}-\frac{1}{(1+r)^n-1} < > \frac{P}{Vr},$$

or (regarding the first approximation on expansion as near enough)

$$\text{as } \frac{1}{m}-\frac{1}{n} < > \frac{P}{V}.$$

Where P is the annual cost of repair, and Vr is the interest—at the usual rate at which the laid-by fund accumulates—on the prime cost V.

Now suppose that really the fence only requires painting every q years, at an expense P^1. Then P in the above problem is the annual fund equivalent to P^1 every q years—that is to say, P is the sum which in q years will yield P^1,

$$\text{or } P=\frac{P^1 r}{(1+r)^q-1}.$$

Here is already one complication introduced. The problem of the most economical value of q is another complication. This can only be solved by knowing what the effect of certain values of P^1 and q upon the value of n is, or perhaps the simple effect of P^1 on q—that is, what expense of repair will make the fence last how long without being repaired again? If the fence at the end of its life is worth so much as old iron, this value may be deducted from V.

Another complication is one which you mentioned in your article in your penultimate issue. Suppose the fence painted every four years, and that the last occasion counting so would occur two years before the fence became useless. It is obviously uneconomical to put a coat of paint which will last four years on a fence which can only last two years. I merely instance this as showing the difficulty of drawing accurately the line of greatest economy even in the simplest case. If q is very small compared with n, this last consideration may be neglected.

With regard to your other question as to the advisability of keeping an extra machine to work during the time of repair of any of the others, I will simplify this case also as much as possible. Suppose V is the prime cost of a machine, and let v be the value of the work turned out by it in an unit of time, so that vt is the value of the worked turned out in time t. Let t be the time taken up by the repair of each machine in the year, and let the unit of time be a year, so that t is a small fraction. Then N t is the time taken up by the repair of N machines; and we will suppose these machines always at work when not under repair. If $(N+1)\,t=1$, one machine suffices for replacing the rest when under repair; and there is always one repairing and the rest working. Generally the yield of N machines is then $N\,v\,(1-t)$ in the year; whereas the yield of the N+1 machines is $N\,v$ a year.

From this we must deduct the cost of repair and wages of men. Let E be the yearly expense of repair of a constantly employed machine; then we will assume for simplicity that $N\,t\,E$ is the yearly cost for the machine that only works for the time $N\,t$ while any machine is under repair. This expression is not strictly correct. A first approximation to it, or expansion of the expression which represents the fund accurately, is—

$$\frac{N\,t\,E}{1-2\,t+t^2+N\,t^2} \text{ or } \frac{N\,t\,E}{(1-t)^2+N\,t^2};$$

but we may generally consider $N\,t\,E$ to be near enough for practical purposes. Also from the gross yield must be deducted the wages of attendants. We will suppose this is w yearly for each machine, and therefore $N\,w$ for N machines. This will be the same in the case of N+1 machines, for we may suppose the attendants of the machine under repair to be transferred to the replacing machine. On the other hand, if there are only N machines, the attendants of the machine under repair must still be paid, or they may be utilised for the repair of the machine or for some other work. This is another complication, the circumstances of which may be different in different cases; and we will therefore here consider the wages to be the same in each case. This will give, then, approximately for the net yield—not counting fund for total renewal—

For N machines, $N\,v\,(1-t)-N\,E-N\,w$ . . . . (1).

For N+1 machines, $N\,v-N\,E-N\,t\,E-N\,w$ . . . . (2).

To compare the value of these yields we must divide each by the respective prime cost, and compare the fraction so obtained. This gives as a result that N machines are more or less economical than N+1, according as

$$\frac{N\,v\,(1-t)-N\,E-N\,w}{N\,V}$$

is greater or less than

$$\frac{N\,v-N\,E-N\,t\,E-N\,w}{(N+1)\,V} \quad . \; . \; . \; . \; (3),$$

or as $(N+1)\,v\,(1-t)-(N+1)\,E-(N+1)\,w >$ or $< N\,v-N\,E-N\,t\,E-N\,w$,

or as $(v-E)\,(1-N\,t) \; > \; < \; w+v\,t$ (*a*),

or as $v-E-w \; > \; < \; (N+1)v\,t-N\,t\,E$ (*b*).

The first expression (*a*) is the same as comparing the net yield of one machine—not counting wages—with the wages for a year of one machine plus what is lost of the gross yield during time of repair. The second expression (*b*) is a comparison between the net yield—counting wages—of one machine and the loss—gross—of having N+1 machines repaired diminished by the calculated yearly cost of repairing the replacing machine; so that this expression holds when for $N\,t\,E$ we put its true value as before indicated.

The above has not taken into account the sinking fund for the total renewal of the machines. Suppose m years is the life of a machine working always except when under repair. Then if we make the approximate assumption that the life of the replacing machine is $\frac{m}{N\,t}$ years, the amount to be sunk yearly in the two cases are respectively—where $100\,r$ is the ordinary rate of interest per cent.—

$$\frac{N\,V\,r}{(1+r)^m-1} \text{ and } \frac{N\,V\,r}{(1+r)^m-1}+\frac{V\,r}{(1+r)^{\frac{m}{N\,t}}-1}.$$

Dividing these by the respective prime cost, we get

$$\frac{r}{(1+r)^m-1} \text{ and } \frac{N\,r}{(N+1)\left\{(1+r)^m-1\right\}}+\frac{r}{(N+1)\left\{(1+r)^{\frac{m}{N\,t}}-1\right\}}$$

A first approximation to these values on expansion gives

$$\frac{1}{m} \text{ and } \frac{N}{N+1}\,\frac{1+t}{m},$$

which should be also deducted from the respective sides of (3). It will be seen, however, that this does not make much difference in the final result, as a rule.

In reckoning t as a fraction of a year, the year must be considered as consisting of so many days as are work days. For instance, if Sundays are free, then the year has 313 days. If Saturday is a half-holiday, then the year has 287 days, &c.

I think this is enough to show that for even the simplest ordinary cases general formulæ are of much too intricate a character for practical use; how much more in a factory where the interdependence of engines, lathes, planes, shears, punches, drills, &c., have all to be taken into account. If, however, the data are at hand for calculating the expenses in any given case, I think a chart, such as I enclose, for reading off the approximate values of these complicated expressions might be of some use to the manufacturer. I shall be happy to send your correspondent, "Long Established," a copy, with explanation, if he would like it. JOHN BLAKESLEY.

23, Fopstone-road, Earl's Court, S.W.

NEW PATENT-OFFICE RULES.

SIR,—Allow me to reply to "Puzzled Patentee," page 125, by giving him and your readers the following official information:—"A patentee who elects to pay the renewal fee of £50 must, if he wish to prolong his patent beyond the seventh or eighth year, pay the further renewal fee of £100 in one sum. On the other hand, he may pay all renewal fees in yearly instalments, in which case he will be allowed to pay several instalments in advance. But the two modes of payment, that by the £50 and £100 fees and that by annuities, cannot be combined. The schedule of fees in the Act might have been made more clear, but it reads, "Or in lieu of the fees of £50 and £100 the following annual fees"—then the annuities are stated. It does not say in lieu of *either* but of *both*, and this is the interpretation the Patent-office have put upon it, as the extract above shows. Even if the Act had allowed, as your correspondent assumes, the fees to be paid partly in annuities and partly in a lump sum, it is absurd to suppose that the required seven days' notice could in any way, as he terms it, "cover this blunder." If the office has decided that fees must either be paid in lump sums of £50 and £100, or by annuities, and not by both, what blunder there is to be "covered" by the rule requiring seven days' notice of payment is a puzzle which your correspondent may explain, but which is beyond the comprehension of a

Manchester, February 18th. PATENT AGENT.

THE RATING OF MACHINERY.

SIR,—Your article of last week on the new rating valuation in the Hunslet Union at Leeds draws attention to a matter of much importance to engineers, and one likely to be followed by similar agitation in other districts. The present diversity of practice is probably due to the fact that the assessments are in the hands of the local authorities, who do pretty much as they like in the absence of appeals to the superior courts. By recent decisions in such cases of appeal it appears to have been clearly laid down that all machinery of a kind so permanent that it would not be provided by a tenant from year to year is rateable, and this without any regard to whether the machines are tenants' fixtures in the ordinary sense, as between freeholder and occupier. This principle, strictly enforced, undoubtedly presses hardly on manufacturers who have, under the old system, paid rates only on the bare value of their premises, with only such undoubted fixtures as boilers included. But it must be remembered that unlike imperial taxation, which is imposed on the whole country, the burden of local rates depends on the needs of each district; and as only a certain total sum is to be raised, a high valuation implies a lower rate per cent. on the rental of each occupier. It is different when, as in the case of the London water companies, an outside corporation takes toll on the rateable value. But for poor-rates, the less one pays the more is left for one's neighbours to pay; and it is they—namely, the community at large—rather than any official authority, who are interested in requiring a fair and full valuation of manufactories. It is useless to characterise, as you do in your article, the fresh valuation as monstrous because it so much exceeds the previous valuation on the old basis; and the question cannot be permanently settled, as it seems to have been at Hunslet, by the local assessment committee consenting to return to the old plan; for the inhabitants of the district, who must pay more than their share if manufacturers pay less, may any of them appeal against the rate as bad on that ground.

Uniformity of practice in the whole country is obviously desirable, as manufacturers highly assessed in one district are handicapped in their competition with those in other districts where an easier system prevails. It would be well if the manufacturers, while their grievance is fresh before them, would unite to take an appeal case to the House of Lords; for it is very questionable how far the arguments put forward in the now famous case of Laing *v.* the Overseers of Bishopwearmouth, and the reasons given by the Judges for their decision, really represent the engineering and other staple trades of the country; and, independently of any possible modification of the rule then established, manufacturers would do well to scan closely the valuation of their premises on the new basis. The rental or rateable value of a factory does not depend merely on its cost. On the one hand, the deterioration by wear and tear must be taken into account, as well as depreciation of value from local causes; and on the other, additions made since the last valuation must be reckoned. In some articles of mine on the "Depreciation of Factories," which you did me the honour to publish in October last, some of the incidents which affect valuation were discussed, and there is much to be said on the subject from the ratepayers' point of view. EWING MATHESON.

London, February 18th.

WATER POWER.

SIR,—Having been almost exclusively occupied with the manufacture of water engines to be driven by town's water, &c., for nearly twenty years, I may perhaps be permitted to say that, while generally admitting the useful nature of the information contributed by Mr. Hett, I fear that if I said an hydraulic engine of the Ramsbottom type—not the "Girard turbine type"—was "the most suitable for a 200ft. fall," this announcement would not be regarded by other makers as either a palatable or an impartial one; and I think Mr. Hett will have some difficulty to establish his statement if he ventures to do so. But, however this may be, users of water motors of all kinds are not unfrequently tempted, on account of first cost, to apply pipes of insufficient size, with the result of finding the power, due to head, crippled thereby. For, in order to fully sustain the head pressure on a water engine, the pipes should be so large that the quantity of water consumed by the engine will not cause any difference or any practical diminution of pressure therein when the engine is running. If required to determine what power might be reasonably obtainable from any existing pipes of any length, size, form, or condition inside, I should ask an intending user what amount of power he required therefrom, and also the head of pressure at command. Then, after computing the quantity of water used per minute at such head pressure, to give out the required power, I would fix, or request user to fix, a pressure gauge on said pipes, and withdraw by a stop tap this computed quantity of water per minute into a cask or measured vessel, and take note of the reduction of pressure thereby incurred. If the pressure at such rate of flow per minute was reduced one-tenth only, then somewhat more than one-tenth of additional speed would be necessary to give out the required power, because the additional discharge thus produced would cause a further loss of pressure. But if the reduction of pressure was much greater than one-tenth, then the pipes would be clearly too small to give out such power with high efficiency. Formulæ such as Mr. Low's excellent letter refers to, while useful for determining reduction of flow in pipes by friction with an open and unrestricted outflow, will be applicable only to such turbines as admit of equally unrestricted passage; but a water-pressure engine confines or limits this flow, and thereby retains the pressure on the pistons of the engine when running, and so makes the flow, or the quantity of water consumed, depend on the piston speed, or on the amount of power required to be given off. J. RAMSBOTTOM.

Leeds, February 18th.

ENGINEERS IN INDIA.

SIR,—The inaugural address of Mr. Arthur Rigg, of the Society of Engineers, and your editorial notice of it, will be read with great interest by all engineers, and particularly by those in India serving under the Government. For the first time the tension between the Civil Engineers of the Public Works and the Government with the Royal Engineers has been noticed in a public manner. Of course I am aware that much has been done in Parliament by Mr. Carbutt, M.P., to induce Government to "improve the terms of their engagement," and to carry out their oft-repeated promises of equality between the Royal and civil engineer. But, Sir, the object of this letter is not to air the grievances of the civil engineer so much as to express my surprise that the first public body to notice the unhappy state of things should be the Society of Engineers and not the Institution of Civil Engineers. I believe that the great majority of the public works' engineers, both civil and military, belong to the latter institution, and it would be a great thing if the council of that body would use its influence to obtain a settlement of that much vexed question. When, in 1870, certain imputations were indirectly made by the Government of India that it was the practice of English engineers to accept commissions from manufacturers, a very firm protest was, I believe, made by the Institution, and with a beneficial result.

With regard to the education of civil engineers for India, the position of Coopers' Hill is rather that of an experiment, not as regards the engineers who come from there, as no one who has worked with them can have failed to recognise that they are eminently well qualified for their work; but unless it can be shown that Coopers' Hill is self-supporting, it is not likely that India will be called on to pay towards its support; and as, no doubt, there will be in future a larger admission of natives of India as engineers in the Public Works' Department, there will be fewer appointments open to the College. INDIAN PUBLIC WORKS.

Westminster, February 19th.

A NEW STEEL.

SIR,—We notice under the above heading a paragraph in the *Sheffield Daily Telegraph*, of the 16th inst., quoted from THE ENGINEER, that Messrs. Hadfield and Co., of Sheffield, claim to have discovered something new in ferro-manganese steel. We do not see that Messrs. Hadfield have found out anything new in this; they have, no doubt, found out something useful which they did not know of before. There are several firms in this town which have used ferro-manganese with other mineral ores in quite as high a percentage as Messrs. Hadfield and Co. state. We manufacture self-hardening tool steel, which contains between 7 and 20 per cent. of ferro-manganese infused with other ingredients, and after being forged into bars it is easily manipulated in the lathe, shaped into circular cutters or any other tool required, and then heated red hot and allowed to cool on the floor, when it becomes self-hardened. We send you a turning tool for inspection, made from our special self-hardening steel, which has been tested with most satisfactory results against a well-known self-hardening steel, which has been used in the engineering trades for many years. We also enclose a file made from the same steel, which has been forged, annealed, ground, and cut in the ordinary way, then heated as above and laid down to cool, and tang tempered in the usual way. Therefore you will see that Messrs. Hadfield's manganese steel is not altogether new.

GEORGE BENNETT AND CO.

Foundling Works, Rockingham-street, Sheffield, Feb. 20th.

RAILWAY MATTERS.

THE number of passengers transported on all the railroads of the United States in 1882 was 289,190,783.

RAPID progress is being made with the Highgate Hill cable tramway, and it is expected that it will be opened next month.

THE total number of miles of railroad in the United States is 124,910, or seven times as many miles as the United Kingdom of Great Britain.

THE Railway Committee of the Lower House of the Reichsrath has accepted the proposals of the Government for constituting the Francis Joseph, Vorarlberg, and Rudolfsbahn State Railways.

THE Bavarian establishment for the manufacture and impregnation of railway sleepers at Kirchseeon is able to produce 500,000 sleepers every year, this quantity being about one-tenth of the total quantity used annually in the maintenance of the German railways.

As the Scotch Pullman train which left St. Pancras at 10.35 a.m. was passing through Hellifield station a few days ago, at a speed of about forty miles an hour, a heavy luggage bogey was swept by the wind off the platform on to the line. The bogey was smashed to pieces; but the engine, fortunately, did not leave the metals, and the train was brought to a standstill.

TWO or three months ago the railway carriers serving the Midlands suddenly increased by from 30 to 90 per cent. the rates for the carriage of heavy ironfoundry work to Leeds, Middlesbrough, and Scotland. Great dissatisfaction was expressed at this procedure, the matter being a most serious one to the large ironfounders and engineers. It is now announced that the carriers have just unconditionally removed these extra freightage rates.

THE Board of Trade of Winnipeg have telegraphed the Dominion Government to confer with the Canadian Pacific Railway, under the new arrangements with that company, for the construction of 300 miles of the South-Western Railway during the next season. The Ministry pointed out that the new arrangements only applied to the main line, and of course nothing could be done in the matter by them. The Canadian Pacific directors, however, have promised to permit 100 miles of road to be built next summer.

DURING the second half of last year the Midland Railway Company secured a larger increase than any other railway in the United Kingdom, although the total mileage worked by its engines was only twelve miles more than in the corresponding period. The coaching receipts yielded £30,248, the merchandise £3957, and the mineral traffic £121,481 more than in the corresponding period. This result is, to a large extent, due to the heavy business which the company has of late years developed between the Derbyshire coalfields and the metropolis. In the past twenty years the company has increased the tonnage of coal which it brings into London by 2,184,000 tons.

THE Indian Government has published the reports of preliminary surveys of some new and important railway lines. The first of these, 736 miles in length, is intended to connect Assam with the sea, and will run from Chittagong through Cachar to Dibrooghur, with a branch to Gowhatty. It is estimated to cost 64,673,000 rupees. A line is also projected from Mogal Seria, near Benares, through Chota Nagpore and Orissa to Pooree, with a branch to Gya. The length will be about 652 miles, and the cost about 68,200,000 rupees. This line will pass through extensive coalfields, and will afford a short route for pilgrim traffic between the North-west and Pooree.

THE ship railway across the Mexican Isthmus of Tehuantepec is now, the *Globe* says, being pressed forward. The survey of the isthmus has been completed under the care of Mr. Van Brocklin, an American civil engineer. A route with even more moderate gradients and cuttings than were expected has been adopted, and the works have been commenced. Mr. J. B. Eads, C.E., the builder of the steel bridge across the Mississippi at St. Louis, and whose improvement of the Mississippi navigation has opened up New Orleans to ships of the deepest draught, is now in London concerning business arrangements with shipowners and others, and the probability is that the ship railway will come under British control, financially and otherwise. Several gentlemen eminent in and in connection with the shipping world are taking the subject up warmly, as this route will, it is claimed, shorten the sailing distance between Europe and the North American Pacific coasts, including, of course, the British possessions, by more than 8000 statute miles, and is 1200 miles less than the Panama route. The Panama Canal Company has had to buy the Panama Railway. Will it have to buy another?

OUR Birmingham correspondent writes:—"The adoption by the North Staffordshire Tramways Company of the Wilkinson type of tramway locomotive is regarded as an economical step. As yet, however, no actual improvement in working expenses has been experienced, for through the additional requirements of the Board of Trade, Messrs. Beyer, Peacock, and Co., have been unable to deliver the twenty engines ordered as rapidly as could be wished. The report of the directors for the six months ending December 31st, which was adopted on the 9th inst., states that at the end of the year only four had been received, and that these had not yet been fairly got to work. Since then four others had been delivered, and the remaining twelve might be expected at the rate of four a month. During the half-year the profits reached the satisfactory amount of £1709, as compared with £563 for the seven months preceding, and £1271 for the entire year 1882. The cost of steam traction per mile—inclusive of all charges—was 11·04d., and of horse-power 6·233. The receipts per mile on the steam lines were 16·59d.; and on the horse line, 6·39d. In Birmingham alone, so advantageous has steam road locomotion been found, that certain omnibus and other companies are contemplating its use instead of horse-power. Among them are the Birmingham Tramways and Omnibus Company. The question is, however, by no means yet settled. Those adverse to the change point out that Manchester has 125 miles of rails laid down; Liverpool, 67¾ miles; London, 34½; Dublin, 32; Edinburgh, 31¾; and Glasgow, 26; yet none of these large towns use steam. The company is about to introduce from Paris omnibuses which they say 'will astonish Birmingham.'"

A BOARD OF TRADE report has just been published on a very curious accident which happened on Christmas Day last near Newton Abbott station, on the Great Western Railway. As traffic was heavy, the ordinary down mail to Plymouth had been divided into two parts on the night of the 24th. The first portion reached Newton Abbott at 3.24 a.m. on the 25th; the remaining portion, which consisted of a van and five coaches, was to be sent on to Rattery with two engines, as there are steep rising inclines for the first thirteen or fourteen miles of the railway at the south side of Newton Abbott. A six-wheel coupled tank engine that was employed as a pilot was backed to the train, and was coupled on to it by the porter whose duty it was to couple up the engines and carriages at the station. After coupling up the pilot engine, the porter went to the back part of the train to detach the last coach. The second engine backed on the train just after the porter left. At 3.35 a.m. the guard gave the signal for the train to start. Both engine-drivers sounded their steam whistles, and the train left. There was a thick fog at the time. When the driver of the leading engine got out of the cutting at the south side of the station, he thought that he was running faster than usual, and on looking round he found that his engine had no train attached to it. He stated that he could not hear or see anything of his train, and he therefore assumed that he had left it at Newton Abbott station, and he at once applied the steam brake to stop his engine, but it was still moving at a speed of about three miles an hour, when it was run into by the pilot engine that was attached to the mail train, which was running at a speed of twenty-five to thirty miles an hour. The two engines were a good deal damaged, and the two front wheels of the foremost engine were knocked off the rails. Placing the pilot engine behind the train engine prevented the use of the continuous brake with which the train was fitted.

NOTES AND MEMORANDA.

IN the Hotel Dieu, Paris, already provided with Gramme machines and steam engine, the Administration of the Assistance Publique has decided to introduce experimentally the use of incandescent lights in the halls inhabited by patients. The Hotel Dieu is the largest and the leading French hospital.

AN Oregon correspondent of the *Scientific American* says that, in the Willamette Valley, in 1850, the magnetic needle showed a variation of 20 deg. E., where now it is 21 deg. 10 min. E., thus indicating that the magnetic pole is there moving eastward about 2 deg. a year. He has noticed greatest disturbance in vicinity of recent volcanic upheavals, varying as much as 20 deg. in a mile, and suggests that the thickness of the earth's crust or the varying natural heat of the earth may have some effect.

FOR waterproofing leather the following has been given in the *Ind. Oil and Drug Jnl.*:—"Twenty-four parts oleic acid, 18 ammonia soap, 24 water, 6 raw stearic acid, 3 tannin extract. The oleic acid is first melted with the raw stearine, then the ammonia soap is added, and afterwards the extract, and finally the water. The ammonia soap is obtained by treating oleic acid with ammonia until the smell of the latter does not appear after a lengthy stirring. By adding to the whole mixture a solution of two parts copperas in 6 parts of water a deep black colour is obtained, admirably adapted for dyeing shoe-leather."

PROFESSOR THOMPSON in a recent lecture stated that the magnetic pole is now near Boothia Felix, more than 1000 miles west of the geographical pole. In 1657 the magnetic pole was due north, it having been eastward before that. Then it began to move westward until 1816, when the maximum was reached. This is now being steadily diminished, and in 1976 it will again point true north. Professor Thompson says that the changes which have been observed not only in the direction but in the strength of the earth's magnetism, show that the same causes which originally magnetised the earth are still at work.

DURING the week ending January 19, 1884, in 30 cities of the United States, having an aggregate population of 7,028,900, there died 2754 persons, which is equivalent to an annual death-rate of 20·4 per 1000, a diminution from the rate for the preceding week, which was 22·0. For the North Atlantic cities the rate, as given in the *Scientific American* says, was 20·2; for the Eastern cities, 21·1; for the Lake cities, 16·2; for the River cities, 18·6; and in the Southern cities, for the whites 21·4, and for the coloured 35·7 per 1000. Of all the deaths 33·1 per cent. were of children under five years of age, the highest rates of this class being in the coloured population of the district of Columbia, where it was 62·2, and in the coloured population of Atlanta, where it was 62·5.

FROM the statistical reports from the companies owning the fifteen Bessemer steel works which were in operation in the United States in 1883, it appears that the quantity of Bessemer steel ingots produced in the United States last year was 1,654,627 net tons, against 1,696,450 tons in 1882, showing a decrease of only 41,823 tons. This is a much smaller decrease than has been generally supposed. It was, however, the first decrease that has occurred in the history of the Bessemer steel industry of this country. The production of Bessemer steel ingots in the United States from 1874 to 1883, in net tons, has ranged from 191,933 to 1,654,627 tons. The quantity of Bessemer steel rails produced in 1883 by fourteen of the works above referred to—one of the companies not producing rails—was 1,253,925 net tons, against 1,334,349 net tons similarly produced in 1882, showing a decrease of 80,424 tons.

IN their report on the water supplied to London during January, Messrs. William Crookes, William Odling, and C. Meymott Tidy say they have no hesitation in calling attention to the discordance between their report, based upon analysis of 189 samples, and Dr. Frankland's, based on seven; "or to the circumstance that, according to the report to the Registrar-General, the mean amount of organic carbon in the Thames derived waters supplied during the month of December, 1883, or ·246 part in 100,000 parts of the water, was identical with the mean amount of organic carbon in the Thames derived waters supplied during the month of December, 1882; notwithstanding that throughout December, 1882, the river was in a quite exceptional state of turbidity and flood; whereas at no part of the month of December, 1883, was it in a bad condition for the time of year, while its condition during the latter part of the month was exceptionally good." Dr. Frankland, it will be observed, speaks of the water supplied during the month, while his seven samples are taken on one day of that month.

AN improvement has recently been introduced into the Edison system of electric lighting. The American *Electrician* says that by the addition of a third main conductor it is stated that a saving of 62½ per cent. in the amount of copper requisite for the conductors is effected. The electro-motive force ordinarily used in the Edison system has been 110 volts. By placing two dynamos in series, and running a conductor from each of the outside terminals and a third wire from a point between the terminals, the electro-motive force is increased to 220 volts. The Edison lamps, however, are made to burn on a 110-volt current, so that it is necessary to burn two lamps in each series. This would be inconvenient were it not for the third wire, as both would have to be turned on or off at once. By using the third wire, and putting alternate houses in circuit between the first and second, and second and third wires, each set of lamps may be turned off independently, and the tension of the current in each house can be kept down to 110 volts, and still secure the reduction in the quantity of copper in the mains, and greatly diminish the cost of central station installations.

CONVERTING into gross tons, the *Engineering and Mining Journal* says, "the net tons of steel rails produced in our Bessemer steel works in 1882 and 1883, we have 1,191,383 gross tons produced in 1882, and 1,119,576 gross tons produced in 1883. The figures given for 1882 do not cover the total production of steel rails in the United States in that year, as there were 103,806 net tons of Bessemer rails rolled in iron rolling mills, chiefly from imported steel blooms, and there were also 22,765 net tons of open-hearth steel rails rolled, making a total production in 1882 of 1,460,920 net tons of steel rails. In 1883 we rolled very few tons of Bessemer steel rails in iron rolling mills, either from imported or domestic blooms, and we probably made fewer open-hearth steel rails in 1883 than in 1882; in the absence, as yet, of complete statistical returns, we estimate the total production from these two sources at considerably less than 50,000 net tons. Adding, say, 46,075 tons from these sources to the 1,253,925 net tons of Bessemer steel rails ascertained to have been rolled in 1883 by our Bessemer steel works, we have a probable total of 1,300,000 net tons of steel rails rolled in the United States in 1883, or 160,920 tons less than in 1882."

PREPARATIONS are now being made upon an elaborate scale at the Johns Hopkins University, at Baltimore, under the direction of Prof. Rowland, for the exact determination of the value of the ohm. An American contemporary says: Two principal methods will be employed. First, the resistance will be found by means of the mechanical equivalent of heat. The apparatus used by Prof. Rowland, in his well-known work on that subject, has been set up for this purpose. It is proposed to heat a non-conducting fluid, such as alcohol or turpentine, by heat developed in a conductor whose extremities are kept at a known difference of potential. The same temperature will then be reproduced under like circumstances by mechanical means. The resistance of the conductor will thus be determined directly from the work equivalent of the heat developed in the conductor. The second method to be used is that of Kirchoff, as modified by Rowland in his determination of the ohm in 1876; most of the instruments will, however, be new. If time permits, the earth-inductor method of Weber will also be used. Fifty Planté cells charged by a small dynamo machine will supply the electricity in the calorimetric method. For measuring large currents, an electro-dynamometer has been constructed with the Helmholtz arrangement of two large coils and a single small suspended coil.

MISCELLANEA.

AT the Agricultural Exhibition at Natal on the 2nd and 3rd ult., one of Messrs. E. R. and F. Turner's patent automatic expansion portable engines was exhibited, and the only medal for imported machinery was awarded for it.

THE death is announced of Count Theodore de Mouncel, the eminent electrician, on Saturday night last, at the age of sixty-three. He was the son of a Brigadier-General, and married a daughter of Montalivet, one of M. Thiers' intimate friends.

WHEN the lantern of the Peterborough Cathedral tower was condemned defects, described by us, were observable in both transepts. These have now developed, and the tearing away of transepts from the nave are clearly visible from the triforium to the base.

MM. CHALLIOT ET GRATIOT, of Paris, have constructed what they term a "bi-radial" drilling machine. That is to say, the arm is articulated in the middle, so that the drill can be brought over any point in the surface of the table, without shifting the latter. The power is transmitted by means of bevel gear.

THE new harbour at Trieste, opened in December last, has occupied sixteen years in its construction. There is a breakwater about 1200 yards in length. The works were for the first two years under the direction of M. Pontzen, a French engineer, since which time Herr Bömches has been entrusted with the supervision.

A CASE under the Employers' Liability of some interest has been decided. A boy at Aberdeen employed as a labeller in aërated water works had one eye destroyed by the bursting of a bottle. He sued his employer for £300 damages; but the sheriff found, on the evidence, that the bursting of a bottle during labelling was so rare that it was not incumbent on the employer to provide special protection, and that, therefore, in this case the master could not be held to be liable.

THE report of Mr. Rendell, M.I.C.E., as been made with regard to the Milford Docks. He states that £119,000 will suffice to accomplish all needed in eighteen months. The result would be: Dock space, 15 acres, of which 12½ acres will be 31ft. deep, and the residue 20ft. deep; quay space, 2035ft.; entrance basin lock, 680ft., 93ft., with a depth on the entrance sill of 34ft., and at the other end of 31ft.; dry or graving dock, 560ft. by 70ft., with depth on sill of 26ft.; entrance jetty, 500ft. in length.

ON Tuesday, the 19th inst., an interesting trial of a large dry-air refrigerator was made at the works of Messrs. Siebe, Gorman, and Co., Westminster Bridge-road. The machine, which has been constructed on the patent of Mr. T. B. Lightfoot, is one of several now being made for the Australian frozen meat trade, and is to be put to work on one of the vessels of Messrs. W. Howard Smith and Sons, of Melbourne. Its special features are its simplicity and noiselessness in working, there being none of the clatter and vibration common to many cold-air machines. Besides this it is exceedingly compact, notwithstanding that long strokes have been provided; while the arrangement is such that all parts can be easily got at even when the machine is in operation. A number of visitors were present at the trial, and everyone expressed satisfaction at the results obtained.

A FEW days ago a steam boiler exploded at the office of the *Yarmouth Independent* newspaper. The office was nearly wrecked, and one man much injured. The boiler was on the ground floor, and when it exploded it ripped up the floor above, practically wrecking the premises. The accident occurred on publication morning, but the paper was issued as usual in the course of the day. The *Yarmouth Independent* is not accused of extreme views on boiler insurance questions. Independent, however, of the extremely independent and high-flown notions of its boiler as to means of reaching upper stories, the upper stories of Yarmouth readers are likely to hold their own views as to how far "pressure on space" is here concerned. The *Yarmouth Independent* has not made known any intention of publishing articles on the strength of steam boilers as proved by experiment.

THE fourteenth edition of the City of London Directory has just been published by Messrs. W. and L. Collingridge, and contains a larger number of business names than any preceding volume. The changes have been more numerous than for some years, owing to the re-building of many offices and warehouses, and the improvements in King William-street, Eastcheap, and Great Tower-street, consequent upon the completion of the Inner Circle Railway. The Commercial List contains 41,000 names. The Trades List contains 40,000 names, under 1914 heads. It contains a complete record concerning the Livery companies, their members, fees, charities, and property, and has also the list of the names and addresses of the masters and wardens, and the liverymen who have votes for the City. Public companies are given separately, and any are easily found. The Directory is, as usual, well got up and reference to all parts made easy.

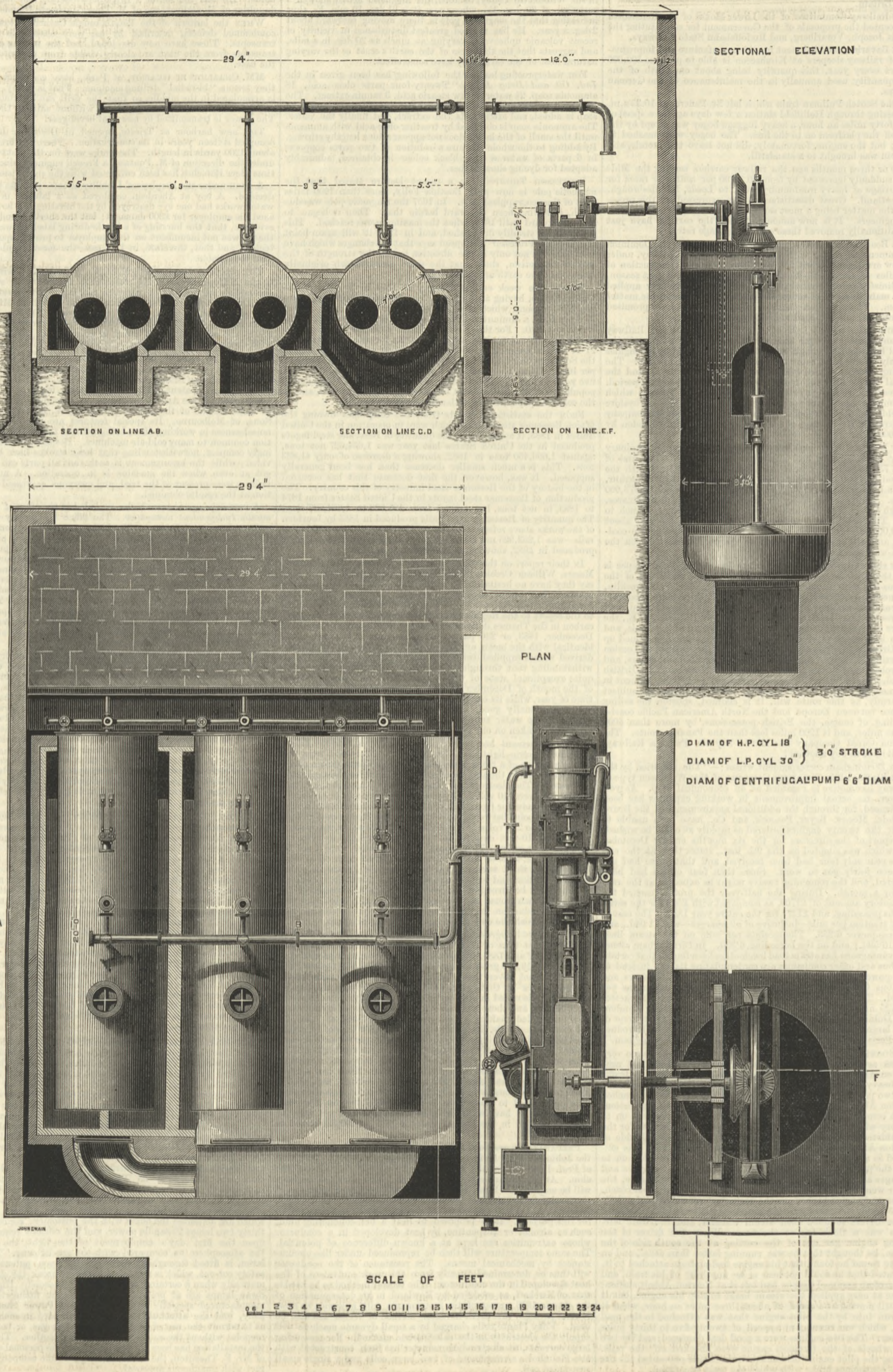
MESSRS. LE GRAND AND SUTCLIFF, of 100, Bunhill-row, have recently completed or have in progress several deep artesian bored tube wells. At one of the largest mineral water manufactories at Berners-street, Oxford-street, they have just finished a 6in. tube well, which is carried down to the chalk springs, and which are 315ft. below the surface. Another tube well, the probable depth of which will be between 200ft. and 300ft., is in progress at Messrs. White and Sons' mineral water works, near the Elephant and Castle, Camberwell. On the estate of a large brick-making company at Pitsea, in Essex, Messrs. Le Grand and Sutcliff are sinking a shaft of 5ft. diameter to a depth of 100ft., from the bottom of which a tube well will be made for a further 200ft. or 300ft. At Lichfield a brewery company is having a tube well sunk in the new red sandstone formation, which has reached about 150ft. and is still being driven deeper. Messrs. Truman, Hanbury, and Buxton have given instructions for an additional 5in. tube well to be sunk at their brewery at Burton-on-Trent in consequence of the favourable result obtained from two similar tube wells which they have had for some years in use, and drawing water from the new red marl which underlies the gravel deposit of that place.

THE Bank of England has now been fitted up with the electric light by the Electrical Power Storage Company, the manufacturers of the Faure-Sellon-Volckmar accumulator. The installation has been fitted up without interfering with the convenience of the staff of the bank. It was intended to take the motive-power from the existing steam engine and boiler, manufactured by Messrs. Boulton, Watt, and Co. over forty years ago, during those hours when the power was not otherwise required, but it was subsequently found to be more convenient to put down a horizontal portable engine and boilers specially to drive the dynamo machine. This is of the Victoria type constructed by the Anglo-American Brush Electric Light Corporation. Its electro-motive force is 120 volts, and it is capable of giving a current of 60 ampères. The dynamo charges a battery of 55 Faure-Sellon-Volckmar cells which in turn feed 150 incandescent lamps. The lamps are distributed throughout what is rather curiously known as the private drawing-office, through the till-office and the vaults. These latter, in which are deposited the boxes with the customers' securities, have thirty-two lamps 20-candle power, and the officials remarked even upon the first day's employment of the light, the purity of the atmosphere as compared with the gas lighting. The installation is fitted throughout with the Anderson patent magnetic safety cut-out, which is regulated so as to break the circuit automatically when a certain fixed current is exceeded. High tension Swan lamps are at present employed. The fittings have been manufactured specially by the Electrical Power Storage Company, and are attached to each gas standard in such a manner as to permit the use of either electricity or gas, or both, at any moment without the one interfering with the other. The whole of the installation has been carried out under the personal supervision of Mr. F. Thornton, the works' manager of the company, and has met with unanimous approval.

COMPOUND ENGINE AND CENTRIFUGAL DRAINAGE PUMP.

MESSRS. HATHORN, DAVEY, AND CO., LEEDS, ENGINEERS.

(*For description see page* 145.)



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NEW YORK.—THE WILLMER and ROGERS NEWS COMPANY, 31, *Beekman-street.*

TO CORRESPONDENTS.

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

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

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

STOKER.—*If you will let us have a description in confidence of your invention, we shall be in a position to advise you.*

PROGRESS.—*You can get a copy of the Act for a few pence from Messrs. P. S. King, King-street, Westminster. We may add that the Act is practically prohibitive.*

W. S. H.—*The sentence should read: "Not one of whom stated it was the custom, &c." If you will apply to Messrs. Hedley and Son, valuers, Sunderland, they will no doubt tell you how to get a report of the appeal in Mr. Laing's case.*

IRON FOR CHILL CASTINGS.

(*To the Editor of The Engineer.*)

SIR,—Will some of your readers kindly give me the best brands of iron for making ploughshares—same as our noted makers make them—to give them a good chill? M. B.

LOCOMOTIVE PERFORMANCE.

(*To the Editor of the Engineer.*)

SIR,—Can any reader give me the greatest mileage known of any engine in England made in one year, two, three, four and five consecutive years; an estimate of the average tons hauled and the average speed per mile; also the road it was done on? C. H.

Sheffield, February 15th.

SPRING MAKING MACHINES.

(*To the Editor of The Engineer.*)

SIR,—Can any reader inform me where I can obtain a machine for making spiral springs ½in. diameter and of 20 B.W.G. wire? I want the spring 6ft. long, or longer, and the end of the spring as it is thrown from the machine to be quite free. Or could any fellow-reader suggest a machine that I could make; also the best manufacturers of light steel wire? SPIRAL.

Salford, February 15th.

THE "WORK TESTER," AND THE MANCHESTER PLATEWAY.

(*To the Editor of The Engineer.*)

SIR,—Some few weeks since I saw in one of the scientific papers, but in which one I cannot remember, an account of an instrument or apparatus called "The Work Tester." It was a contrivance for recording the actual work done by a steam engine; it was not an engine counter merely, but an instrument which took note, so to speak, of the resistance the engine met with at every stroke. I have searched high and low for the paragraph, which, by the way, was illustrated, but I cannot find any trace of it. Can any of your numerous readers help me with a reference to the name and address of the makers? While I am writing I should also like to ask whether the Manchester Plateway scheme is still in promotion, and where or how I may put myself into communicatiou with the promoters? It has occurred to me that you may perhaps be willing to help me as to these inquiries through your correspondence columns. M.

London, February 19th.

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

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

MEETINGS NEXT WEEK.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, Feb. 26th, at 8 p.m.: Ordinary meeting. Paper to be read with a view to discussion, "Hydraulic Propulsion," by Mr. Sydney W. Barnaby, Assoc. M. Inst. C.E.

SOCIETY OF TELEGRAPH ENGINEERS AND ELECTRICIANS.—Thursday, Feb. 28th, the following papers will be read:—"On Some Prejudicial Action in Dynamo Machines," by Mr B. W. M. Mordey, Associate. "On the Effects of Induction in Alternate Current Machines," by Professor Forbes, F.R.S.

SOCIETY OF ARTS.—Monday, Feb. 25th, at 8 p.m.: Cantor Lectures. "Building of London Houses," by Mr. Robert W. Edis, F.S.A. Lecture II. Sanitation, lighting, heating, and ventilation. Tuesday, Feb. 26th, at 8 p.m.: Foreign and Colonial Section. "Reflections on Chinese History, with Reference to the Present Situation of Affairs," by Mr. Demetrius G. Boulger. Wednesday, Feb. 27th, at 8 p.m.: Twelfth ordinary meeting. "Internal Corrosion and Scale in Steam Boilers," by Mr. G. Swinburne King. Mr. E. A. Cowper, M. Inst. C.E., will preside. Thursday, Feb. 28th, at 8 p.m.: Applied Chemistry and Physics Section. "Recent Progress in Dynamo-Electric Machinery," by Professor Silvanus P. Thompson. Mr. W. H. Preece, F.R.S., will preside.

THE ENGINEER.

FEBRUARY 22, 1884.

ELECTRIC LIGHTING.

BY degrees the various speculative companies which did so much to injure the reputation of electricity as an illuminant are dying out; and it seems that we are within a measurable distance of the time when electric lighting will be placed on a proper commercial basis. The truth is, that two or three years ago, electricians had little or nothing to offer the world, although they believed themselves to be possessed of a great deal. They lacked knowledge of all kinds, save that acquired in the laboratory or the class-room. Concerning the cost of lighting they had no experience whatever. Of the conditions to be fulfilled in order that the public might be satisfied they had only a vague conception; while the art of electric lighting was in such a condition that even at the Crystal Palace failures of all kinds constantly took place, notwithstanding a lavish outlay by exhibitors. A rush was made by dozens of competitors, all desirous to light not only theatres and shops, but the entire metropolis. Notions the most crude were backed up by estimates too wild to deserve serious attention for a moment. Incompetence reigned everywhere. Honest men did not know but thought they did. Dishonest men cared nothing whether they were ignorant or not so long as the public held them to be learned. The speculator and the financier saw in such a combination their opportunity. The measure of success attained, such as it was, gave the world the most beautiful artificial light ever seen—a light, too, which was full of an infinity of glorious promise. Nothing that could be urged against the light had much chance of a hearing, because no one could prove his case. Those who advocated the new light and those opposed to it were alike ignorant. The Stock Exchange and the City saw their way to a glorious harvest. Even tender consciences tried to make money. Who could tell that a company would not succeed? And so speculation raged. A few people made money, a great many lost it; and at the present moment it is probable that we are not much nearer the general adoption of electric lighting than we were two years ago.

The intrinsic worth, however, of electricity as an illuminant renders its ultimate success a matter of certainty. The only point open to question is the meaning to be attached with propriety to the word success. Our conviction is that electric lighting will extend, not rapidly but steadily, and that individuals first and then companies will undertake the work of lighting houses, districts, and towns. There are only two things necessary now. First, trustworthiness in the light; and secondly, moderation in its cost. By trustworthiness we mean a certainty that the light will not go out. Experience acquired on this point so far is not satisfactory. Unless where storage batteries are used, or the installation is such that machinery exists not only in duplicate but in triplicate, darkness takes the place of light now and then. A typical case was supplied last year in the Holborn district. The installation of the Edison Company is in duplicate, but the engine of one set broke down and the dynamo of the other set. Of course there was no long delay, but a short period of darkness is nearly as bad as a long one. Thus, if a hotel or a church be plunged in total darkness for even a minute or two the circumstance is likely to prove disastrous to the reputation of the light. Such things must be avoided, and we think it may be taken as certain that these events cannot be prevented without the use of storage batteries. The extravagant notions entertained at one time concerning the efficiency of these batteries, and the magnitude of the part they were to play in the world's economy, have long since succumbed to the logic of facts. But none the less is it clear that the storage battery is capable of doing a great deal of excellent service. It is one thing to suppose that a storage battery will never wear out and that it will return 98 per cent. of all the work done in charging it; that 2-horse power for a couple of hours can be carried in a box under one's arm, and so on; it is quite another to know that by the use of half a ton or so of porous lead plates the electric lighting of a large building may be rendered proof against disaster. It is something to know that this can be done—as, for example, at Eberle's Hotel in Westminster. In this way confidence may be placed in the incandescent lamps with which our rooms are lighted. Surely this is a great advance. Safety such as this is worth paying a little for.

But it must not be forgotten that storage batteries are an item of expense, and unless the cost of electric lighting can be reduced, its use must remain comparatively limited. The conditions of cost are tolerably well understood. It is not in the engines, or the dynamos, or the lamps, that a great saving can be effected, although there is room for improvement here. In the conductors lies the principal item of cost, and the expense is incurred not so much in the purchase of the wire, as of the insulating material with which the wire is covered. Prof. Forbes knows what he is about in dealing with electricity, and he recently stated that the cost of conductors for the supply of 100,000 incandescent lamps, if electricity was supplied from a single source, would be £224,000 per mile. A solid bar of copper 20in. square would be needed; if the bar were of less section, then it would become overheated. His reasoning is too close and careful to permit us to doubt the general accuracy of this statement; but it contains nothing really alarming, though it leads to much which is very suggestive. In the first place, large numbers of lamps must not be worked from one central station. But this is not all. The need for an enormous conductor ceases as soon as we take it out of the ground and hang it up in the air. Let the conductor have ample opportunities of being cooled by radiation and the blowing of the wind upon it, and we at once have our leads brought within practical dimensions. But this obviously means overhead wires. We do not know what is the precise limit to the number of the wires that the houses in a city can support, but it is hardly a figure of speech to say that in parts of the City now the sky is darkened by overhead wires. If we turn to the streets it will be found that there is scarcely space left for another wire. Whether the lines shall be overhead or underfoot, who can say? We can say, however, that to enable electricity to compete with gas they ought to be overhead.

Mr. Killingworth Hedges read a paper before the Institute of British Architects, on Monday, the 18th inst., on "Precautions to be Adopted on Introducing the Electric Light into Houses." We give in another place an abstract of Mr. Hedges' sensible paper. We would call particular attention here to one portion of it, namely, that dealing with fire risks. In order that these may be avoided, it is essential that none but skilled hands should be employed in "wiring" a building. In one district in the United States are sixty-one mills, all lighted by electricity. No fewer than fifteen fires have taken place in these mills, all due to the overheating of circuit wires. In almost all cases this was due to want of skill and caution on the part of those who wired the mills. Mr. Hedges insists on the necessity of employing only competent men to carry out electric lighting. There is, however, no small danger just now that competition will set in sharply, and with the usual result, namely, that contracts will be let to the lowest tender. If this practice obtains, the results will be as bad as possible. That class of work known as "cheap and nasty" cannot be attempted with impunity in the case of the electric light. We agree with Mr. Hedges that the best guarantee of safety is the employment of experienced men in the work of installation. In such hands it is far less dangerous than gas. But we would supplement Mr. Hedges' remarks by asking, How are measures to be taken to ensure the work being always safely done? What have insurance companies to say on this point?

WHAT IS FRICTION?

IT is now just a century since Coulomb first investigated the laws of friction, and half a century since Morin made at Paris the series of experiments which has rendered his name immortal; and yet it would hardly be too much to say that it is only at the present moment that we are beginning to arrive at a clear conception of what we mean by so familiar a term. In saying this we by no means wish to insinuate the slightest disparagement of the illustrious physicists we have named. The fault lies not with them but with us. They had no desire—in the case of Gen. Morin, at least, we have his own authority for saying so—to impose their investigations on mankind as the last word of science, as absolutely and everywhere true, beyond as well within the limits within which they were tried. They claimed to have laid the foundations and to have laid them aright, but they looked for other workmen to come forward and complete the edifice. Until very recently, however, such workmen have been less than few, their contributions more than scanty. To the past generation of engineers, immersed in the practical details of construction, and in the thousand-and-one cases of commercial manufacture it was much easier to take Morin's results as they stood, and work by them, than to investigate the question any further for themselves. The same spirit of indifference has crept into our text-books; which quote Morin's results—with or without the courtesy of mentioning his name—as if they were no less rigidly true and general than the theory of gravitation itself. Yet it required the labours of a whole generation of astronomers to place Newton's theory beyond the reach of cavil; while the question of its possible limitation remains in dispute to the present day. In the sharpest contrast to this keen activity on the part of the votaries of science, the question of friction, whose practical importance it is scarcely possible to overrate, has been allowed to sink back, after the light flashed on it by the experiments we have referred to, into a hazy twilight, from which it is only just beginning to emerge.

To illustrate the present state of the case, let us begin with the treatment of friction, as it will be found in any standard book on "Applied Mechanics." First, we shall probably find a distinction drawn between statical friction, where the two surfaces are initially at rest, and dynamical friction, where they are already in motion. There we shall find a statement of what are called the "Laws of Friction" in something like the following terms:—(1) Friction, whether statical or dynamical, varies directly as the force which presses the two surfaces together; (2) this force remaining the same, it is independent of the area in contact; (3) under the same conditions the value of dynamical friction is much less than that of statical friction, but it is constant at all velocitise. To the statement of these laws may be added, in more elaborate and theoretical treatises—such as Moseley's "Engineering and Architecture"—a few words as to the limiting cases in which the laws cease to be exact, as, for instance, where the pressure approaches that of abrasion; and also of the state of things which prevails when the surfaces are fully lubricated with oil or grease, in which case Morin concludes that the friction, whatever the nature of the surfaces, approaches to a constant value at between 7 and 8 per cent. of the pressure. Then will follow tables, taken almost exclusively from Morin's results: (*a*) for plane surfaces at rest, sometimes dry, sometimes wet, sometimes lubricated; (*b*) for plane surfaces in motion, under similarly varied conditions; (*c*) for gudgeons or axles revolving upon their bearings, and more or less lubricated with ingredients of various descriptions. In collections of formulæ and rules, such as those of Molesworth and Rankine, these tables in an abridged form will be found to be the whole that is offered upon the subject. So deeply rooted is this "orthodox" doctrine, that we are acquainted with but one work on mechanics in which it is even hinted that the third law, as to dynamical friction, is by no means universally true; or that the friction of dry and lubricated surfaces are not phenomena of the same character. Yet scepticism on these points has long existed, but it is only within the last few years that it has broken out into open rebellion. We are now able to assert positively two facts of which the compilers of our text-books have not had the slightest glimmering. The first is that what is called friction in the case of dry surfaces, and what is called friction in the case of fully lubricated surfaces, are not analogous phenomena, but totally different in every respect, observing different and even contrary laws, and having nothing whatever, but an unfortunately chosen name, to bind them together. The second is that dynamical friction is constant for similar surfaces only within comparatively narrow limits of velocity; and that beyond those limits it either increases or diminishes, as the speed varies, in a very unmistakeable manner. It is evident that these two facts completely overthrow the sweet simplicity of the laws and tables of friction as they appear in our existing manuals.

It is worth while to dwell for a moment on the steps by which this change in our view of the question has been brought about. As long ago as 1852 the experiments made by Poirée and Bochet on shoe brakes and on the wheels of railway vehicles sliding on rails showed that the coefficient of friction diminished very much as the velocity increased. Between the limits of 900ft. and 3600ft. per minute the coefficient of friction in the case of wheels sliding on rails diminished from ·2 to ·13. It is obvious that this is altogether contrary to the so-called law of dynamical friction, but it does not seem to have really awakened the sense of engineers to the question. There is nothing further chronicled until 1877, when Professor Kimball presented to the Royal Society a paper on the relations between friction and velocity. At ordinary speeds he found that the friction between pieces of pine wood diminished rapidly as the speed increased. Again, with a wrought iron shaft 1in. diameter, running in a cast iron bearing and well oiled, an increase of velocity from 6ft. to 100ft. per minute caused the coefficient of friction to fall as low as three-tenths of its first value. The same result was found with lower pressures, the pressure having in the first case been 77 lb. per square inch. About the same time Professor R. H. Thurston was carrying out in America a number of experiments intended to test, under varying conditions of speed, temperature, pressure, &c., the friction of well lubricated journals. These were subsequently published in his well-known book, "Friction and Lubrication." As to velocity, his conclusion was that the coefficient of friction at first *decreased* with increase of velocity, but after a certain point *increased*, and that the point of change is different at different pressures and temperatures. On the whole he considers that, with well lubricated bearings, the friction increases with the velocity at all speeds exceeding 100ft. per minute, and that the rate of increase is approximately as the fifth root of the speed. Almost contemporaneously with these researches of Prof. Thurston, another American, Mr. George Westinghouse, was carrying out, in conjunction with Captain Douglas Galton, the magnificent series of experiments on the brake question which have since become classical under the name of the "Galton-Westinghouse Experiments." These threw much light upon the question of friction as between metals —generally cast iron and steel—which were rubbing over each other without lubrication, and at very high speeds. In every case they showed a remarkable diminution of friction as the speed increased. This result held throughout the whole range of the experiments, in which the speed varied from 400ft. to 5300ft. per minute. It should be observed, however, that, owing to the nature of the instruments used, the observations only lasted half a minute, and it was found that during that time the coefficient of friction continued to diminish. The ultimate values assumed by it under different circumstances cannot, therefore, be exactly known; but from the appearance of the curves, obtained by plotting the results, it is clear that the values for high speeds would still be much smaller than for low speeds. Professor Kennedy has deduced from the same experiments the result that the coefficient of friction was sensibly less at high than at low pressures, and that between the wheels and the rails—where the pressure was, no doubt, far greater than that on the brake blocks—the friction was not more than one-third of the amount found for the latter. This experiment is in accordance with Professor Thurston's results as to pressure, with ordinary velocities and loads; but the latter found that after a certain point a change took place, and further increase of pressure occasioned an increase in the friction. These results varied greatly under various circumstances, and they applied to lubricated journals, which, as we have seen, are really in altogether different circumstances from those of dry friction, as illustrated by the behaviour of brake blocks.

Such was the state of the case when the Institution of Mechanical Engineers took up the question. Their progress in determining it has certainly been of the slowest; but they have lately issued a report which consolidates and advances our knowledge of the question in a remarkable degree. The experiments, which were conducted with great care by Mr. Beauchamp Tower, were first directed to ascertain the friction of journals under the best possible circumstance of lubrication; in other words, with a journal running in what may be described as an oil bath. By this it is not meant that the journal was absolutely buried in oil, but simply that its lower surface was always in contact with fresh oil, the upper surface being that on which the pressure rested. The results of these first experiments were very remarkable. In the first place, it was found that the absolute friction, that is the actual tangential force per square inch of bearing required to resist the tendency of the brass to go round with the journal, was much smaller than had ever been suggested before, falling in many cases as low as $\frac{1}{1000}$ of the pressure existing on the same area; secondly, it was found that this friction was nearly constant under all loads within ordinary working limits, and certainly it did not increase in direct proportion to the load, as writers on friction have always assumed. It only began to vary considerably when the pressure became excessive, and then the friction rose very rapidly and the bearing heated and seized. From this result it was naturally deduced that the friction of bearings in such circumstances is rather liquid than solid friction. The theory of liquid friction is that it is independent of the pressure per unit of surface; is directly a dependent upon the extent of surface, and increases as the square of the velocity. In the case of these oil-bath experiments the friction, as we have seen, is nearly independent of the pressure, and it was also found to increase with the velocity, at least with speeds beyond 150ft. per second. The question of its variation according to the surface in contact was not gone into. As regards other results, it appears that an increase in temperature caused a very marked diminution in the friction. For instance, with lard oil, the coefficient with the temperature at 120 deg. Fah. was only one-third of what it was at 60 deg. Fah. This is in accordance with previous results, but shows remarkably the advantage derived from keeping bearings warm. Again, it was discovered, though by accident, that the pressure existing in the film of oil at the top of the bearing, where the external pressure was highest, was very large; indeed, so great as to force the oil up through a small hole against a pressure of at least 200 lb. per square inch, this pressure being more than double the mean load on the horizontal sections of the journal.

Subsequent experiments with ordinary methods of lubrication were by no means so satisfactory. The methods for introducing the lubricant, which are found to answer in the case of railway vehicles, were found to fail altogether with this experimental journal. The cause is attributed, and no doubt rightly, to the absence of any shock or vibration in this case, such as goes on continually with a railway vehicle in motion. Fair results were, however, obtained by using an oily pad, pressed lightly against the under-surface of the journal. Although the supply of oil was so small that the journal scarcely felt greasy, yet the bearing carried about 500 lb. per square inch; but in this case the results approximated much more closely to the laws of solid friction. The coefficient was approximately constant at about 1 per cent. of the load, and no very definite variations of friction with the speed could be observed. The lubricating of the journal by means of side grooves fed from a syphon lubricator was also successful, and gave somewhat the same results, as far as the constancy of the moment of friction is concerned, with those obtained by the oil bath; but the absolute amount of the friction was about four times as great. Now it will be observed that these results are practically coincident with those of Professor Thurston, and may be taken to establish the first of the two facts with which we started, viz., that the friction of thoroughly lubricated journals is a totally different phenomenon from what is commonly known as friction between dry surfaces. A complete reformation in the treatment of the subject by text-books, and in the tables supplied therein, becomes an imperative necessity.

It will be observed that none of the investigators we have mentioned commit themselves to any theory as to the real nature of friction, whether solid or liquid; they are content to record facts, and leave others to frame hypotheses from them. It is, however, a well-known rule in the history of science, that the most fruitful progress in any department is made under the influence of some definite hypotheses, which it is the object of experimenters to confirm or disprove. Any physicists, therefore, who would put forward a good working hypothesis on the question of friction, or rather on the two questions of solid and liquid friction, would probably deserve well of the engineering profession and the world at large. There are plenty of problems, besides those we have indicated, which such a theory should embrace. For instance, we know of a case some years ago where steel tubes were manufactured by pulling an annular ingot of steel, in the cold state, through an opening in a plate, much after the fashion of wire-drawing on a large scale. In this process the finished tubes as they came out were generally perfectly cool, a result which probably few would have expected; on the other hand, one would occasionally appear which was sensibly warm, if not hot. But the cause of this was well known by the workmen engaged in the manufacture; it could always be traced to the presence of a minute piece of grit or other substance which had got into the hole, and had drawn a fine scratch upon the surface of the steel as it passed through. This is surely a remarkable fact. We do not at all say that it is impossible or even difficult of explanation, but we may at least commend it to the attention of our readers; and it would not be hard to mention many others of the same kind. To attempt an answer to these problems would lead us far beyond our present limits, but taken in conjunction with the experiments here described, they may at least justify us in putting forward the question placed at the head of this article, viz., What is friction?

BOILER INSURANCE.

If boilers continue to explode it is not for lack of facilities for competent inspection. In return for very moderate payments any and every steam user can have his boilers carefully examined by competent men who will tell him whether they are or are not safe, and if not safe how they can be made so. The reports sent in by inspectors to the engineers-in-chief of boiler inspection and assurance companies are, as a rule, perfect models of what such papers ought to be. They leave practically nothing to be desired. It is a question, however, whether action is always taken upon them, and we propose here to consider an aspect of boiler insurance which does not receive quite as much attention as it deserves.

It is very much to be desired that boiler insurance companies should be perfectly independent. If they are not, then their policy cannot fail to be warped and strained. There is much reason, however, to fear that nothing like absolute independence is possessed by any of the numerous companies whose officers now pronounce on the condition of boilers; and this fact may go far to limit the usefulness of the system. When boiler insurance and inspection were first started many years ago under Fairbairn's auspices, there was no competition; but for a considerable period competition has been severely felt by the boiler insurance companies which now exist in considerable numbers. These companies, instead of confining their operations to given districts, poach on each other's preserves; and when two companies compete for a given boiler or boilers, risks are frequently taken which neither company would dream of accepting were it not for the other. In such an article as this it is obviously impossible for us to give the names of particular companies; and we may add that what we have to say applies to all boiler insurance, assurance, and inspection companies alike. We single out none. What is true of one is, so far as we can ascertain, true of all. This point being, as we hope, made quite clear, we may go on to say that boilers which are really unfit for service are insured; and that factors of safety of as little as one and a-half to one are accepted as sufficient. We do not say that this is an invariable practice. It often happens nevertheless, and it happens in this way:—A proposal for insurance is made to a given company. The inspector comes down, examines, and sends in an adverse report. The reply of the boiler owner is that he is sorry to find that the boiler cannot be insured by the company in question; that, however, he has no doubt it can be insured by another company, which he names. Then the first report is reconsidered; certain patches are perhaps put on the boiler here and there, the safety valve load is reduced a pound or two, and the boiler is accepted for a year. Anything, in fact, is done rather than let the rival company in. It must be a very bad boiler indeed that cannot at this moment be insured somewhere. It must not be forgotten that this system is entirely opposed to the wish of the engineers and inspectors of the companies. They have really no choice in the matter. Apparently free agents, they are virtually bound to do that which will please the directors and bring in business.

It may be said that boiler insurance cannot be so bad a thing as we would make out, because so few insured boilers explode. Now it so happens that we are not trying to make out that boiler insurance is bad—on the contrary, we believe it to be very good; but we cannot approve of the abuses of the system which are undoubtedly creeping in. It is above all things desirable that we should be able to place perfect confidence in the safety of an insured boiler, not because it is insured, but because it is properly inspected. If, however, risks are run in order to secure business, confidence in the efficiency of the whole system will be shaken, and in the end the companies will be ruined. We have no hesitation in saying that there are dozens of boilers insured now which ought not to be insured. It may be urged that this is purely an affair of the insurance companies, and that the losses by any explosions that take place will fall on them; but this is a very inadequate statement of the facts. The influence of a steam boiler is by no means limited; an explosion may do a vast amount of mischief which no insurance company can repay. With insurance standing alone, we have, of course, nothing to do; but insurance does not stand alone. It means much more than the promise to pay a certain sum if a boiler explodes. It is tantamount to a guarantee that a boiler will not explode, and it is, in a sense, a deed of indemnity for the boiler-owner. It is quite well understood that when a steam user has insured his boilers with a respectable company he is clear of responsibility. No jury could be empannelled which would convict of manslaughter, or even reprimand, a manufacturer whose insured boiler exploded. The responsibility would all be thrown on the shoulders of the company. Now, the insurance companies owe a duty to the public, which is that the guarantee which they supply shall be really trustworthy. So long as the companies practised insurance without inspection they might do as they pleased, and adopt any policy, however suicidal, without protest from us. But inspection being combined with insurance, the whole aspect of affairs is altered; and nothing more objectionable can well be conceived than the system of granting guarantees concerning really unsafe, because unsound, boilers. We have heard of cases in which inspectors were told not to inspect properly, that is rigorously, lest a given battery of boilers could not be accepted. Such an event is we have no doubt purely exceptional; but it is not exceptional that boilers in very bad condition indeed are assumed to be safe for a year. Indeed, some companies appear to use this year-to-year insurance as a cloak to cover a multitude of sins. They will by no means take a given boiler for an indefinite period, but they will take one for a year rather then let a rival company have it.

It is a noteworthy fact that none of the companies have ever put forward any statistics to prove that the practice of insurance has decreased the number of boiler explosions. There are not wanting, indeed, persons who say that the system never yet prevented an explosion. We need not say that from this statement we entirely dissent. Among the other subjects over which boiler companies quarrel is the propriety of insuring a boiler at all. Into such a dispute we cannot enter, nor has this article anything to do with such questions. It is intended to maintain that boiler insurance companies should come to some understanding either among themselves or otherwise, that they will not by accepting insurances on defective boilers, give substantial guarantees of safety when they ought not to be given. In this matter honesty is above all things necessary; and if boiler companies sacrifice it in the pursuit of business, they will have cause to repent it sooner or later. Need we add that the steam user who insists on working his boilers after he has been warned that they are unsafe, can by no means shift his responsibility on to the shoulders of a weak-kneed insurance company. At least, right thinking men will hold that he cannot. The majority of steam users are, we may add, far too exacting and expect far too much for their money. It is difficult under the circumstances for companies to be as independent as it is imperative that they should be. Indeed, the sums now paid for insurance are so small that they can scarcely pay for adequate inspection, to say nothing of risks.

CANALS AND RAILWAYS.

In our impression for the 25th of January we referred at length to some of the points which are occupying the attention of those to whom transport at low rates is a matter of importance, and gave some reasons for looking upon canals as a means of cheap transport of heavy goods. Among many railway engineers, canals in this country are looked upon as played out. One of the chief reasons for this opinion is based upon the statistics of canal navigation as at present carried on. These statistics are appealed to as showing that even in districts served by canals, such as the Aire and Calder, the competing railway gets its price and plenty of freight, even of goods specially suited for canal transport, such as timber, although the canal is not in the hands of the railway company. It is also noted that the price thus obtained for this freight by the railway company is as great as that charged by the railway company where it has not to compete with any canal. Two leading explanations of this are given. One is that canal-carried material often has to be loaded and unloaded four times instead of twice, because the canal does not run into the receiving places of the goods or into the places of destination. Canals cannot or are not run into works and other places as are railway sidings and branches. Hence low freight on a canal is rendered of no avail because of the cost of frequently breaking bulk. Another explanation is that the time occupied in canal transport places the traffic in the hands of the railway companies. Not simply because rapid transport is generally to the advantage of freighters, but because merchants in some commodities are enabled to do with a smaller stock than would be necessary if these commodities were canal borne. For instance, a coal merchant can telegraph to a colliery for a few truck loads of coal of a particular kind, and get it sent on by one of the next coal trains; but in many cases if this coal had to be sent by canal he would, if the demand for the coal were occasional, have to keep a stock of it. This objection does not, of course, obtain with materials for which there is a continual sale. These objections, it will be seen, may both be met by the advocates of canals. In the first case, canals in the hands of private companies may, in many of those districts where low rates are really essential, construct branch canals, which would save very much of the breaking of bulk. Moreover, the loading and unloading of barges would soon become a mere mechanical operation once the demand for machinery for the purpose really arose. In the second case, the question of time, there is no doubt that much remains to be done to improve the speed on canals; but whether the custom of merchant traders makes it often necessary that minerals, timber, &c., should be wanted in a hurry as a means of reducing the necessary stock keeping, we cannot say; but it clearly becomes a subject for the merchant to decide whether he can best afford to keep a larger stock and pay low rates, or pay high rates and keep no stock. The subject is one which may be very usefully discussed, considering the amount of attention which is being paid to the high rates charged by railway companies. None of these objections, it will be observed, obtain with canals from sea to sea, such as that which is required between the Bristol and English Channel, or such other ship canals as would enable ships to pass farther inland towards the great distributing centres than they can at present get by the chief river estuaries. As showing the interest which attaches to the question, it may be noted that the South Staffordshire Railway and Canal Freighters' Association has now been formally established, and Wolverhampton has been selected as its home. Mr. Alfred Hickman, who is the head of the largest pig ironmaking firm in South Staffordshire, has been appointed chairman, with a committee consisting of influential manufacturers and merchants, and upon which Mr. Richard Tangye, of the Soho Works, has consented to serve. A guarantee fund of £1300 has already been subscribed in case the subscriptions are insufficient for Parliamentary, legal, and other purposes.

CLIMBING TRICYCLES.

MANY visitors to the Stanley Exhibition of bicycles and tricycles recently held at the Floral Hall, Covent-garden, must have been very much struck with the multiplicity of forms and devices there shown, and many will doubtless have been sorely puzzled in their minds as to the special advantages possessed by each different type. Certainly there appeared to be enough variation to perplex anyone not thoroughly acquainted with the practical working of cycles on the road; and the ordinary outsider wishing for information must have been fairly bewildered. The cycle trade is one which has been developed with great rapidity within the last ten years, and like all new industries, has called forth a considerable amount of ingenuity and skill on the part of those engaged in it. We cannot help thinking, however, that much of this ingenuity has been misplaced, and that instead of striving after new forms involving considerable complication and weight, it would have been better and more profitable if manufacturers had moderated their aspirations and aimed at greater simplicity of design; for it must be remembered that cyclists are, as a rule, without the slightest mechanical knowledge, while the machines themselves are subject to very hard usage, and considerable wear and tear in travelling over the ordinary roads in this country. We refer, of course, more especially to tricycles, which in one form or another are fast taking the place of bicycles, and which promise to assume an important position in everyday locomotion. Hitherto one of the chief objections to the use of the tricycle has been the great difficulty experienced in climbing hills, a very slight ascent being sufficient to tax the powers of the rider to such an extent as to induce, if not compel him, in most instances to dismount and wheel his machine along by hand until more favourable ground is reached. To obviate this inconvenience many makers have introduced some arrangement of gearing, speeds of two powers giving the necessary variation for travelling up hill and on the level. We noticed, however, one machine at the exhibition which seemed to give all that could be desired without any gearing or chains at all. This was a direct-action tricycle shown by the National Cycle Company, of Coventry, in which the pressure from the foot is made to bear directly upon the main axle, and so transmitted without loss to the driving wheels on each side, the position of the rider being arranged so that just sufficient load is allowed to fall on the back wheel as to obtain certainty in steerage. The weight of this machine is much less than when gearing is used, and the friction is also considerably reduced, trials with the dynamometer having shown that on a level smooth road, a pull of 1 lb. readily moved it, while with a rider in the seat 4 lb. was sufficient. On this tricycle any ordinary hill can, it is stated, be ascended with great ease, and as a proof of its power it was exhibited at the Stanley show climbing over a piece of wood 8in. high, without any momentum whatever. We understand that at the works at Coventry a flight of stairs has been erected, and that no difficulty is experienced in ascending them on one of these machines.

THE IMPROVEMENT OF THE TYNE.

A STATEMENT has been issued of the quantities of dredging performed in the Tyne, since the commencement of operations in that river in the year 1838, and down to the end of the past year. Six dredgers seem to have been employed. The oldest of these, employed in seven early years, raised 118,000 tons; No. 1 dredger has been at work, with the exception of a slight recess, from 1843, and has raised 4,758,000 tons of material. No. 2, since 1855, has raised 7,843,000 tons. The "Fanny" follows next, working in five of the middle years, and raising 619,000 tons. Next in order of date is No. 3, which commenced work in 1861, and has up to the end of the past year raised 11,609,000 tons; No. 4, in a similar period, has raised 15,358,000 tons; No. 5, from 1863, with an interval of over three years' rest, raised to the end of last year 13,476,000 tons; and the last on the list, at work in every year from 1876 to the past, raised 17,166,000 tons. The largest quantity raised was in the year 1866, when a total tonnage of material of 5,273,000 was raised. Since that time there have been considerable fluctuations. In 1881 the quantity raised was 1,745,000 tons, and last year it had risen to 3,336,000 tons. In all there has been raised since the commencement of the dredging operations, 70,950,000 tons of material, a vast work for any great public board to effect in the period referred to, and this more especially when it is known that concurrently there have been great works in progress—docks and piers that have altered the character of the Tyne as a navigable river. Some of these works are now approaching completion—the Coble Dene dock is expected to be opened this year—and it is possible that the permanent works being completed, there may be the greater attention paid to dredging work that must be to some extent necessary in the Tyne at all times. As it is, under the chairmanship of the late Sir Joseph Cowen, and of Mr. Stevenson, M.P., there have been river works and river dredging on the Tyne for twoscore years that have made it remarkable in the history of river engineering, and that have been justified by an enormous increase in the volume of the great trades on the stream. That increase must be expected now to continue, and it may be that with the development of the great works that are near completion, the growth of manufactures in the future may be still greater than in the past.

LITERATURE.

Modern American Locomotives, their Design, Construction, and Management. A Practical Work for Practical Men. By EMORY EDWARDS, M.E. Henry Carey, Bird, and Co., Philadelphia; Sampson Low, Marston, Searle, and Rivington, London. 1883.

Recent Locomotives: Illustrations with Descriptions and Specifications and Details of Recent American and European Locomotives. Reprinted from the *Railroad Gazette.* New York: Office of the *Railroad Gazette.* London: E. and F. N. Spon. 1883.

THE late Mr. Charles Beyer is reported to have said that "anything would do for a locomotive." His attention had just been called to some strange type of engine, which he was given to understand performed very well. Mr. Beyer knew as much about locomotives as most engineers; and we fancy that there are few men of experience in railway working who have not noticed that locomotives do seem to get along in an extraordinary way, when they apparently ought not to get along at all. We know ourself of one case in which an engine had ninety flues plugged out of 240, and it did not seem to make the least difference. We find that in almost every civilised country there is what may be termed indigenous types of locomotives; but the work they have to perform is the same, and is done in much the same way everywhere. It consists in overcoming a tractive resistance, while the engine has to accommodate itself to a more or less uneven, crooked, or hilly track. The true evidence of the good qualities of a locomotive is not to be found in its power of hauling heavy loads at a great speed, but in its power of doing this at a low price. The merits of the modern engine are decided by purely financial considerations; and these, to a certain extent, govern all that the locomotive superintendent can do in the way of designing. What we have said is powerfully exemplified by American locomotive practice, which is so fundamentally different from English, that, if we are right, it would seem that Americans must be wrong, and *vice versâ*. The truth seems to be, however, that both parties are right, at least so far as the mere mechanical work done by an engine is concerned.

Mr. Emory Edward's book is an octavo volume of 382 pages, illustrated by seventy-eight engravings, and by reading it anyone previously knowing something of steam and the steam engine can form a very good idea of the natural history—if we may use the phrase—of the American locomotive. With the practical part of the work we have little fault to find, but we cannot say this of the introduction, which deals with the science of steam engineering. We suppose that the number of men who have any accurate idea of what steam is must be very small. It is, at all events, certain that those who write lucidly and with precision on the subject are rarely met with. The truth is that such extremely vague ideas are inculcated by so-called science teachers, that it is almost impossible that second-hand information can be accurate. For example, the word "force" is continually being used by teachers of science, who insist on laying down certain definitions of it, concerning which they are not agreed among themselves; but to the greater number of men who have to use the word, force invariably implies the idea of a push or effort. We speak of a piston being forced from one end of a cylinder to the other, and we assume at once that the steam pushes it, and so on. Mr. Edwards naturally comes to grief over this unhappy word. He tells us first of all that "The very foundation of science is the faculty of calling things by their right names, for by such method only can one be understood and answered accordingly:" and a little further on he defines force as "any action that can be measured by weight alone." This definition has at least the merit of novelty, and we are really not disposed to say that it is not as good as some others, but it is certainly not in accord with ordinary text-book teaching. Again, "Dynamic energy is the mechanical power or work produced by forces in motion." Is it? What, we would ask, can be Mr. Edwards' idea of a "force in motion?" Has anyone any accurate idea what such words mean, or even what they are intended to convey? We suppose that Mr. Edwards had in his mind when he wrote them, a push moving; as, for example, he would speak of the moving force of a locomotive shunting a train. It is probable that it has never crossed Mr. Edwards' mind that a force is entirely incapable of producing motion. However, we do not think that his definitions will do any harm to any one, and so we may pass them by without further comment.

We may remark here, incidentally, that in dealing with liquefaction in steam cylinders, Mr. Edwards gives credit to Professor Tyndall for making certain statements about ten years ago, thereby ignoring his compatriot, Mr. Isherwood, who nearly twenty years ago explained, in one of the most masterly treatises on the action of steam in an engine ever written, namely, the "Introduction" to the second volume of "Experimental Researches in Steam Engineering," nearly all that is fathered upon Professor Tyndall.

A good part of this book is entertaining reading. There is a great deal which is open to criticism, but much of it is sound common sense. We may cite the chapter on locomotive running. What is said about the experiences of new firemen is very true and very amusingly told. But if Mr. Edwards is accurate, locomotive engine driving is entrusted in the United States to very incompetent men. For example, why should it be necessary to write such a passage as the following:—"A difficult thing for an inexperienced man to control in running a locomotive at night, when the conditions of adhesion are bad, is the slipping of the drivers. Slipping is a simple matter enough to those who feel it in the vibration of the engine; but the novice has not this sensitiveness to slipping vibration developed, and he must depend on his eyesight or his hearing to detect it." Why should an inexperienced man be permitted to drive an engine? We can scarcely realise in this country the conditions under which a locomotive superintendent would be reduced to such extremities that he had to entrust engines to drivers who could not tell whether an engine was slipping or not, unless they could get a sight of the coupling rods or a peep at the top of the chimney. For the benefit of the uninitiated we may say here that the merest tyro who ever stood on a foot-plate has only to feel an engine slip once. Never again, night or day, can he fail to perceive the vibration to which Mr. Edwards refers. It seems, however, that in the Western States, "Men are taken from all occupations, no preliminary training being deemed necessary before putting a man on an engine as fireman." The driver has to break him in as well as he can. Happy must be a life on the foot-plate in the West. The kid glove and gold watchchain business is, we fancy, rather out of place just thereabouts. Given a heavy train, a stormy night, and a fireman—save the mark!—fresh from tending cows or "doing chores," and the "engineer"—to give him his western rank—will be placed in a position to thoroughly enjoy a run of a hundred miles or so. Mr. Edwards tells us of one driver who did not know he had a hot crank-pin until a drop of molten Babbit metal hit him in the eye. An episode such as this would, perhaps, be the one thing lacking, without which our western friend would not be truly happy. Mr. Edwards is full of latent fun, which bubbles up to the top now and then; as, for example, when he tells us, referring to the Babbit metal affair, "An experienced engineer, watching the rods, would have detected the condition of affairs before Babbit was thrown." The sententious way in which this piece of gratuitous information is supplied is delicious. Mr. Edwards is careful to tell his readers that they are not to be misled by his anecdote into supposing that Babbit metal is purposely employed, like the safety-plug in a boiler, to give warning of approaching danger. The trained driver does not need hot Babbit metal in his eye to tell him that a bearing is coming to grief.

We opened Mr. Edwards' book with a faint hope that some light would be thrown on a subject concerning which English engineers know very little, and American engineers somewhat less, we believe—namely, the cost of repairs of American locomotives. In this country we can tell precisely what is the expense of keeping an engine in order; but it does not seem that knowledge of this kind is prized in the States. No doubt on a few roads proper books are kept; but their contents are not public property. Now, as we have said at the outset, the cost of maintenance is the great test of the value of a locomotive engine, and on this Mr. Edwards throws no light whatever.

Mr. Edwards has a good deal to say about high-speed American trains, and there is no doubt that on some of the best roads near New York very high speeds indeed are maintained; although we may be excused if we refuse to credit the story that a velocity of ninety-three miles an hour has been maintained for a few miles. But the Americans are beginning to like speed, and what they like they will have. The people in Philadelphia are always in a hurry to get to New York, and the New Yorker wants to get to Philadelphia as fast as he can. The distance is 90 miles. It is intended that this shall be done in 90 minutes. It is said that it has been done once or twice; and the engineering world will watch with interest for the regular repetition of the fact. It is interesting to learn from Mr. Edwards that engines of the English pattern are to be used.

Mr. Edwards' book might be improved. It would be better without the science. The practical part would be better if it had been written by a man well experienced in locomotive work, which Mr. Edwards apparently is not. He is, if we are not mistaken, a marine engineer; but we have no doubt that the book will prove amusing and even useful to many people.

Yet we cannot help feeling surprised that so big a book should have so little in it.

The reprint from the *Railroad Gazette* is a very different work from that by Mr. Edwards. It is a fine volume containing engravings of no fewer than seventy locomotives, admirably printed and beautifully executed. In a brief preface we are told that they have appeared at various times in the *Railroad Gazette* during the past twelve years. The preface is, in a manner, an apology. We are told that "a complete treatise, with engravings specially prepared for it, would be a much more valuable book than this." This is by no means a foregone conclusion, everything depending on the way in which the treatise was written. As it is, the volume before us is a treatise, because proper descriptions of all the engines illustrated are given; and it must be remembered that a hint accompanied by a good drawing will suffice to make things quite clear to the experienced railway engineer. We can very heartily recommend this book to those who take an interest in locomotive practice, for some of the best English locomotives are illustrated, as well as the most modern American engines. Certain of the engravings are very suggestive and interesting; one in particular we may mention, showing the results of an accident on the Chicago and

North-Western Railroad. The engraving is entitled, "They met by chance: The usual way." Our readers must be left to learn from the book itself what the meeting was like, and what "they" did when they met—something, we can assert, which no one would have anticipated, but truth is stranger than fiction in the railway world.

SECONDARY BATTERIES.

THE Consolidated Electric Light Company has now completed the secondary battery which has for some time engaged the attention of its officers, and their regular manufacture and use for electric lighting stations have been fairly entered upon. Amongst other places to which the batteries have been sent and put into work is Colchester, where the company has for some time had an installation at work, chiefly employing incandescent lamps. The battery consists of lead electrodes, anode and cathode being of the same character. They are constructed of narrow ribbons of lead, each element being made from long lengths of the ribbon about or nearly 0·20in. width, rolled together into a flat cake like rolls of narrow webbing, as illustrated by the annexed diagram, Fig. 1, the greater part of the ribbon being very thin and flat, but intermediate thicker ribbons are also employed, as in Fig. 2, this thicker ribbon being corrugated as

FIG 1

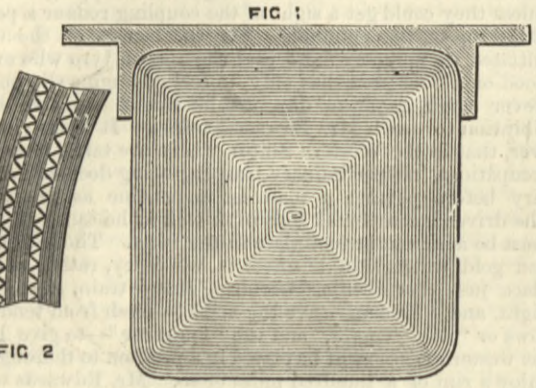


FIG 2

shown, and affording passage room for the circulation of the electrolyte. From four to eight coils of the plain ribbons are between every pair of corrugated ribbons. They are wound up together tightly, and pressed into the nearly rectangular form shown. The bar for suspending the coil plate so made in the cells is soldered to the coil. The object of this construction is of course to obtain large lead surface, and of course a much larger surface is so obtained than could be practically obtained from plain lead plates in the same compass. A battery thus made may be seen at the offices of the company, 110, Cannon-street.

A very ingenious device for cutting the battery out of circuit when charged as much as is thought desirable is used by the company. In a cell is an element which has a determined lower capacity than those in the rest of the battery. Over this element is placed a gas-tight chamber in which is a diaphragm, this diaphragm being of very flexible material placed in the cover of the box of cells. When charging has proceeded as long as is desirable, or proceeds too fast, hydrogen is evolved, and this collecting in the chamber referred to, acts upon the diaphragm, and by means of a rod connected thereto, switches the current, which is supplied to an electro-magnet and by which circuit is made through the medium of mercury contacts. The object of this is to save the battery from destruction by overcharging or charging by too large a current.

PRIVATE BILL LEGISLATION.

ON Tuesday the Standing Orders Committee, presided over by Sir John Mowbray, met for the first time to consider the case of Bills which had been reported as not having complied with the Standing Orders. They had no difficulty in dispensing with the non-compliance in the Aldershot, Farnham, and Petersfield Railway; the Edinburgh Northern Tramways; Folkestone, Sandgate, and Hythe Tramways; Mersey Railway; Metropolitan District Railway; and Scarborough and Whitby Railways. The London, Chatham, and Dover (Further Powers) Bill was allowed to pass on condition that the plans and sections were deposited with the Clerk of the Peace of the county of Middlesex. The consideration of the London, Reigate, and Brighton Bill was deferred till next week. About seventy miles of railway have been surveyed, and there are upwards of 14,000 properties separately described, and there are only six allegations of non-compliance sustained. This justifies the observation of the examiner that the referencing was "wonderfully accurate," and the promoters are sanguine of having the Standing Orders dispensed with.

The examiner held that the requirements of the Orders had been complied with in the following cases which came before him on proof of compliance with the Standing Orders applicable to the Bills subsequent to their introduction to the House in which they have respectively commenced:—Ballyclare, Ligoniel, and Belfast Junction Railway Bill (H.L.); Belfast Central Railway—Steam Vessels and Traffic Arrangement—Bill (H.L.); Belfast Central Railway—Western Extension—Bill (H.L.); Belfast, Strandtown, and High Holywood Railway Bill (H.L.); Buenos Ayres, and Eusenaila Port Railway Company Bill (H.L.); Ouse—Lower—Improvement Bill (H.L.); North-Eastern Railway Bill; East London Railway Bill; Barrnull and Kilwinning Railway Bill; Taff Vale Railway Bill; Great Northern Railway Bill; London, Tilbury, and Southend Railway Bill; Cleveland Extension Mineral Railway Bill; Manchester, Sheffield, and Lincolnshire Railway—Chester to Connal's Quay—Bill; Manchester, Sheffield, and Lincolnshire Railway—Additional Powers—Bill; Severn Bridge and Forest of Dean Central Railway Bill.

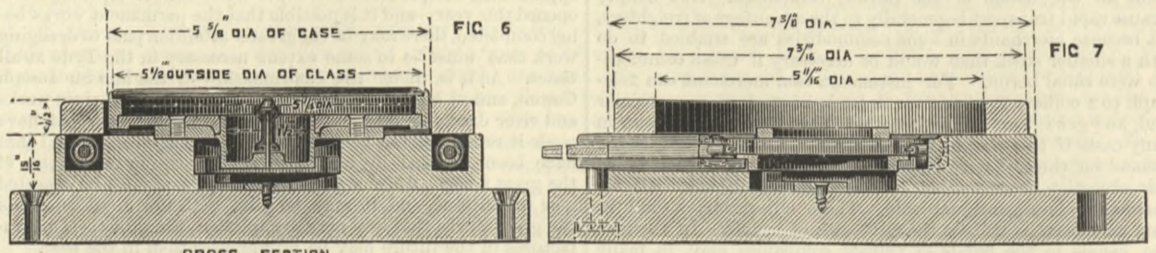
DECLINE IN TRADE.—The Board of Trade returns in regard to steel rails, steel, hardware, and cutlery, show that in January last there was a very serious falling off. Steel rails have fallen from £415,103 in January, 1883, to £213,202; unwrought steel from £117,069 to £98,641, hardware and cutlery from £341,982 to £283,446. The United States, which took a value in steel rails of £33,661 in January, 1883, only took £10,062 last month. In January, 1882, the value of steel rails sent to the States was £125,883. Mexico has fallen from £25,732 to £1119, the Argentine Republic from £46,963 to £21,195, British Possessions in South Africa from £32,964 to £6136, British East Indies from £91,417 to £51,253, and Australasia from £66,325 to £46,376. Italy and British North America are altogether blank; in January of 1883 they took £33,566 and £33,465 respectively. Egypt, which had nothing in January, 1883, received a value of £9781 last month. In steel—unwrought—the decline in the United States trade accounts for the total falling off. In hardware and cutlery the United States has decreased £14,000

NEW INSTRUMENTS FOR MEASURING ELECTRIC CURRENTS AND ELECTRO-MOTIVE FORCE.

By Messrs. R. E. CROMPTON and GISBERT KAPP.*

IN consequence of the rapid development of that part of electrical science which may be termed "heavy electrical engineering," reliable measuring instruments specially suitable for the large currents employed in lighting and transmission of energy have become an absolute necessity. As usual, demand has stimulated supply, and many ingenious and useful instruments have been invented, the manufacture of which forms at the present day an important industry. Mr. Shoolbred, in a paper which he recently read before this Society, gave a full and interesting account of the labours of our predecessors in this field. To-day we add to the list then given a class of instruments invented by us, examples of which are now before you on the table. We have preferred to call them current and potential indicators in preference to meters, considering that the latter term, or rather termination, ought to be applied rather to integrating instruments, which the necessities of electric lighting, we believe, will soon bring into extensive use. The principal aim in the design of these indicators has been to obtain instruments which will not alter their calibration in consequence of external disturbing forces. If this object can be attained, then it will be possible to divide the scale of each instrument directly into ampères or volts, as the case may be, and thus avoid the use of a coefficient of calibration by which the deflection has to be multiplied. This is an important consideration when it is remembered that in many cases these instruments have to be used by unskilled workmen, to whom a multiplication involving the use of decimal fractions is a tedious and in some cases even an impossible task.

All measurements are comparative. We measure weights or forces by comparison with some generally known and accepted unit standard weights, lengths, areas, and volumes, by comparison with a unit length, resistance by a standard ohm, and so forth. In the same way currents could be measured by comparison with a standard current; but this would be a troublesome process, not only on account of the apparatus necessary, but also because it would be a matter of some difficulty to have a standard current always ready for use. In general, measurement by direct comparison with a standard unit is discarded for the more indirect method of measuring not the current itself, but its chemical, mechanical, or magnetic effect. The chemical method is very accurate if a proper density of current through the surface of the electrodes be used,† but since it requires a considerable time, and, above all, an absolutely constant current, its use is almost entirely restricted to laboratory work and to the calibration of other instruments. For practical ready use, instruments employing the mechanical or magnetic effect of the current are alone suitable. We weigh, so to speak, the current against the force of a magnet, of a spring, or of gravity. The measurement will be exact if the thing against which we weigh or counterbalance the current itself retains its original standard value. Where permanent magnets or springs are used as a balancing force, this condition of constancy in our weights and measures is not always fully maintained, and to make



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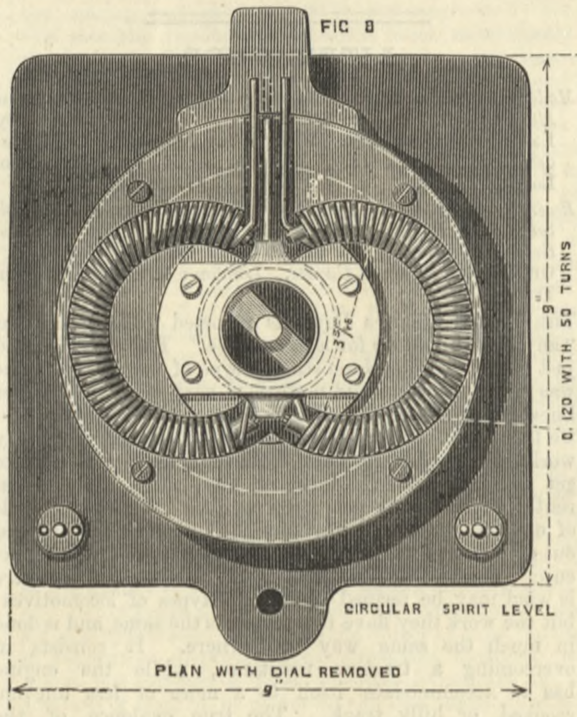

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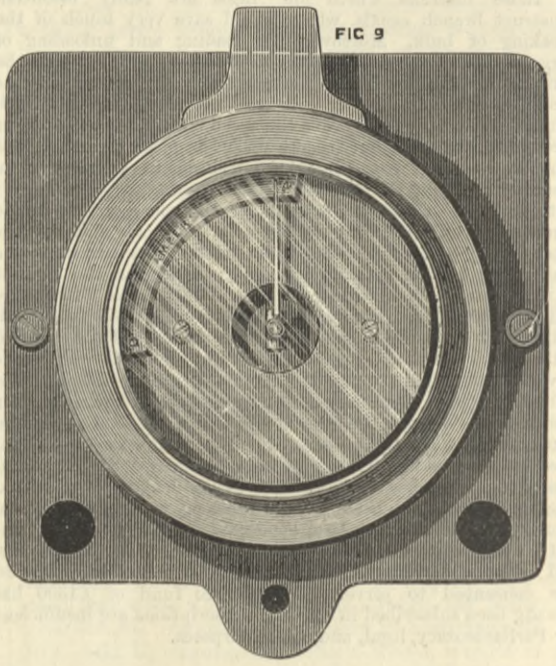

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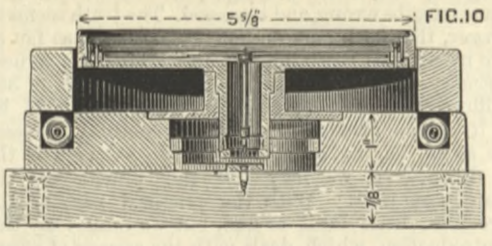

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CURRENT INDICATOR

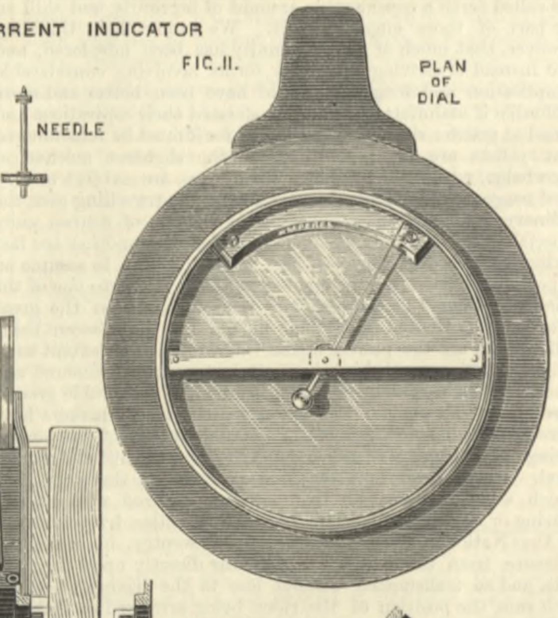
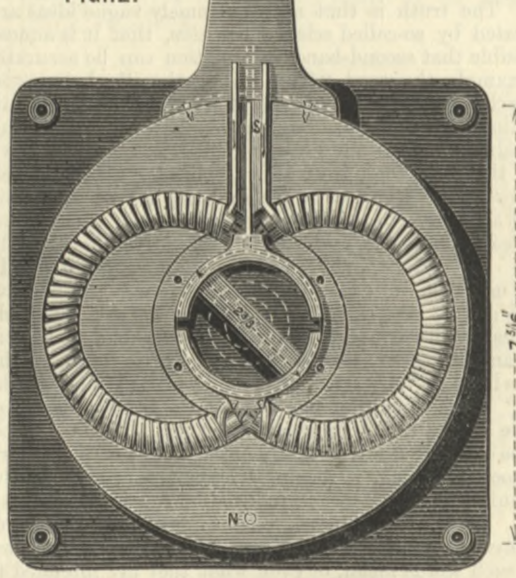


FIG.12.



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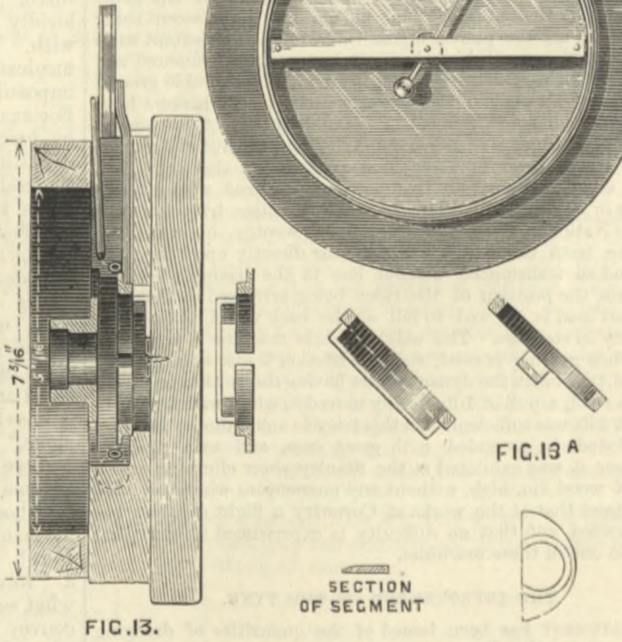


FIG.13.

* Paper read before the Society of Telegraph Engineers, 14th February, 1884

† According to recent experiments made by Dr. Hammerl, the density of current in a copper voltameter should be half an ampère per square inch of surface.

matters worse, there is no visible sign by which a change, should it have occurred, can be readily detected. A spring may have been overstrained or a steel magnet may have become weakened without showing the least alteration in outward appearance. To overcome this difficulty, the obvious remedy is not to use springs or steel magnets at all, but to substitute for these some other force which should be either absolutely constant, such as the force of gravity, or at least should vary only within narrow limits, and this in accordance with a definite law. This latter condition can be fulfilled by the employment of electro-magnets.

To imitate with an electro-magnet as nearly as possible a permanent magnet, so that the former can be used to replace the latter, it is necessary that the magnetism in the iron core should remain constant. This could, of course, be done by exciting the electro-magnet with a constant current from a separate source. (In a recent note to the Paris Academy of Science, M. E. Ducretet described a galvanometer with steel magnet, which is surrounded by an exciting coil. When recalibration appears necessary, a known standard current from large Daniell cells is sent through this coil during a certain time, and thus the magnet is brought back to its original degree of saturation. M. Ducretet also mentions the use of a soft iron bar instead of a steel magnet, in which case the current from the Daniell cells must be kept on during the time an observation is taken.) But such a system would appear to be too complicated for ready use. Moreover, some sort of indicator would be required by which we could make sure that the exciting current has the normal strength.

The plan we adopt is to excite the electro-magnet by the whole or a part of the current which is to be measured. Since this current varies, the power exciting the core of the electro-magnet

each angle of deflection corresponds one definite strength of current.

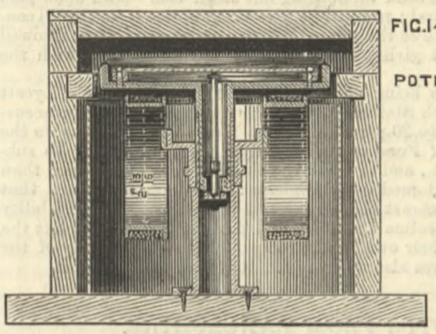
The force with which the electro-magnet tends to keep the needle in its zero position, that is, in line with the poles S N, is due partly to the magnetism of the core, which is nearly constant, and partly to the magnetic influence of the coils *c c* themselves, which is, of course, simply proportional to the current. The total magnetic force acting on the needle is, therefore, represented by the sum of these two forces, and consequently not nearly so constant as might be desired in order to get a good imitation of a tangent galvanometer with a permanent magnet. In the diagram, Fig. 2, the curve O A B represents the magnetic moment of the iron core, the straight line O D E that of the exciting coils *per se*, and the dotted line O F M the sum of the two, obtained by adding for every current O C the respective ordinates C D and C A.

$$CF = CD + CA$$

The rise of this curve shows that the force which tends to bring the needle back to its zero position increases with the current, though at a slower ratio than the deflecting force of the current. It follows from this, that for large currents the increment in the angle of deflection is comparatively small, and the divisions on the scale whereon the current is to be read off would come too near together to allow accurate readings to be taken. In other words, the range of accurate reading in an instrument so constructed would only be limited. But it is very easy to eliminate the magnetic effect of the coils of the electro-magnet on the needle, by introducing an opposite magnetic effect, so that only that part of the force remains which belongs to the soft iron core proper. One way of doing this is by surrounding the needle with a coil, the plane of which is at right angles to the line S N, and coupling this

equality which holds good for all currents, then we shall have an almost perfect imitation of a tangent galvanometer with permanent magnets. But we can go a step further than this; we can overbalance the exciting coils by setting the deflecting coil at a greater angle than necessary for the mere elimination of the former, and thus attain that an increase of current results in a slight weakening of the field in which the needle swings, thus allowing the increment of the angle of deflection to be comparatively large even for large currents. In this way it is possible to obtain a more evenly-divided scale than in the case when the deflection follows the law of tangents as in an ordinary tangent galvanometer. This principle of overbalancing the exciting coils is shown on diagram, Fig. 2. The straight line O G represents the magnetic effect on the needle of that component of the deflecting force which is parallel, but in sense opposed to S N; as mentioned above, the magnetic effect of the exciting coils is represented by the straight line O E. The combined effect of these two forces on the needle is represented by the line O K, the ordinates of which must be deducted from those of the curve O A B, in order to obtain the total directing force due to each current. This is shown by the curve O P Q shown in a thick, full line. This curve shows how the directing force or strength of field in which the needle swings decreases with an increasing current. That this does actually take place can easily be proved by experiment.

Fig. 4 shows two curves; the one drawn in a full line is obtained by plotting the deflection in degrees of the needle of a potential indicator as abscissæ, and the corresponding electro-motive forces measured simultaneously on a standard instrument as ordinates; the dotted line shows what this curve would be with an ordinary tangent galvanometer.



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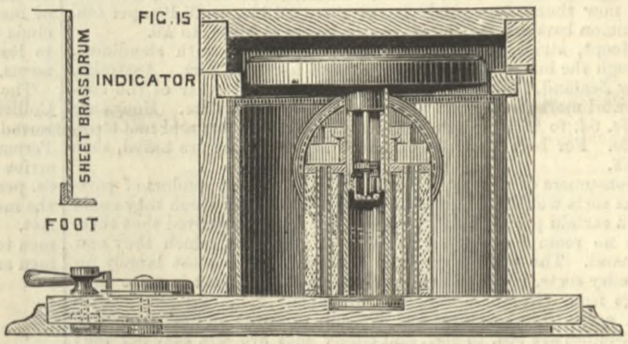

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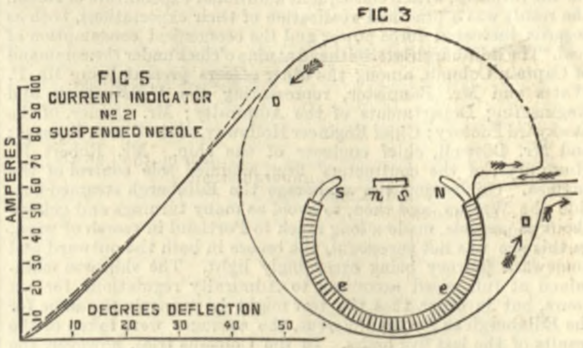

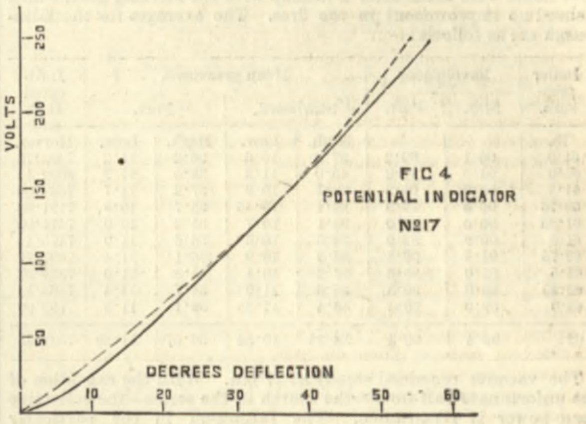

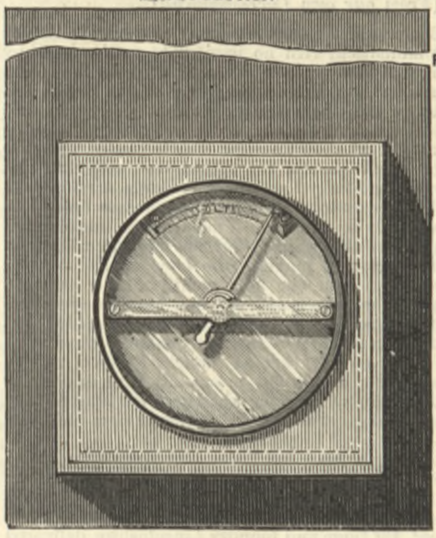

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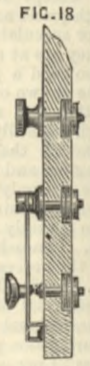

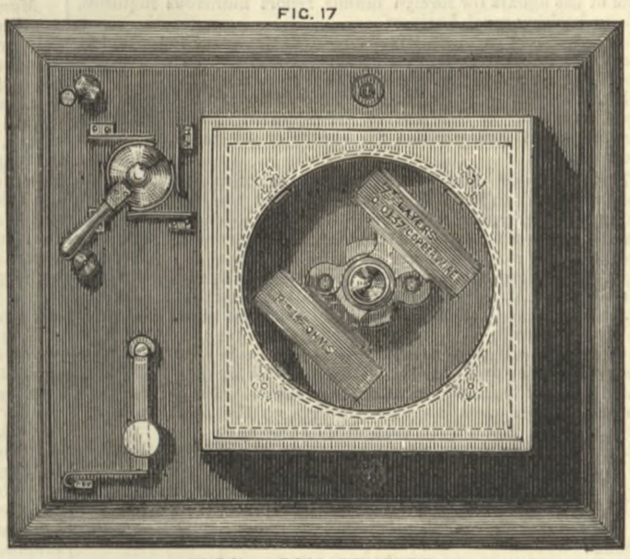

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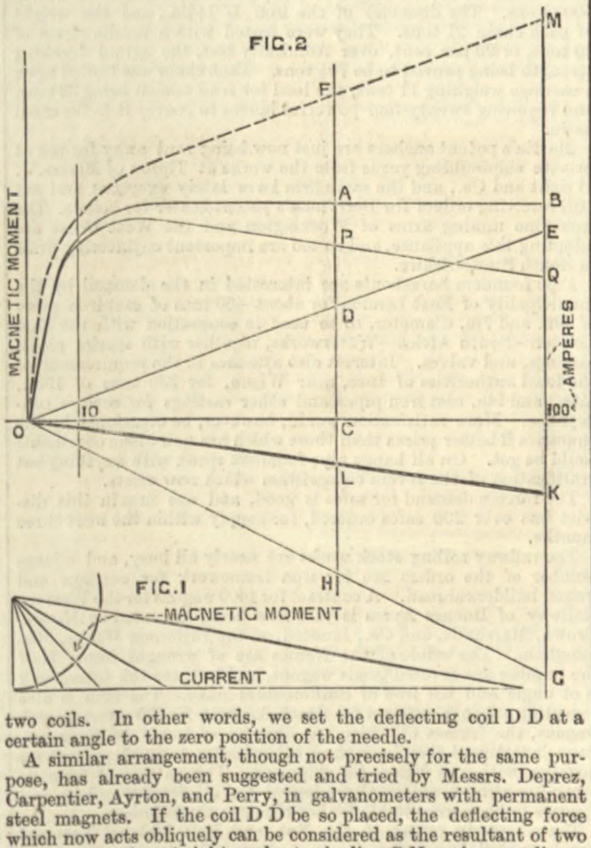
must also vary; and since we require the core to have as nearly as possible a permanent magnetic force, we are brought face to face with the question, whether an electro-magnet can be constructed that has a constant moment under varying exciting currents. This question has been answered by the well-known experiments of Jacobi, Dub, Mueller, Weber, and others. To get an absolutely constant magnetic moment is not possible, but between certain limits we can get a very near approximation to constancy.

The relation between exciting power and magnetic moment is very complicated, depending not only on the dimensions and shape of the core and the manner of winding, but also on the chemical constitution of the iron of the core. It is not possible, or at least it has hitherto not been found possible, to embody all these various elements into an exact mathematical formula, which would give the magnetic moment as a function of the exciting current; but the above-mentioned experiments have shown that within certain limits, and in the neighbourhood of the point of saturation, the relation between the two is that of an arc to its geometrical tangent. It will be seen that for large angles the arc increases much slower than the tangent; that is for strongly excited cores, a very large increase of the exciting current will produce only a slight increase of magnetic moment. If Mueller's formula were correct for all currents, absolute saturation could only be reached with an infinite current. Whether this be the case or not, it is certain that the greater the exciting current the less will a variation in it affect the magnetic moment of the core. To imitate as nearly as possible permanent steel magnets, it is therefore necessary to use electro-magnets, the cores of which are easily saturated. The core should be thin and long and of the horseshoe type; the amount of wire wound round it should be large in comparison with the size of the core.

Here is a magnet partly wound which was used in one of our earliest experiments, but which was a failure on account of having far too much mass in the core in comparison with the amount of copper wire wound round it. Since then we have greatly diminished the iron and increased the copper. The cores of the instruments on the table are composed of two or three No. 18 b.w.g. charcoal iron wires, and are wound with one layer of 0·120in. wire in the case of the current indicators, and eighteen layers of 0·0139in. wire in the case of the potential indicator. If from the diagram Fig. 1 we plot a curve the abscissæ of which represent exciting current, and the ordinates magnetic moment of the soft iron core, we find that a considerable portion of the curve is almost a straight and only slightly inclined line. If it were a horizontal straight line the core would be absolutely saturated, but such as it is, it answers the purpose sufficiently well, for with a variation of exciting current from 10 to 100 ampères the magnetic moment varies but slightly. If a small soft iron or magnetic steel needle *n s* be suspended between the poles S N of an electro-magnet of such proportions as described above, and the current after exciting the electro-magnet *c c* be led round the coils D D, it will be found that for all currents between 10 and 100 ampères the needle *n s* shows a definite deflection for each current. Here we have a galvanometer with permanent calibration. In this case the deflection of the needle will not strictly follow the law of tangents, because the directing power of the electro-magnet is not absolutely constant; but whatever the exact ratio between deflection and current may be, it must always remain the same, and to

coil in series with the deflecting coil D D. If the proportions of this transverse coil and the direction of the current through it be properly chosen, its magnetic effect can be made to exactly counterbalance that of the exciting coils *c c* without perceptibly weakening the magnetism of the iron core. But instead of employing two coils, one parallel and the other transversely to the zero position of the needle, we can obtain the same result in a more simple manner with one coil only, if this be placed at such an angle that its magnetic effect can be substituted for the combined effects of the



two coils. In other words, we set the deflecting coil D D at a certain angle to the zero position of the needle.

A similar arrangement, though not precisely for the same purpose, has already been suggested and tried by Messrs. Deprez, Carpentier, Ayrton, and Perry, in galvanometers with permanent steel magnets. If the coil D D be so placed, the deflecting force which now acts obliquely can be considered as the resultant of two forces, one acting at right angles to the line S N, as in an ordinary galvanometer, and the other parallel to this line, but in a sense opposed to the action of the electro-magnet and its exciting coils. If the angle of obliquity be so chosen that this latter component exactly equals the magnetic effect of the exciting coils *per se*, an

The needle of the potential indicator is mounted at the lower end of a steel axle, to the upper end of which is fastened a light aluminium pointer, whereby the deflection of the needle can be read off on a scale divided directly into volts. The scale is placed within a circular dial plate with glass cover, giving sufficient room for the pointer to swing all round, and the needle is placed within a central tube fitting it closely, which acts as a damper and so makes the instrument almost dead beat. Tube and dial are in one casting. The electro-magnet is of horseshoe form fastened to a central tubular stand, which also serves to support the two deflecting coils, one on either side of it. The tube within which the magnetic needle swings is inserted into the stand, which is bored out to the external diameter of the tube. The electro-magnet and deflecting coils are wound with from 50 to 100 ohms of fine insulated copper wire, and an additional resistance coil of from 450 to 900 ohms of German silver is added, which can, however, be short circuited by depressing a key when the instrument has to be used for reading low electro-motive forces. In this case the indication of the pointer must be divided by ten. If a current be sent through the instrument the wrong way, the needle turns through an angle of 180 deg., and thus brings the pointer to the side of the dial opposite to where the scale is. In this position no reading can be taken, and to facilitate the sending of the current in the right direction a commutator is added, and the same is so coupled up that when the pointer stands over the scale the handle on the commutator points to the positive terminal screw. There is a limit of electro-motive force below which the indicator fails to give reliable readings. For instance, an instrument wound with 100 ohms of copper wire and 900 ohms of German silver can be used for electro-motive forces varying between 300 and 3 volts, but would not be reliable for measuring less than 3 volts.

For very exact measurements the instrument should be placed north and south, in the same position in which it was calibrated. Two different patterns of current indicators are on the table; one with double needles suspended on a point in the way compass magnets are suspended, the other with one lozenge-shaped needle mounted on an axle and pivotted on jewels, in every way similar to the needle of the potential indicator first described.

For measurements of currents from 10 ampères upwards, there is no need to employ a complete coil as the deflecting agent; one half coil, or one strip passing close under the needle gives sufficient deflecting force, and thus the construction of the instrument is rendered extremely simple. The current, after entering at one of the flat electrodes, splits in two parts, each part passing round the winding of an electro-magnet of horseshoe form, the similar poles of both magnets pointing towards each other and towards the needle. After traversing the winding, the current unites again, and passes through a metal strip close under the needle, and finally out of the instrument by the other electrode, which lies close under that at which the current entered, but is insulated from it by a sheet of fibre. The metal strip is set at an angle, to balance or overbalance, as may be preferred, the magnetic influence of the exciting coils. The effect of this overbalancing is shown in Fig. 5, where the full curve represents the current as a function of the deflection—obtained by comparison with a standard instrument—and the dotted curve shows what that relation between deflection and current would be if the law of tangents held good for these instruments. It will be seen that, about the middle of the scale, the dotted line coincides nearly with the full line, whilst at the extreme end of the scale the dotted line is higher. From this follows, that if we compare our indicator from which this curve was taken with any form of tangent instrument showing an equal angle of deflection at the medium reading, it will be seen that the needle of our indicator will be deflected to a greater angle at high readings than that of the tangent galvanometer. Consequently, the divisions on the scale will be widest apart in our instruments, which greatly facilitates high readings.

HER MAJESTY'S SHIP EDINBURGH.

THE sister ships Colossus and Edinburgh have so far been distinguished by the remarkably successful trials of their engines, those of the former manufactured by Messrs. Maudslay, Sons, and Field, and illustrated by us last week, and the latter by Messrs. Humphrys and Tennant, of Deptford. Perhaps in no other ships has the power developed during the six hours of continuous full-power steaming been so largely in excess of the contract. The first trial of the engines of the Edinburgh occurred as far back as the 18th of September, when the result of the run gave a total mean of 6808·72 horses, or 808·7 beyond the covenanted power; the figures relating to the Colossus will be found in our last impression. Great as this excess was the contractors were not satisfied. The *Times* says they felt assured in their own minds that the engines were capable of developing still more, especially as there was abundance of steam and to spare. They also felt convinced that a serious mistake had been made in the case of the Edinburgh, as regards the consumption of fuel, the calculations showing that upwards of 3lb. of coal had been used per unit of horse-power developed. Such an expenditure of fuel was in direct contradiction to the experience derived from the machinery by the same manufacturers in the Alexandra, Téméraire, Dreadnought, and the Indian troopships. Representations to this effect having been made to the Admiralty, their lordships authorised a second full-power trial being made, although perfectly willing to accept the engines from the contractors on the strength of the previous test.

The second trial was made on the 6th inst., and although the contractors laboured under the serious disadvantage of there being no wind, necessitating the free use of the blast to secure a draught for the furnaces, with a consequent additional expenditure of steam, the result was a practical realisation of their expectations, both as regards increased force power and the economical consumption of coal. The Edinburgh left Spithead at nine o'clock under the command of Captain Colomb, among the other officers present being Mr. P. Watts and Mr. Bannister, representing the Constructive and Engineering Departments of the Admiralty; Mr. Corner, of the Dockyard Factory; Chief Engineer Holloway, of the Steam Reserve; and Mr. Boswell, chief engineer of the ship. Mr. Robert H. Humphrys, of the contractors' firm, assumed sole control of the engines. On leaving the anchorage the Edinburgh steamed outside the Warner, and then, to avoid as many turnings and goings-about as possible, made a long reach to Portland in search of wind. In this she was not successful, the breeze in both the outward and homeward journey being exceedingly light. The ship was maintained at full speed according to Admiralty regulations for six hours, but in order that the test might be precisely the same for the Edinburgh as for the Colossus, the averages were taken of the results of the last five hours. In the Colossus trial, however, the five hours were taken after a mishap with the steering gear, which caused no improvement in the fires. The averages for the Edinburgh are as follows:—

Boiler pressure.	Revolutions.		Mean pressures.				Indicated H.P.
	Star.	Port.	Starboard.		Port.		
lb.			High.	Low.	High.	Low.	Horses.
61·0	90·1	90·2	37·2	10·6	36·2	11·2	7402·73
65·0	91·5	91·2	40·0	11·3	38·5	11·9	8002·14
61·5	90·9	90·3	38·1	10·9	37·2	11·7	7661·90
60·75	90·0	89·3	36·1	10·45	35·7	10·9	7191·83
61·25	90·6	90·0	38·1	10·7	35·8	10·9	7411·90
61·0	90·9	89·9	38·5	10·6	36·6	11·0	7475·19
62·75	91·6	90·3	38·2	10·9	36·1	11·4	7607·77
61·5	91·0	89·8	37·2	10·4	35·8	11·0	7334·92
62·25	89·0	90·5	38·6	11·0	36·7	11·4	7566·14
63·0	89·0	90·5	40·4	11·35	38·1	11·3	7759·99
62	89·4	90·4	38·24	10·84	36·67	11·29	7541·45

The vacuum remained steady at 27·5in. With the exception of one unfortunate half-hour—the fourth in the series—the collective horse-power is remarkable. The falling-off in the particular instance, which affected the total mean of the trial, was due to a change of watch in the stokeholds occurring simultaneously with the going about of the ship. On the other hand, the results were steadily rising when the trial ceased, and had time permitted another hour's additional steaming would have still further added to the triumphs of the day. As they stand, however, the data gave a total of 1458·55 horses in excess of the stipulated power. When the engine were developing their greatest capacity a throw of the log showed that the ship had attained the extraordinary speed of 19 knots; but the mean of the whole trial gave a speed of 17·2 knots, which is more than ships of the class were ever expected to realise.

THE ELECTRIC LIGHTING OF PRIVATE HOUSES.

A PAPER was read at the ordinary meeting of the Royal Institute of British Architects on the "Electric Lighting of Houses and the Precautions to be Adopted on its Introduction," by Mr. Killingworth Hedges, C.E. The steady increase of electric lighting for house purposes was shown by the number of installations which have recently been made by the occupants of houses both in town and country. In large cities a temporary check had been experienced with the general supply of electricity as contemplated by the Act of 1882. This was partly because the companies who obtained provisional orders were of too speculative a character, and also because the stringent regulations of the Board of Trade prevented the introduction of capital. The electrical currents which would be employed for lighting a dwelling are far more powerful than those now used for telephones and for electric bells; and, unless some precautions were taken to insure their being properly regulated, they might cause great risk from fire. Mr. Hedges pointed out how this risk might be occasioned, and suggested that the rules of the Fire Risk Committee should be strictly adhered to, especially those which advised that all work should be under the supervision of a competent electrician. Many fires had been caused by the electric light, which is used largely in America for mill lighting, the official report showing that all these were either due to neglect of precautions for safety or by not having the work properly supervised. As regards cost, the fixed charges with electric lighting—such as interest, &c.—caused it to be much dearer than gas, when used for a short period; but if these charges were spread over a number of hours, electricity was relatively much cheaper. In a country house the expense would not be more than for gas. Even if it was dearer; for Mr. Hedges recommended the introduction of the electric light on account of the ultimate saving in the renewal of decorations, and preservation of works of art. The property of not vitiating the air should alone make electricity rank, independent of its cost, as one of the greatest sanitary improvements of the age. The paper was followed by a discussion.

TENDERS.

NOTTINGHAM CHURCH CEMETERY.

TENDERS for retaining walls in buttress and arcade work for intermural interments in vaults and catacombs. Mr. Frederick Jackson, C.E. and Architect, Nottingham.

	£	s.	d.
Lynam and Kidd, Nottingham	1925	0	0
Bradley and Barker, Nottingham	1865	0	0
Meats Bros., Nottingham	1770	0	0
Joseph Hodson, Nottingham	1471	0	0
Thomas Beck, Matlock	1308	0	0
Thomas Smart, Nottingham	1282	0	0
S. and J. Cargill, Nottingham	1250	0	0
Foster and Barry—accepted	1127	0	0
Architect's estimate	1233	10	0

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

(*From our own Correspondent.*)

ON 'Change in Birmingham this—Thursday—afternoon, and yesterday in Wolverhampton, ironmasters manifested considerable indisposition to have it become known what are the prices which in actual business they are at the present time accepting. All, however, protested that they would accept nothing less than "paring rates," and that rather than depart from this policy they were prepared to continue to refuse many of the inquiries which reach them, particularly from middlemen who do an export business.

Specifications in completion of orders some time ago booked were still eagerly sought by the finished iron makers, and it is not impossible to keep all the mills and forges on five days a week. Here and there inquiries for sheets were reported a little better, the demand of the Australian, South American, and Canadian markets, together with some European houses, being fairly satisfactory. Makers of common sheets accepted £8 for doubles and £9 to £9 5s. for treble gauges, whilst best—thin—sheets were £10 to £11 per ton. The plate mills are very indifferently employed. Tank sorts are selling better than boiler plates at from £7 7s. 6d. to £7 10s. and upwards at works. Boiler plates were £8 10s. to £9 and £9 10s.

Best bars are still quoted at £7 10s. for B.B.H. "Mitre," and similar makes, with £8 2s. 6d. nominally for Round Oak iron. The business doing in these quality irons is limited, and the orders arriving are chiefly on colonial and foreign account. The largest demand runs on medium bars, which most of the leading houses are now themselves producing at about £6 15s. to £6 10s. per ton. Common bars are moving off pretty freely at £6 5s. to £6.

Hoops, strips, and the like are being rolled with steadiness, though the business is chiefly of a hand-to-mouth sort. Australia, New Zealand, South America, Italy, Spain, and other of the continental markets are the best export buyers at date. Hoops are £6 7s. 6d. to £6 10s.; gas strip, £6 2s. 6d., and on; and nail strip, £6 5s. For best qualities of hoops higher prices are asked, such as £8.

Consumers of pigs reported this afternoon that vendors of partmine sorts would not give way beyond a level at which they could see a certain profit; and vendors on their part reported that there was no room for any departure from the rates which they now demand. The call for pig iron this week bulks most largely for foundry sorts, which consequently are a shade firmer in price than forge iron. Northampton pigs are about 44s., and Derbyshires 46s. easy. Lincolnshires are 47s. 6d. upwards, delivered; native part-mines are 50s. to 45s., and cinder pigs are 40s. easy per ton; all-mines are 62s. 6d. down to 60s., and hematites 57s. 6d. to 59s. Some of the agents for foreign brands report numerous inquiries, without booking much business.

The galvanised sheet makers are not this week able to report any substantial improvement, and at several works some of the vats remain empty. A fall of 10s. per ton is to be noted in New South Wales. No great importance is, however, attached to the decline, since fluctuations in this market are frequent. Home prices are given as about £13 per ton for sheets of 24 gauge, delivered Liverpool.

This—Thursday—afternoon the annual meeting of the Wages' Board was held in Birmingham. The report was adopted. Mr. Benjamin Hingley, chairman, said it would be a good thing if both sides did the best to sustain the board. Although trade was getting worse, masters would be sorry to see a reduction in the present wages. The Ironmasters' Association also held their annual meeting to-day, and Mr. Hingley was re-elected chairman for three years.

Prominent among the bridge building contracts which are under execution at date is a large bridge for Manilla Creek, Sydney, New South Wales, which is being made in the Dudley district. The structure is being built on the lattice principle, and when erected it will present quite an imposing appearance. The makers have also secured contracts for other bridges on the same principle, likewise for the New South Wales Government.

Engineers and ironfounders who supply the needs of the mills and forges in such portions of plant as wheels, rolls, helves, hammers, anvils, and other castings share in the current quietude in the iron trade. New work is difficult to secure, though towards the close of last year manufacturers were doing a fair amount of business.

The late activity in the cable and anchor trades is not being fully maintained. The new year has not so far brought out any large quantity of business. Nevertheless, some of the South Staffordshire firms state that January was a satisfactory month. Certain of the yards are now only engaged two-thirds and others half time. Orders for crane chains and the best descriptions of rigging chains are arriving steadily, as also for colliery chains. In all the branches lowness of present prices is much complained of.

Two massive chains of special manufacture have just left the works of Messrs. Jones and Lloyd at Cradley, near Dudley, for use on the large floating bridge connecting Portsmouth and Gosport. Each chain is of the length of 640 yards, and consists of nearly 5000 links. The diameter of the iron is $1\frac{11}{16}$in., and the weight of each chain 21 tons. They were tested with a tensile stress of 40 tons, or 20 per cent. over Admiralty test, the actual breaking strength being proved to be $70\frac{1}{2}$ tons. Each chain was loaded upon a carriage weighing 11 tons, the load for road transit being 32 tons, and requiring twenty-four powerful horses to convey it to the canal basin.

Martin's patent anchors are just now being sent away for use at private shipbuilding yards from the works at Tipton of Messrs. J. Wright and Co., and the same firm have lately executed and are still receiving orders for Berryman's patent heater for boilers. The ironstone mining firms of Workington and the West Coast are adopting this appliance, and so too are important engineering firms in South Staffordshire.

Pipe founders hereabouts are interested in the demand by the municipality of East London for about 400 tons of cast iron pipes of 5in. and 7in. diameter, to be used in connection with the East London—South Africa—Waterworks, together with special pipes, castings, and valves. Interest also attaches to the requirement of the local authorities of Ince, near Wigan, for 336 tons of 15in., 12in., and 9in. cast iron pipes and other castings for sewage conveyance. More satisfaction would, however, be occasioned by the enquiries if better prices than those which are now alone obtainable could be got. On all hands pipe founders speak with anything but gratification of the severe competition which now exists.

The foreign demand for safes is good, and one firm in this district has over 200 safes ordered, for supply within the next three months.

The railway rolling stock works are nearly all busy, and a large number of the orders are for iron framework for carriage and wagon builders abroad. A contract for 1400 wagons for the Western Railway of Buenos Ayres is just now being executed by Messrs. Brown, Marshalls, and Co., Limited, of the Britannia Works, Birmingham. The whole of the frames are of wrought iron. Half the number are covered goods wagons, and in these the framework is of angle and tee iron of Staffordshire make. The firm is also executing another contract for South America for 230 covered goods wagons, the frames of which are likewise of iron. In their carriage department they have three other contracts on at present for carriages with iron frames for shipment. This pattern of frame is becoming almost universally adopted for all foreign orders, and appears to be more suitable for hot climates than timber.

The quarterly report of the Nut and Bolt Makers' National Amalgamated Association does not draw a bright picture of the present state of trade. It states that the members of the Workington branch have been idle for nearly the whole of the past quarter from the want of orders. Sheffield, Middlesbrough, and the Northern branches have experienced a great depression.

The Hamstead Colliery Company, Limited, has now practically completed the erection of its powerful working plant, and is raising about 2000 tons of coal and slack weekly. During the past year a pair of 30in. cylinder hauling engines have been purchased and erected on the surface to work the underground haulage; and a third engine, formerly used for pumping, has been utilised for the same purpose. Attached to these engines are 8000 yards of steel rope. The new electric system of signalling has been successfully adopted throughout the workings.

So fully satisfied are the Gas Committee of the Birmingham Corporation that the heavy expenditure which they have already incurred in the erection of new plant at their gasworks has been a wise outlay, that they have recently authorised further extensions of machinery at the Windsor-street works, of buildings at Saltley works, and of mains in connection with Adderley-street works, the total cost being about £15,000.

The sale of gas by the Birmingham Corporation during the past year was an increase upon the previous year of $6\frac{1}{2}$ per cent. The net profits of the year amount to £55,389, which the committee propose to appropriate as here:—To the improvement rate, £25,000; to reserve fund, £5000; to the sinking fund for paying off loans and annuities, £25,389. The income of the department by the sale of gas during the year was £336,274, and by the sale of residual products £125,113. The committee propose to reduce the price of gas from the end of the present quarter.

Colliery owners in North Staffordshire are using the present time of trade depression to promote that regularity of work by their hands which suffered so rude a shock ever since the heavy demand for their labour in 1875. Mr. W. Y. Craig, M.P., has determined to close portions of his Podmore Hall Collieries, and to require that the colliers for whom work can be found shall labour all the working days and send up nothing but clean coal—both upon pain of instant dismissal; nor will he give them notice if he should conclude to wholly close the pits. The men on their part are allowed to leave without giving notice if they are dissatisfied with the terms.

The shadow is being preferred to the substance at the Lycett Collieries in North Staffordshire. The employers have been accustomed to subscribe 20 per cent. of the men's contributions to the Permanent Relief Fund of the colliery. They now offer to subscribe 50 per cent., and to make the sick allowance 9s. rather than 6s. per week, and medical attendance. The conditions are that the men shall contract themselves out of the Employers' Liability Act. The men decline the offer, and the employers have left the men to keep up their own fund, from which, however, many of the men are themselves also now withholding their subscriptions.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester.—Business all through the iron trade of this district continues without animation, with no immediate prospect of any improvement. Pig iron makers, however, are busy with the orders they have on their books, and there is no giving way in prices, but there is very little new business coming forward. Consumers are working off their deliveries on account of the contracts given out a month back, and at present show no disposition to place out further orders, except for small parcels for actual requirements; and although prices are undoubtedly low, they offer little or no inducement for speculative transactions, as there is no present indication that they are at all likely to advance. Finished iron makers are not in so good a position as the blast furnace proprietors. It is only one or two of the leading makers who have orders on their books that will see them over the next month or six weeks, and although generally they are kept going, the new business given out is so small that prospects for the future are anything but encouraging, and there is a tendency towards weakness in prices.

There was only a very dull market at Manchester on Tuesday, with prices nominally unchanged, but practically little or nothing doing to actually test values. For pig iron there was scarcely any inquiry. Lancashire makers are doing only a very limited business; but for the orders they do get they hold out for their full rates of 44s. 6d. to 45s., less $2\frac{1}{2}$ per cent. for forge and foundry qualities delivered equal to Manchester, and they still decline to entertain deliveries beyond the end of June. In district brands a few small sales during the past week are reported on the basis of 44s. 6d. to 45s., less $2\frac{1}{2}$ per cent. for forge and foundry Lincolnshire delivered here, and at these figures makers are firm. As regards outside brands, the business doing here can scarcely be said to be of a satisfactory character. In Scotch iron there is still a good deal of underselling, with iron offering at 6d. to 9d. per ton under makers' prices, and in North-country iron, whatever hardening tendency the blowing out of furnaces in the Cleveland district had upon the market, has disappeared, and Middlesbrough brands can be bought at prices quite as low as any that have been ruling recently.

In hematites a slight improvement is reported, and in some cases rather better prices have been obtained during the past week; but business is still anything but good, and foundry brands can be bought at as low as 56s. to 56s. 6d., less $2\frac{1}{2}$ per cent. delivered equal to Manchester.

The finished iron trade continues very quiet. Most of the makers have specifications in hand to keep them pretty well employed, but they are getting very few new orders, and in some classes of iron very low prices are being taken. Common plates, owing to the falling off in the demand for shipbuilding purposes, are now being pushed into the market, and can be bought here at as low as £5 12s. 6d. to £5 15s. per ton; hoops are also to be got at £6 5s. to £6 7s. 6d., and sheets at £7 10s. to £7 12s. 6d. per ton. For good ordinary local and North Staffordshire bars makers are holding for £6 as their minimum, but there are sellers in the market taking considerably under this figure for inferior brands.

The engineering trades of this district continue fairly employed, and although there is still no great weight of new business coming forward, moderately good orders are being got in some branches, and prospects for the future are, perhaps, not quite so discouraging as they were a few weeks back. Employment generally continues steady, and the returns for the past month issued by the Trades Union Societies do not show any material increase in the number of members in receipt of out-of-work support. The Amalgamated Society of Engineers has at present on its books about $3\frac{1}{2}$ per cent. of the members in receipt of out-of-work support. This represents also about the average for the Manchester and Salford districts, which are generally a pretty fair index of the state of employment throughout the kingdom generally. This is a slight increase, but the number of members actually out of work is less in proportion as compared with this time last year. Many of the large engineering centres in Lancashire have, however, been injuriously affected by the recent strike in the cotton trade, and reports from a considerable number of the districts return trade as only dull. In the report of the Steam Engine Makers' Society it is stated that none of the branch returns could be said to be more cheerful than last month as to the prospects of a revival in trade; but, on the other hand, it was satisfactory to report that trade was no worse, and the present number of out-of-work members is only a little over $1\frac{1}{2}$ per cent. In the Manchester and Salford districts trade is returned as rather flat; but from some of the Lancashire districts a more hopeful tone is expressed, owing to rumours that considerable orders have recently been secured. The report also alludes to a further attempt to reduce wages in the Barrow district, which it was expected the men would firmly resist, and adds that the various branches of the iron shipbuilding districts report a serious state of affairs brought about by the employers giving notice of excessive reductions on the platers and rivetters, which it was not anticipated the men would accept in full.

We hear of several new works being started in the neighbourhood of Manchester; one as a steel works, and another for the manufacture of steel cables, but at present there does not seem to be anything definitely known. Mr. West, who has recently resigned his position as chief engineer to the Manchester Corporation Gasworks, has taken a large works at Newton Heath, formerly known as the

Albion Ironworks, where the company, which has recently carried on its operations at Maidstone, Kent, will now extend its manufacture of Mr. West's patent charging and withdrawing machinery for retorts in connection with gasworks, which has already been adopted by some of the London gas companies, and also at several works in the provinces.

In the coal trade business continues very quiet, and, with very few exceptions, the collieries throughout Lancashire are not working more than about four days a week. Even with this restriction of the output, supplies are in excess of the demand, and stocks, which are accumulating, are forced upon the market at very low figures. The better classes of round coal for house fire purposes move off very slowly, owing to the mildness of the season, but for common round coals there is only a moderate inquiry for general trade purposes, with the prospect that requirements will rather decrease than increase. Engine classes of fuel are moving off pretty freely, and as there is only a small quantity of round coal being screened, slack is getting scarce, with a tendency to stiffen in price. At the pit mouth prices average about 9s. 6d. to 10s. for best coal; 7s. 6d. to 8s. for seconds; 6s. to 6s. 6d. for common; 4s. 6d. to 5s. for burgy; 3s. 9d. to 4s. 3d. for best slack; and 3s. to 3s. 6d. per ton for ordinary qualities; but in round coals there is a good deal of underselling, and for special sales very low figures are quoted.

In the shipping trade there are more inquiries stirring, but the actual business doing is still very small, and low prices are quoted, good Lancashire steam coal being offered at Liverpool and Garston at about 7s. 6d. per ton.

For coke there is a moderate demand at about late rates.

A pretty fair index of the state of the coal trade is afforded by the result of the operations of one of the largest companies in Lancashire—Messrs. Andrews, Knowles, and Sons, Limited—during the past year. The total quantity of coal raised by the company at its various collieries amounted to 1,091,000 tons, but prices have ruled so low that out of this large output it is only able to pay a dividend of 2½ per cent.

Barrow.—So far as I can see, the slight improvement in the hematite pig iron trade, which I reported as having taken place last week, still continues, with every sign of becoming permanent. The aspect of the future is much brighter. Business transactions have increased to a considerable extent, and all round a greater confidence seems to be placed in makers. The orders to hand this week on home account are extensive. The foreign trade also shows an appreciable change, and good enquiries are to hand from German and Russian consumers. The stocks of metal now warehoused at makers' are much lighter than they have been for some time past, and now that the output has seen such a great reduction, stocks are weekly decreasing. Prices are firmer, and, if anything, have an upward tendency. Quotations this week stand at 49s. per ton net at works, prompt delivery, for No. 1 samples; No. 2 is selling at 48s. per ton; and No. 3, 47s.; while No. 3 forge is in demand at 46s. 6d.; and inferior samples at 45s. per ton net. I note that there is rather a better tone in the steel trade all round. Orders as yet, however, are rather scarce, but makers have one or two good contracts on hand. The demand for rails, which are quoted at £4 10s. to £5 per ton, is rather slight. The merchant department is much brisker, and the men are pretty steadily employed. Steel shipbuilders show greater activity, and several good orders have been booked. Iron ore is in, if anything, a little better request. Prices are very low, being from 9s. 6d. to 12s. per ton net at mines. Heavy banks of ore are held at mines.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

THE Yorkshire Miners' Association have not yet abandoned the idea of getting the 10 per cent., but they seek it now in rather a roundabout way. They have put before the employers a code of rules, which they say, "the district has agreed to ask the coalowners of Yorkshire to accept, and work by in the future." The scheme referred to is prefaced thus:—"We, the miners of Yorkshire, are willing to agree to a joint committee of coalowners and workmen, as per the following resolution of Conference held in Barnsley on Monday, November 26th, 1883." The first condition runs thus:—"That the present rate of wages, with 10 per cent. added, be the minimum rate of wages." The very insertion of this clause seems to point to the insincerity of the desire to have a sliding scale in operation, as it is well enough known that the colliery owners will not consent to any such proposal. Mr. C. E. Rhodes, the secretary to the coalowners, in replying to Mr. Pickard, promises to lay the scheme before the coalowners at an early date.

It is impossible to travel any distance in the colliery districts without seeing how depressed the condition of the coal trade is. Wagons laden with coal still block up the sidings, and stocks continue to accumulate at the pits, while one company offers a large discount to dealers to clear off several thousand tons of accumulations. I hear of another company offering hards to London merchants at 6s. per ton on wagons. Deducting 9d. per wagon, this leaves 5s. 3d. for the coals. What hope of profit is there here? Would it not be better to leave the coal in the pit than scoop out our national cellars at such a ruinous sacrifice? An advance of 1s. a ton on certain qualities of house coal was made at London on Monday, but there has been no corresponding firmness here.

In the iron trade the low prices already noted continue in force, with no indications of an upward tendency in quotations. There is some activity in contract work as well as in specialities of certain works in the neighbourhood.

My anticipation that the new Dore and Chinley Railway would meet with the tacit approval of the Midland Company was justified by last Friday's meeting of the shareholders at Derby. The chairman of the company, in moving that the Midland give its consent to the passing of the Bill, was pressed to say if the line was "a promoters' line" which would afterwards be acquired by the Midland. He declined to commit himself to any statement in the matter, stating that all they had before them at the meeting was the proposal not to oppose the new company's application to Parliament. Mr. Thompson did mention, however, that the Midland had twice attempted to get through the district, and now the effort was being made by an independent company. It is probable, I hear, that the promoters will so far vary their plans as to come nearer the important village of Baslow—for Chatsworth—in which case the line would be of much more importance to Sheffield than as at present projected. Baslow is the favourite recreation ground of the Sheffield people, who reach it by a twelve-mile ride over the hills. An extensive and well-appointed hydropathic establishment has recently been erected overlooking Chatsworth Park and House, and Baslow is certain, with railway facilities, to develope into a place of some consequence.

The Midland Iron Company reports that it is fairly busy in all departments; the Rotherham Forge and Rolling Mills are also well employed; Messrs. Steel, Peech, and Tozer, at the Ickles Works, find their special departments in steel prospering, and will soon be in a position to largely increase the output.

At the armour-plate mills there is full employment, ordnance being also in good demand; the steel trade generally keeps very dull. A slight improvement is reported in several markets; but the general condition of both the crucible and Bessemer industries is not at all encouraging.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

THE Cleveland pig iron trade continues in a dull and listless condition; but prices continue fairly steady and unaffected by the variations of the Glasgow market. At the market held at Middlesbrough on Tuesday last there were merchants willing to sell small quantities of No. 3 g.m.b. at 36s. 9d. per ton for prompt delivery, but makers would not accept less than 37s. Some buyers gave that price for forward delivery. Prices of forge iron have stiffened again during the last few days, and on Tuesday quotations ranged from 34s. 9d. to 35s. per ton. The compact for blowing out eighteen blast furnaces is now complete, and it is expected that the restrictive arrangements will be in full operation by the end of next week.

Warrants are nominally 37s. per ton. The stock of Cleveland pig iron in Messrs. Connal and Co.'s Middlesbrough store declined 801 tons during the week ending Monday last. Their stock at Glasgow was, on Monday, 593,196 tons, being an increase of about 3000 since the beginning of the month.

Shipments are going on at a very satisfactory rate. The quantity of pig iron sent away to the 18th inst. was 42,107 tons, being about 4000 tons more than in January, and 13,000 more than in February last year, corresponding periods being taken.

Great slackness prevails in the finished iron trade. Orders and specifications are scarcer than ever, and several mills are now idle or working intermittently. Prices remain about the same as quoted last week, and are as follows:—Ship plates, £5 5s. to £5 7s. 6d. per ton; shipbuilding angles, £4 15s. to £5; and common bars, £5 2s. 6d. to £5 5s., prompt delivery, all free on trucks at makers' works, cash 10th, less 2½ per cent.

It is reported that the Rosedale ironstone mines have been taken on lease for twenty-one years by a large iron company, and that arrangements are being made to open the mines at once. They have been closed for several years.

Messrs. Bolckow, Vaughan, and Co.'s Eston Steel Works, which have been in full operation since the termination of the strike, turned out last week 4310 tons of rails. This is a larger quantity than was ever before made in one week.

Messrs. Sadler and Co., Limited, of Middlesborough, have just concluded an arrangement whereby their chemical business will be amalgamated with that of Messrs. Forbes and Abbot, of the Ammonia and Acid Works, Old Ford, Bow, and the Tar Works, East Greenwich; also with that of the Sussex Chemical Works Company, Limited, whose works are at East Greenwich and Shoreham. It is proposed to increase the capital to £500,000 by issuing 12,500 new shares at £20 each.

Owing to the restriction of output at the blast furnaces large numbers of workmen are being discharged at the collieries and ironstone mines. Messrs. Bolckow, Vaughan, and Co. are about to close three of their collieries, two at Crook and one at West Auckland; the same firm will also pay off a considerable number of men at their Eston mines. Notice has also been given to about seventy miners at the Chaloner pit, Guisbrough, to terminate their engagements.

No settlement has yet been arrived at with regard to the blast furnacemen's wages, but the men have now asked to have the matters in dispute submitted to arbitration. The two main points for consideration are, first, the 5 per cent. reduction of which the masters have given notice; and second, the extra pay for Sundays of which the men gave notice. If the employers will agree to arbitration, the men will accept the sliding scale for eighteen months. The blast furnacemen employed by Messrs. Bolckow, Vaughan, and Co., at Witton Park, have agreed to a 5 per cent. reduction on receiving an intimation that the whole of the furnaces would be blown out if they did not do so.

The workmen employed by Messrs. Raylton Dixon and Co., iron shipbuilders, of Middlesbrough, have agreed to submit to a 10 per cent. reduction from the 25th inst., the arrangement to hold good till July 1st, when a month's notice from either side must be given if any change is desired. Nothing definite has been settled at the other shipyards where the masters ask a reduction of 12 to 15 per cent.

Several of the proprietors of the leading plate, angle, and bar mills are seriously considering the desirability of closing their works for an indefinite period. They have mostly done well during the last two or three years, and are quite strong enough financially to meet all their engagements and await events. At present prices of shipbuilding iron the loss by manufacturing is at least double the loss which would accrue by standing. Were there any immediate prospect of a revival they would not mind continuing to produce for a short time. But as their horizon is still without a ray of light, they are seriously contemplating the step indicated. This course will have the further advantage from their standpoint of forcing down to a lower level both materials and labour, which are now maintained at a somewhat artificial level by means of combination.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

THERE has been rather more firmness in the warrant market this week, and the quotations do not show very much alteration. A better feeling has been imparted by an improvement in the past week in the amount of the exports of Scotch pig iron, together with the belief that a fairly good foreign business will be done in the course of the spring. Merchants speak more hopefully regarding the inquiries they are receiving both from the Continent and the United States. There are ninety furnaces in blast as compared with 111 at the same date last year.

At a meeting of ironmasters held in Glasgow on Wednesday, a committee was appointed with full powers to investigate the truth of the allegations that have recently been made as to the introduction into Messrs. Connal's stores of pig iron in the manufacture of which a considerable proportion of cinder has been used.

Business was done in the warrant market on Friday at from 42s. 9½d. to 42s. 8d. cash, and 42s. 11d. to 42s. 9½d. one month. The market was steady on Monday at 42s. 7½d. cash and 42s. 9d. one month, there being hardly any variation in the quotations on Tuesday. On Wednesday the market was flat at 42s. 7d. to 42s. 5½d. cash, and 42s. 8½d. to 42s. 7½d. one month. To-day—Thursday—business was done down to 42s. 3d. cash, afterwards recovering to 42s. 4d.

The market values of makers' iron are a shade lower, as follow:—Gartsherrie, f.o.b., at Glasgow, per ton, No. 1, 53s. 6d.; No. 3, 51s. 6d.; Coltness, 58s. and 51s. 6d.; Langloan, 54s. 6d. and 51s.; Summerlee, 52s. 6d. and 48s. 6d.; Calder, 54s. 3d. and 48s.; Carnbroe, 52s. 6d. and 48s. 6d.; Clyde, 48s. and 45s. 6d.; Monkland, 44s. 6d. and 42s.; Quarter, 44s. and 41s. 6d.; Govan, at Broomielaw, 44s. 6d. and 42s.; Shotts, at Leith, 54s. and 52s.; Carron, at Grangemouth, 49s.—specially selected, 56s. 6d.—and 47s. 6d.; Kinneil, at Bo'ness, 46s. and 45s. 6d.; Glengarnock, at Ardrossan, 52s. 6d. and 46s. 6d.; Eglinton, 46s. 9d. and 43s. 6d.; Dalmellington, 49s. 6d. and 46s. 6d.

The hematite trade is a shade firmer, and the quotations about 6d. per ton higher than they were a week ago. Large arrivals of ore are just now taking place from abroad, owing in some degree to former interruptions to shipping, resulting from the tempestuous weather at sea. At the same time the demand for foreign iron ore has of recent times been steadily on the increase.

In the malleable iron department there is little change to note. The inquiry is very quiet, and the orders in hand are in many cases being rapidly worked off. There is a good business doing in the foundry trade, especially in general founding, and the consumption both of Scotch and Cleveland pigs in the foundries is large, the employment of English iron being, indeed, on the increase. The week's shipments of iron manufactures from Glasgow embraced £30,100 worth of machinery, £6680 sewing machines, £19,000 iron manufactures, there being scarcely any steel goods exported. In a few weeks hence, however, it may be expected that there will be a renewal on a fair scale of the exports of steel, as their interruption is due to the strike, which is now at an end.

The coal trade in most districts is quiet, not to say depressed. In the Lanarkshire mining localities the demand is slow for every sort, only dross being in extra demand, because owing to the smaller output it is more difficult than usual to obtain. The prices of household coals have now been reduced by 1s. per ton, following in this respect the course already adopted in the case of shipping qualities. The week's shipments at Glasgow included 2350 tons to Lisbon, 1200 to Bordeaux, 1500 to Odessa; smaller quantities to a variety of places, 4830 tons sent coastwise, and 1545 tons for the use of steamers. At Ayr 6493 tons of coals were shipped, 4198 at Troon, and Grangemouth 877 tons.

In the Eastern mining counties the demand for all sorts of coals is quiet, and storing is largely resorted to at a number of the collieries.

The miners in Lanarkshire have so far accepted quietly the second reduction of 6d. a day in their wages. Several meetings have been held in the Hamilton district, but all the men have proposed to do is to limit the output, a proceeding to which they have already been compelled in numerous instances by the slackening in the demand for coals.

Messrs. William Dixon, Limited, have stopped their ironworks at Fauldhouse, and 150 men have been thrown idle there in consequence.

The coalmasters of Fife and Clackmannan have intimated that fifteen days after the 18th February the wages of all miners will be reduced 10 per cent., and underground workers in proportion. At the same time the price of coals to the workmen will be reduced to 4s. 2d. per ton at the pithead.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

ALL the pilots of Cardiff, with one solitary exception, have voted against the Barry Docks Bill. Little notice has been taken of the fact that this Bill prejudices the interests of the Rhondda and Swansea Bay Railway. A great expenditure is going on to establish this connection, which is making rapid progress, and yet the promoters of the Barry scheme seek for powers to strike in midway between Cardiff and Swansea, and jeopardise the success of the line, injuring Swansea the same as Cardiff.

If it were permissible for anyone to cut a canal, form a line of rail, or construct docks by simple arrangement with littoral or ordinary land holders, and trust to one's own ability or enterprise in carrying out the venture, just as in any retail or wholesale business, well and good, capitalists must run their own risks; but so long as the State governs for the good of the many, and undertakings have to pass through a crucial inquiry, I do hope that this point of Swansea Bay and Rhondda Railway, as well as the one mentioned in my last of the large outlay of the Marquis of Bute, will carry weight with the committee of the House. The general meeting of the shareholders of the Swansea Bay and Rhondda Railway was held this week, the Earl of Jersey presiding, and the progress of the line was commented upon with satisfaction. The earl announced the fact that the Cwmavon Railway had been taken, and that in four or five months this would be yielding a revenue.

The subject of the Fleuss life-saving apparatus and the need of stations in the colliery districts has been the subject of some discussion of late. Mr. Mahon, the colliers' representative, has advocated it in a published letter to the coalowners; but direct action, I understand, will be brought to bear on the matter by the Associated Coalowners at their next meeting.

It is remarkable that explorers neglect even the simplest expedients. At one of the Gethin explosions a collier traversed the whole of the working while the pit was full of gas, and his safeguard was his cap saturated with cold tea, and held to his mouth and nostrils.

I have little encouraging news concerning the iron and steel trades. There is a dulness in the market, and low prices are not successful or tempting to business. The outlook, with orders being rapidly worked off, and few of any consequence placed, is not good. The position of managers at the present juncture is, to say the least, an uneasy one. On the one hand, proprietors or companies are constantly disappointed with *nil* returns; on the other, tardy buyers, are hanging back even in small purchases, expecting a further fall. This, however, may be said, that the buyer is more anxious to have good material than in the past, and the little done is of the best. I note that old iron of the cold blast kind, such as Anthony Hill's, realises good figures, and does not remain long waiting for purchasers. So too in tin-plate. The best makers are well sold, though cheap brands are still enquired for, and orders in some cases have been booked for 14s. 6d. coke plate.

There is no complaint about the coal trade. The activity at the Welsh ports is undiminished, and the leading coalowners, those having good areas of the best four feet or No. 3 Rhondda, literally command the position. There never was a better time for the trade, and the increased use of P. and O. steamers for Egypt lately has increased the briskness. In addition the new contracts are being placed, foreign railways and the like, and for these small as well as large coal is in demand.

The Mountain Ash colliers of Messrs. Nixon have agreed to join the Rhondda Miners' Association.

The Caerphilly—Llantwit—men have resumed work, but it has only been at the sacrifice of the official weigher.

An influential colliery company called the Wenallt Merthyr has been formed to work an area of 1000 acres of coal near Neath. Cardiff and Swansea capitalists are amongst the prominent movers.

The returns of the Forest of Dean iron ore trade show a falling off, and in those of coal also. The reason assigned is trade disputes, operating thus injuriously both against master and man.

THE LATE WILLIAM BROOKES.—We regret to record the death of Mr. William Brookes, a well-known patent agent, which took place on the 14th inst. Mr. Brookes was born in London in September, 1817, and was in due time articled to the late Mr. John Moore, of Lincoln's-inn-fields, who enjoyed a large practice as an architect about half a century ago. On leaving Mr. Moore he entered the service of Messrs. Poole—afterwards Poole and Carpmael—where he learned the business of a patent agent. About 1850 he started on his own account, and for many years he enjoyed a lucrative practice. Inheriting a strong taste for mechanics from his father, who was an excellent amateur workman, Mr. Brookes became practically familiar in early life with machinery and mechanism, thus laying the foundation for the sound and accurate knowledge of such subjects which he displayed in after life. Thoroughly conscientious and scrupulously honourable in his dealings, he leaves behind him a large circle of friends to regret his loss.

THE ELECTRICIANS' DIRECTORY.—The second issue of this Directory has been published, and is a marked improvement upon the first. It is now well arranged, and the information given under the different directory headings seems to be complete. The different interests and industries are separated and placed under headings which readily suggest themselves to one seeking information, and the two practical articles, the one on "Electric Conductors," and the other on and with "Tables for Corrections of Measurements in Horse-powers and Watts, &c.," will be found to contain much that makes the practical application of figures of high value. The list of dynamo machines contains much that has never been published before, and is unique in the completeness of the particulars and dimensions which it gives of all the machines that are made. The Directory contains the following:—Obituary notices, electrical conductors, tables for correcting measurements of horse-power, watts, &c.; list of dynamo machines, with their capacities; useful details relating to arc lamps, useful details relating to incandescent lamps, list of applications for provisional orders, companies registered in 1883, telegraph tariffs to all parts of the world, the British cable fleet, list of local authorities and their chief authorities in London and the provinces; post-office telegraphs, officers on the staff; railways of the United Kingdom and their officials, a directory of the professions and trades connected with electricity and its applications; postal information and calendar.

THE PATENT JOURNAL.

Condensed from the Journal of the Commissioners of Patents.

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

Applications for Letters Patent.

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

12th February, 1884.

3109. FEED VALVE for STEAM BOILERS, P. C. Noble, London.
3110. CASH BOXES, C. Price, Wolverhampton.
3111. AMELIORATION of VARICOSE VEINS, E. Diver, Surrey.
3112. PROTECTORS for TELEGRAPH, &c., INSULATORS, W. P. Fisher, Dudley.
3113. CIRCULAR FLUE STOVES, J. Woolven, Brighton, and W. Eade, Hove.
3114. INCREASING TRAVELLING FACILITIES, G. and H. A. Rumbelow, Soham.
3115. SARDINE PASTE, H. E. Wintle, Great Knowle.
3116. MAINSPRINGS, W. T. Braham, Manchester.
3117. ADVERTISING in SOAP, T. C. Lovewell, Brighton.
3118. PROPELLING BOATS, J. A. Stephan, Worcester.
3119. PRESERVING WINE, &c., R. Dunlop, Cardiff.
3120. MATCH BOXES, E. H. Cashmore and F. W. Mole, Birmingham.
3121. CURLING HAT BRIMS, H. Polak & H. Lowe, Hyde.
3122. STUDS, &c., A. M. Taylor, Handsworth.
3123. CAST IRON PLATES, W. T. Allen, Aston.
3124. PULLEY BLOCKS, W. Thompson.—(*G. Smith, jun., New York, U.S.*)
3125. FOUNTAIN PENS, W. P. Thompson.—(*L. E. Waterman, Brooklyn, U.S.*)
3126. STRETCHING TROUSERS, F. McIlvenna, Manchester.
3127. WINDOW CLEANING CHAIRS, W. P. Thompson.—(*A. Dormitzer, New York, U.S.*)
3128. EYE-GLASSES, P. P. Grünfeld, London.
3129. REPEATER ACTION, A. Nicholas, Handsworth.
3130. SPINNING, &c., MACHINERY, T. Wheelhouse, Brighouse, and G. Bamsden, Keighley.
3131. IMPROVED PULLEY, C. G. Gill, London.
3132. COOLING FURNACES, F. Firth, Dewsbury.
3133. CIRCULATION of WATER for HEATING PURPOSES, J. Jackson, Newcastle-under-Lyme.
3134. SPRING BUFFERS, &c., W. Towell and E. Playle, Boston.
3135. ROLLING METALS, W. H. Brown, Sheffield.
3136. HAY-MAKING MACHINES, A. Sims, Bedford.
3137. ARTIFICIAL TEETH, J. Massey, Maghull.
3138. FILTERS, F. H. Landon, London.
3139. PRINTING MACHINES, W. R. Lake.—(*C. B. Cottrell, Stonington, U.S.*)
3140. MANUFACTURE of PAPER BAGS, W. R. Lake.—(*W. B. Purvis, Philadelphia, U.S.*)
3141. ARTICLES of HARNESS, J. Stanley and T. F. Lemassena, Newark, U.S.
3142. HINGED LIDS, S. Lloyd, jun., Wolverhampton.
3143. FASTENING CLASPS, A. G. Brookes.—(*T. C. Bates, Worcester, U.S.*)
3144. STOP VALVES, J. A. and J. Hopkinson, York.
3145. WHEELS FOR RAILWAY VEHICLES, W. R. Lake.—(*R. N. Allen, Cleveland, U.S.*)
3146. TELESCOPIC DRINKING VESSELS, J. T. Dann.—(*T. Bergmann, Baden.*)
3147. FIRE-GRATES, G. Dyer, London.
3148. VENTILATING COVERS for SEWERS, G. Waller, Southwark.
3149. GUN CARRIAGES, H. C. E. Malet, Brighton.
3150. BOILER FURNACES and FLUES, R. Duncan, J. Gillespie, and D. McColl, Paisley.
3151. FLUSHING WATER-CLOSETS, &c., G. F. Sanders, Birmingham.
3152. GARDEN SYRINGES, J. Pumphrey, Birmingham.
3153. SHIPPING CASES, A. J. Boult.—(*A. M. Pratt, U.S.*)
3154. ELECTRIC BELL INDICATOR, W. W. Hacking, Nottingham.
3155. DEVICE for STRETCHING BOOTS, &c., A. J. Boult.—(*H. Glines, Bridgeport, U.S.*)
3156. LEG REST, F. Kaye, London.
3157. STOPPERING of BOTTLES, &c., S. Cox, Charlton.
3158. LUBRICATORS, R. Baird, Glasgow, and C. R. Boult, Liverpool.
3159. INSULATING ELECTRIC WIRES, W. R. Lake.—(*W. W. Averell, New York, U.S.*)
3160. TRAMWAY ENGINES, T. C. Fidler, Westminster.
3161. VELOCIPEDES, G. Rickard, Truro.
3162. BRICKS and TILES, P. Bawden, London.
3163. BUTTER, H. H. Lake.—(*Th. Pilter Co., Paris.*)
3164. ENSURING PERFECT GRIP of RIDER'S FOOT on PEDAL of BICYCLE, E. S. Wilson, Camberwell.
3165. BUCKLES, &c., G. C. Reddick, London.
3166. SULPHO-ACIDS, F. Wirth.—(*O. Mühlhäuser, Griesheim-on-the-Main, Germany.*)
3167. SCREW PROPELLERS, H. H. Lake.—(*H. C. Pearsons, Ferrysburg, U.S.*)
3168. BUTTONS, H. J. Haddan.—(*C. Weyerbusch and Company, Elberfeld, Germany.*)
3169. MAKING ENVELOPES, H. Piper, London.
3170. ROLLER LEVERS of SPINNING MACHINES, J. Gillespie, Dundee.
3171. SUBSTITUTES for LEATHER, M. Zingler, London.
3172. DRILLING ROCK, &c., G. Rickard, Truro.
3173. COILS for PRODUCING ELECTRICITY, L. Gaulard and J. D. Gibbs, London.
3174. TANNING HIDES, A. Myall.—(*F. Chailly, Paris.*)

13th February, 1884.

3175. FROST NAILS, J. Lilley, Saddleworth.
3176. ELECTRIC BRUSH, W. Tapp, Bristol.
3177. BALLS of YARN, W. P. Thompson.—(*L. J. Vezac, Angers, France.*)
3178. TRICYCLES, S. Leek, Walsall.
3179. HAT BRUSH, J. Morgan, Bristol.
3180. TRAWL NETS, W. Jones, Scarborough.
3181. GAS STOVE BURNER, F. A. Hill, Birmingham.
3182. CASTING ZINC NAME, &c., PLATES, W. Pope, Harborne.
3183. DIVISIONAL COFFEE-POT, J. Morris, Ashton-upon-Mersey.
3184. COCKS, J. Blake, Manchester.
3185. SPRING MATTRESSES, &c., G. L. Scott and I. Chorlton, Manchester.
3186. MOVING GRAIN in BULK, H. Garland, West Kirby.
3187. TUBE for CASING IRON, WOOD, &c., G. S. Marshall, Birmingham.
3188. LUBRICATORS, E. Morgan, Wolverhampton.
3189. HOSE for AIR BRAKES, J. H. Johnson.—(*F. A. Magowan, Trenton, U.S.*)
3190. WASHING CARRIAGES, &c., J. McDermid, Basford.
3191. EXPANDING WRITING CABINET, A. Paice, Ryde.
3192. COMBINATION COCKS or VALVES, J. G. Connell, Glasgow.
3193. SELF-ADJUSTING PULLEYS and WHEELS, J. Tenwick, Grantham.
3194. FURNITURE CASTORS, W. Yates, Sherston.
3195. TURF-CUTTING and ROLLING MACHINES, F. T. Drummond, Bridgnorth.
3196. MARINER'S COMPASS, F. M. Moore, Belfast.
3197. MORGAN'S BALANCE SOCK, J. Morgan, Bristol.
3198. MORGAN'S RIBBED KNIFE BOARD, J. Morgan, Bristol.
3199. VALVES for REGULATING FLUID PRESSURES, &c., J. Hopwood, Horwich.
3200. MORGAN'S CLEANING and FINISHING FORK CLEANER, J. Morgan, Bristol.
3201. PEN and PENCIL CASES, A. H. Woodward, Birmingham.
3202. WATER-MARKED PAPER, J. H. Johnson.—(*Messrs. Blanchet Brothers and Kleber, Rives, France.*)
3203. FORGING NUTS, W. Leyland, Bolton.
3204. FRICTION MOTIONS, T. Hand, Blackburn.
3205. SHEEP SHEARS, T. Myers, Tinsley.
3206. DISPLAYING ADVERTISEMENTS, &c., J. Brown, H. P. Ruston, and F. E. Bradburn, Liverpool.
3207. FISHING-RODS, J. Gregson, Blackburn.
3208. AUTOMATIC LOCKING DEVICE for GUNS, S. Warren, Birmingham.
3209. LAWN TENNIS BATS, A. J. Altman.—(*W. Cole, New Zealand.*)
3210. ELECTRIC ARC LAMPS, H. W. Pendred, Streatham.
3211. SURFACES for PRINTING, J. H. Johnson.—(*A. Tournoux, Paris.*)
3212. VENTILATING TUNNELS, S. Coleridge, London.
3213. ATTACHING BUTTONS, G. Hall, Tiverton.
3214. WASTE and SOIL PIPES, F. W. Hagen, Kingston-upon-Hull.
3215. FOLDING BEDSTEADS and CRIBS, C. T. Shepard, Albany, New York, U.S.
3216. AUTOMATIC GOVERNOR, W. H. Percival, London.
3217. UTILISING the INSIDE of HANDLES of PINCERS, &c., H. Jennings, London.
3218. CRANES, J. W. F. Bryan, Glasgow.
3219. SAFETY APPLIANCE for SHIPS, &c., C. G. Clarke, Kingston-upon-Hull.
3220. FLUSH PAN CLOSETS, J. Friend, Exeter.
3221. BOOTS and SHOES, A. Bowman, Birmingham.
3222. ELECTRICAL CURRENT MEASURER, H. F. Joel, London.
3223. GAS PURIFIER SCREENS, H. J. Haddan.—(*J. Cabot, U.S.*)
3224. BEDSTEADS, W. Nussey, Charlton.
3225. RE-USING EXHAUST STEAM, W. K. Tapp, Leeds.
3226. CARDING MACHINERY, F. E. Robinson, Leeds.
3227. HYDRO-PNEUMATIC CIRCUIT MOTIVE ENGINES, G. Laird, Birkenhead, and C. Matcham, Horsham.
3228. HOLDING CURTAINS, R. Hunter, L. D. Hyland, and E. Dobin, London.
3229. SWEEPERS, R. Lanham, London.
3230. STUFFING MATTRESSES, J. Sawtell, Holt.
3231. WINE BINS, R. Edbrooke, Bristol.
3232. HANDLES, A. Pirard, Puteaux, France.
3233. METALLIC COMPOUND, J. Randford, Shipley.
3234. FILTERING APPARATUS, J. F. C. Farquhar, London.
3235. FUZES, T. Nordenfelt, Westminster.
3236. CONVEYING AWAY COKE, H. Hack, Saltley, Birmingham, and F. Ley, Barrow-on-Trent.
3237. FOLDING CARRIAGES, W. Singer and F. H. Hinterleitner, Berlin.
3238. ASCERTAINING the HEIGHT of LIQUIDS in CASKS, &c., F. W. Denison, Kingston-upon-Hull.
3239. KNEE and THIGH BOOTS, J. R. Dean, Westminster.
3240. METALS or ALLOYS, J. Lewthwaite, Halifax.
3241. MATCH-BOXES, A. C. Argles, London.
3242. FIRE-ESCAPES, W. W. Cowes, Harrow.
3243. SECURING TILES to ROOFS, W. Vincent, Reading.
3244. SUGAR, W. R. Lake.—(*K. Trobach, Berlin.*)
3245. SECURING WEDGES, W. King, London, and G. S. V. Godfrey, Hastings.
3246. TREATING VINES, E. Edwards.—(*A. B. Escourron, Moux, France.*)
3247. ROLLER BLIND ACTIONS, J. Lewtas, Stretford.
3248. IRON or STEEL VESSELS, J. Imray.—(*A. Baude, Paris.*)
3249. PREPARATION of SELENIUM, W. R. Lake.—(*C. E. Fritts and D. H. Hopkinson, U.S.*)

14th February, 1884.

3250. REGULATION of the MOTION of SALMON, &c., REELS, R. Heaton, Birmingham.
3251. PACKING for GAS SLIDES, &c., J. Whitworth, Royton.
3252. FASTENING DOOR KNOBS, &c., J. Anniss, Waterloo, near Liverpool.
3253. HORSE HOES, S. Mason and A. Hill, Leicester.
3254. ASTRAGALS, W. R. Lester, Glasgow.
3255. REMOVING INCRUSTATION in BOILERS, &c., C. J. Flather, Southport.
3256. SWITCHES, J. H. Holmes, Newcastle-on-Tyne.
3257. CLIPS, S. Morgan, Batterley, near Atherstone.
3258. NAILS, J. T. King.—(*J. S. Dickson and A. Meyer, Pittsburgh, U.S.*)
3259. TWO-WHEELED CARRIAGES, H. Lloyd, Liverpool.
3260. MUTING BICYCLE, &c., BELLS, G. A. Taylor, Birmingham.
3261. SELF-ACTING TIME-KEEPER, L. Hanson, Halifax.
3262. CURRY-COMB HANDLES, J. and S. Wakelam, Willenhall.
3263. LIGHTING RAILWAY CARRIAGE ROOF LAMPS, J. Brown, Warrington.
3264. LOCOMOTIVE TRAVELLING WHEELS, T. W. Roberts, Bramley.
3265. CLOSETS, &c., W. J. Young, Greenock.
3266. PRESERVING WASHING-MACHINE ROLLERS, J. Watson and G. Whalley, Keighley.
3267. FASTENER for HOLDING METAL LETTERS, &c., J. H. Hollinghurst, London.
3268. FURNACES of STEAM BOILERS, R. Wilson, London.
3269. COCKS for CONTROLLING the FLOW of STEAM, R. F. C. Tonge, Pendleton.
3270. PROTECTING HATS when NESTED, W. T. Brooks, Stockport.
3271. GLOVE FASTENERS, S. Twelvetrees, London.
3272. SHIPS to PREVENT SEA-SICKNESS, &c., E. Rollason, Coventry.
3273. GOVERNING ENGINES, S. H. Adams, York.
3274. WATER-CLOSETS, S. H. Adams, York.
3275. LAWN-TENNIS BALLS, J. de L. Watson, London.
3276. LAWN-TENNIS BATS, A. J. Altman, London.
3277. SAND-BLAST APPARATUS, H. Sarsons, Birmingham.
3278. BOTTLE STANDS, H. Croyle, Sheffield.
3279. PAINTING, &c., LATHS, J. Heywood, Huddersfield.
3280. LOOMS, J. Crabtree and J. Brearley, Heckmondwike.
3281. REGULATING the FLOW of GAS to BURNERS, T. Thorp, Whitefield.
3282. MECHANICAL GENERATION of ELECTRICITY, E. L. Voice, London.
3283. SEATS of BICYCLES, &c., R. Mason, Birmingham.
3284. BOXES, W. Thomas, Birmingham.
3285. PITCHFORK, R. Gough, Wilmington.
3286. VENTILATING CABINS, &c., R. Gough, Wilmington.
3287. MAINTAINING CABINS of SHIPS on a LEVEL POSITION, R. Gough, Wilmington.
3288. VENT-PEG for CASKS, G. F. Belling, Little Ilford.
3289. GEARING for CRANES, &c., F. W. Scott, London.
3290. WIRE DRAWING, &c., APPARATUS, E. Capitaine.—(*Schmidt Brothers, Schwelm, Germany.*)
3291. MEASURING DRY and WET OBJECTS, E. Witt, Germany.
3292. LAWN-TENNIS BATS, A. J. Altman, London.
3293. VENTILATING BROUGHAMS, E. Hills, jun., and W. H. Hills, Dover.
3294. CRICKET BATS, A. J. Altman, London.
3295. HOLDERS for ELECTRIC INCANDESCENT LAMPS, S. J. Mackie, London.
3296. DRYING, &c., PEAT, S. D. Cox, New Charlton.
3297. REGULATING, &c., STEAM ENGINES, H. Kühne.—(*Dr. Proell and Liharwosky, Dresden.*)
3298. DRAWING CORKS from BOTTLES, W. Rushworth, Idle.
3299. TEACHING to READ by means of REVOLVING BANDS, J. R. Cooper, Canterbury.
3300. WORKING JACQUARD, &c., CYLINDERS, I. Thomis, Wyke, and M. Priestley, Wibsey.
3301. LOCKS, E. Gilyard, Bradford.
3302. BOILER, &c., FURNACES, R. and W. Welford, Sunderland.
3303. INDIA-RUBBER SOLES for BOOTS, R. Moss, London.
3304. CUTTING WOOD into STICKS, W. Carwood, London.
3305. POLISHING POTTERS' WARE, A. and W. Purvis, Glasgow.
3306. RAILWAY BUFFERS, A. Slater, Gloucester.
3307. BUFFER SPRINGS, A. Slater, Gloucester.
3308. INSULATED SWIVEL COUPLING for TELEGRAPH CABLES, J. S. Hepburn and G. Souter, Elgin.
3309. EVAPORATING and DISTILLING, W. A. Barlow.—(*P. Calliburcès, Paris.*)
3310. UTILISING CENTRIFUGAL FORCE, J. C. Mewburn.—(*A. Mouillard, Lyons.*)
3311. PREPARING TEA, G. Rittinghaus.—(*W. Henschen and Co., Germany.*)
3312. DABBING APPARATUS for WOOL COMBING, W. T. Garnett and J. Wheater, Bradford.
3313. CORD for SUSPENDING PICTURES, &c., C. E. Hodges, London.
3314. CRICKET BOOTS and SHOES, A. V. Newton.—(*J. Keats, Frankfort-on-the-Main.*)
3315. REGULATING the SUPPLY of GAS to RAILWAY CARRIAGE LAMPS, H. E. Newton.—(*Société Internationale d'Eclairage par de Gaz d'Huile, Paris.*)
3316. SAFETY DEVICE for SMALL-ARMS, E. Hughes, London.
3317. BROOCHES, J. G. Rollason, Birmingham.
3318. LAYING DOWN ELECTRICAL CONDUCTORS, C. E. Webber and F. Bolton, London.
3319. STEAM ENGINES and BOILERS, W. R. Lake.—(*E. Friedrich and M. Jaffé, Vienna.*)
3320. BOTTLES and STOPPERS, J. Edwards, London.
3321. UMBRELLAS and PARASOLS, J. Willis, Bournemouth.
3322. REVERSING GEAR for ELECTRIC MOTORS, A. M. Clark.—(*J. C. Henderson, New York.*)
3323. TREATING ACID SULPHATE of SODA, &c., F. Wirth.—(*H. Herberts, Germany.*)
3324. TOY, A. M. Clark.—(*C. A. Volke, Japan.*)

15th February, 1884.

3325. REMOVING the WATER of CONDENSED STEAM, &c., D. Halpin, London, and J. Gresfiam, Salford.
3326. FLUSHING SEWERS, T. Caink, Malvern Link.
3327. MIXING TEA, J. A. R. Main, near Glasgow.
3328. SOLES of LAWN TENNIS SHOES, &c., F. G. Myers, Wellingborough.
3329. FIXING ROOF RAIN-WATER GUTTERS, &c., G. Kay, Kilbarchan.
3330. VELOCIPEDES, H. J. Brookes, Smethwick.
3331. PACKING for GLANDS and JOINTS, D. Taylor, Liverpool.
3332. REGISTERING the NUMBER of PASSENGERS and FARES, J. Culley, London.
3333. ESCUTCHEON RINGS and NAILS, &c., F. W. Gorse, Birmingham.
3334. FACILITATING WRITING, J. Holding, Salford.
3335. BAG for HOLDING WOOL, St. J. V. Day.—(*P. S. Swan, Calcutta.*)
3336. DECK SEATS, J. Linkleter and W. P. Mears, Tynemouth.
3337. MULES for SPINNING FIBRES, J. S. Cooke and A. Hardwicke, Liversedge.
3338. FLANGE for WARP BEAMS, H. Sharp, Bolton-le-Moors.
3339. TRICYCLES, T. B. Howard, Coventry.
3340. MAGNETS and MAGNETIC CLOTHES, &c., G. Carron, London.
3341. ATTACHING BOLSTERS to CUTLERY, C. Wingfield, Sheffield.
3342. POCKET GAUGE for CRICKET BATS, A. J. Altman, London.
3343. BAG for HOLDING WOOL, St. J. V. Day.—(*P. S. Swan, Calcutta.*)
3344. BUTTON-HOLE SEWING MACHINES, J. K. Macdonald.—(*Singer Manufacturing Company, New York.*)
3345. PINS for BUTT HINGES, H. Springmann.—(*T. Springmann, Hagen.*)
3346. BEARING for ROLLER BLINDS, &c., J. Partridge, London.
3347. STENCH TRAPS, T. S. Truss, Chiswick.
3348. DETACHING-GEAR of LIFE-BUOYS, &c., J. S. Comrie, Glasgow.
3349. FIXING RAIN-WATER, &c., PIPES, J. and A. Law, Glasgow.
3350. REVOLVING CUTTERS, W. and J. Maiden, Hyde.
3351. PREVENTING RADIATION of HEAT, &c., L. Mascho, London.
3352. SASH BALANCE, F. Howcroft.—(*Jno. A. Stewart, Rochester, U.S.*)
3353. STEAM BOILERS, E. H. Nicholson and A. T. Allcock, Newark-upon-Trent.
3354. PORTABLE WATER-CLOSETS, T. Welton, London.
3355. FURNACES for BURNING SMALL FUEL, C. D. Abel.—(*G. Alexis-Godillot, Paris.*)
3356. SEWING MACHINES, C. F. Gardner.—(*H. C. Gros, Cannstatt, Germany.*)
3357. REVOLVING STANDS for SHOW-CASES, A. J. Boult.—(*S. T. Culp, Toronto.*)
3358. UNDER GARMENTS, T. Walker, Roseneath.
3359. LAMPS for BURNING LIGHT, &c., OILS, J. Hinks, Warwick.
3360. CRATES, E. T. Lucock, Stourport.
3361. TOBACCO, J. Bennie, Glasgow.
3362. BURNERS for MINERAL OILS, G. Lyth, Stockport.
3363. ARTIFICIAL STONE, &c., J. Elliott and F. J. Parsons, Hastings.
3364. INDICATING the TIME at which CLOCKS should be WOUND UP, H. Barnes, London.
3365. TESTING GAS, A. Thomas, West Cowes.
3366. ROTARY PUMPS, &c., W. Helmsley and J. McL. Harley, Lewisham.
3367. BOOT STUDS, &c., A. Walker and T. L. Leach, Birmingham.
3368. DOLLIES, J. Battes, Bradford.
3369. ELECTRIC RAILWAYS, F. H. Danchell, Maidstone.
3370. BILLIARD RESTS, J. W. Reffit, Leeds.
3371. FIREPROOF COMPOSITIONS, D. H. Dade, London.
3372. CANDLESTICKS, W. H. Bulpitt, Birmingham.
3373. BRICKS, &c., W. G. Hudson, Cheetham.
3374. LEATHER, A. Myall.—(*E. Martin and A. Fugier, Paris.*)
3375. TANNING HIDES, J. Salamon.—(*L. Verges, France.*)
3376. UMBRELLAS, J. Feldman, London.
3377. SOUND-BOARDS of PIANOFORTES, J. Delcrue, Portugal.
3378. TREATING LEATHER, W. Guest, London.
3379. FASTENING TOGETHER the ENDS of LEATHER DRIVING BELTS, W. Guest, London.
3380. PROTECTING from RAPID WEAR the EXTERIOR UNDER SURFACE of BOOTS, W. Guest, London.
3381. HOT-AIR ENGINES, T. Heron, Manchester.
3382. MINERS' SAFETY LAMPS, G. Saint, jun., Ruabon.
3383. FASTENERS for GLOVES, &c., M. T. Neale, London.
3384. FORMING, &c., CASKS, E. Patterson, Liverpool.
3385. MOTOR, A. M. Clark.—(*E. H. Racine, France.*)
3386. STANDS of DRAPERS', &c., BUSTS, A. W. and G. B. Childs, London.
3387. TELEPHONE SYSTEMS, I. Joseph.—(*R. M. Hunter, Philadelphia, U.S.*)
3388. LEATHER, G. Pearce and A. Fox, London.

16th February, 1884.

3389. WINDOW BLIND PULLEY RACKS, H. Wyatt, London.
3390. GARDEN RAKES, A. W. Partridge, Wednesbury.
3391. SIFTING or SORTING TEA, J. A. R. Main, Possil Park, near Glasgow.
3392. BICHROMATE of SODA, T. Carlile and J. Park, Glasgow.
3393. SUPPLYING WATER to KITCHEN RANGE, &c., BOILERS, H. W. Tyler, Bath.
3394. PROPELLING ONE-WHEELED VELOCIPEDES, J. Shrowton, Comber.
3395. CULINARY UTENSILS, G. J. Harcourt and B. W. Horsford, Clifton.
3396. SELF-ACTING SYPHON, T. H. Tait, Edinburgh.
3397. SEWING MACHINES, W. P. Thompson.—(*H. E. Vigneron, Paris.*)
3398. SHIPS' BOATS, &c., J. Clayton, Seacombe.
3399. BRACES, F. Stubbs, Askern.
3400. HAIR PINS, P. Watkins, Painswick.
3401. MAKING MILK a LIGHT and REFRESHING BEVERAGE, E. Hoddinott, Stratton Swindon.
3402. WINDING FRAMES, W. E. Hacking, Burnley.
3403. PICKERS for WEAVING, W. E. Hacking, Burnley.
3404. BAGS, T. Briggs, Manchester.
3405. ATMONEMETOR, A. Wright, London.
3406. DEADENING the NOISE of WHEELS, &c., W. Martin, Manchester.
3407. CAMP BEDSTEADS, J. B. Rowcliffe, Glossop.
3408. APPLYING to BICYCLES, &c., APPARATUS for CARRYING UMBRELLAS, &c., F. A. Rüther, Brighton.
3409. PACKING SOFT SOAPS, J. P. Humble, Birstall.
3410. LOOMS, R. Hall and J. Hobson, Bury.
3411. LOOMS, R. Hall and J. Hobson, Bury.
3412. CLIP for GLAZING, J. Booth, Bolton.
3413. CONSTRUCTING HANDLES from HOLLOW TIPS, T. R. Ellin, Sheffield.
3414. HANDLES of TABLE CUTLERY, C. Ibbotson, Sheffield.
3415. CUTTING, &c., WOOD, J. Rowley, East Dulwich.
3416. COVERING ELECTRICAL CONDUCTORS with INSULATING MATERIALS, A. Muirhead, London, and D. Phillips, Fulham.
3417. PURIFYING NOXIOUS VAPOURS, J. Nuttall, Rochdale, and F. Nuttall and J. Rouse, Oldham.
3418. APPLYING PRESSURE to PRESSING ROLLERS, S. J. V. Day.—(*P. S. Swan, Calcutta.*)
3419. PISTONS, W. Froggatt, Nottingham.
3420. GOVERNOR for ENGINES, H. J. Haddan.—(*Zalm, Rotterdam.*)
3421. REDUCING VALVES, J. J. Royle, Manchester.
3422. ADJUSTING NECKTIES, G. R. Holding, Norwood.
3423. POCKET PIANO, E. Winter, London.
3424. APPLYING PRESSURE to PRESSURE ROLLERS, S. J. V. Day.—(*P. S. Swan, Calcutta.*)
3425. UMBRELLA STICKS, J. T. Ackman, London.
3426. AUTOMATIC SNARLING MOTION for SPINNING MULES, J. Cheetham, Oldham, and W. Butterworth, Bradford.
3427. LOCKS, A. M. Clark.—(*D. Morris, Ohio, U.S.*)
3428. APPLYING PRESSURE to PRESSING ROLLERS, S. J. V. Day.—(*P. S. Swan, Calcutta.*)
3429. REMOVING STAGY HAIRS from FUR SEALS, &c. SKINS, A. Paterson, London.
3430. HATS, W. D. Zerffi, London.
3431. FASTENINGS for GLOVES, &c., R. W. Bradnock, Birmingham.
3432. ORNAMENTING BUTTONS MADE of IVORY, &c., W. Newman, Birmingham.
3433. TREATING SACCHARINE SOLUTIONS, J. H. Johnson.—(*V. Four, Paris.*)
3434. NIGHT, &c., LIGHTS, L. Groth.—(*F. Berta, Fulda.*)
3435. CONDENSING STEAM, B. Tower, London.
3436. TELEGRAPHIC APPARATUS, J. Graham, London.
3437. BOILER FURNACES, S. Schuman, Glasgow.
3438. BICYCLE, W. Bennett, London.
3439. KNEADING MACHINE, H. H. Lake.—(*J. Rudolphs, Stockholm, Sweden.*)
3440. WRAPPERS for CARDS, &c., B. T. Newnham, Bath.
3441. LADIES' COSTUMES, H. Gratz, London.
3442. SELF-LIGHTING GAS BURNER and TAP, A. Kinnear, London.
3443. WROUGHT IRON or STEEL DRUMS, A. B. Perkins, Bradford.
3444. AIR PASSAGES in REGENERATOR FURNACES, C. Hunt, Birmingham.
3445. FILLING LUBRICATORS, A. Budenberg.—(*W. Noll, Minden, Germany.*)
3446. LUBRICATORS, A. Budenberg.—(*W. Noll, Minden.*)
3447. SURFACES of STEREOTYPES, C. Moseley, Manchester.
3448. FORMING MOUTHS of BOTTLES, &c., A. Barham, Croydon.
3449. SEPARATING FIBRES, J. Howson, London.
3450. ATTACHMENT for PLOUGHS, A. M. Clark.—(*V. Wood, Peru, Indiana, U.S.*)
3451. INODOROUS NIGHT COMMODE, L. Appleton, London.
3452. DISTILLING LIQUIDS, H. H. Lake.—(*P. A. Mallet and T. A. Pagniez, Paris.*)
3453. PITCH CHAINS, F. Ley, Barrow-on-Trent.
3454. BOTTLES for AERATED LIQUIDS, I. Rheinberg, London.

18th February, 1884.

3455. DISINFECTING APPARATUS, T. Bradford, Manchester.
3456. WATERPROOF GARMENT, H. Markus, Fleetwood.
3457. GLAZING BARS, J. Fraser, Arbroath.
3458. SUPPLYING FUEL to FURNACES, T. Henderson, Liverpool.
3459. COATING SCREW PROPELLER BLADES, A. Dumbell, Liverpool, and J. Dumbell, Bootle.
3460. SAFETY CANOES, J. Watson, Glasgow.
3461. METAL ROLLERS, W. A. Carlyle, Birmingham.
3462. COMMUTATORS of DYNAMO MACHINES, &c., W. A. Carlyle, Birmingham.
3463. PROPELLER SHAFTS, J. Whitley, Leeds.
3464. COTTERS and GIBS, H. S. Stewart, London.
3465. ABSTRACTING VALUABLE PROPERTIES from SOLUTIONS, J. Pedder, Appleton-in-Widnes.
3466. FIRE-OVENS, J. and R. Young, Bolton.
3467. METALLIC SCREWS, W. H. Richards, Birmingham.
3468. CASTING FIGURES, J. W. Stanley, Crewe.
3469. IGNITING APPARATUS for GAS ENGINES, H. G. Hellier, London.
3470. BOTTLES, H. Arch and C. Wozencroft, Leeds.
3471. OBTAINING SULPHATE of SODA, C. Ellis, Glasgow.
3472. CEE SPRINGS for CARRIAGES, J. Allen, London.
3473. ELECTRICAL SELF-ADJUSTING PENDULUM INDICATORS, F. King and W. P. Mendham, Bristol.
3474. LOOMS, C. Bedford and T. Kershaw, Birstall.
3475. FIRE-ESCAPE, J. Bates, Huddersfield.
3476. SPANNERS, &c., W. Wise, Birmingham.
3477. TYING APPARATUS, H. Courteen, Nottingham.
3478. TURN BUTTONS, J. Walker, Birmingham.
3479. STANDARDS for METAL FENCING and HURDLES, R. R. Main, Glasgow.
3480. FIRING PRIMERS for ORDNANCE,, G. Quick, Gloucester.
3481. PRESSES for MAKING BRICKS, TILES, &c., T. Whittaker, Accrington.
3482. HOLDING NEWSPAPERS, &c., C. B. S. Webb, Stanway.
3483. CUTTING PILE FABRICS, H. H. Lake.—(*F. Colcombet and Co., France.*)
3484. NUMBERING, &c., TICKETS, CHEQUES, &c., J. M. Black, London.
3485. HEAT-REGULATING APPARATUS, H. H. Lake.—(*J. B. Garadot, France.*)
3486. CONTROLLING the MOVEMENT of FLUIDS, &c., H. W. Pendred, Streatham.
3487. LINIMENT, J. Partington, Manchester.
3488. ROAD VEHICLES, F. Bosshardt.—(*P. C. Guillard, France.*)
3489. APPLYING OILLESS CARBONATE, &c., to AXLES, &c., E. B. Petrie and A. W. Shaw, Rochdale.
3490. INEXTINGUISHABLE LIGHT, J. R. Holmes, London.
3491. CLEANING BOOTS, A. H. Thompson, London.
3492. HAMMERLESS GUN LOCKS, F. Beesley, London.
3493. DISSOLVING LEATHER, W. Martyn, Wadebridge.
3494. SOOT ERADICATING and SANITARY GLASS FACING, T. G. Pim, Battersea.
3495. GAS ENGINES, E. Cobham and J. Gillespie, Stevenage.
3496. MECHANICAL MOTOR for SEWING MACHINES, C. J. Griffiths, London.
3497. VELOCIPEDES, C. Gottens, London.
3498. COLLECTION, &c., of FLUE DUST, H. Barclay and R. Simpson, Cumberland.
3499. MECHANICAL STOKERS, C. C. S. Knap, London.
3500. STRETCHING TROUSERS, &c., R. V. Ash, Portsmouth.
3501. CASTING INGOTS of STEEL, J. D. Ellis, near Rotherham.
3502. OPEN-AIR BRAZIERS or STOVES, F. C. Hardy, London.
3503. SWEETENING, &c., SOUR LIQUIDS, &c., E. W. Scofield, Brixton.
3504. AIR-TIGHT METAL VESSELS, W. Crawford and Son, Glasgow.
3505. GLOWING GLASS, J. A. Briggs and W. Collins, London.
3506. CARTRIDGES, W. Hebler, Fluntern.
3507. SHIPS and FLOATING PIERS, &c., A. S. Hamand, London.
3508. COOKING RANGES, &c., J. Currall, Birmingham.
3509. FISH JOINTS, E. Edwards.—(*J. Freund, Paris.*)
3510. PORTABLE LEGS, &c., for CAMERAS, &c., H. B. Sharp, Liverpool.
3511. VELOCIPEDES, A. J. Eli, London.
3512. SEWING MACHINES, &c., R. D. Sanders, Norwood.
3513. MACHINERY for PRESSING BRICKS, &c., W. Johnson, Leeds.
3514. SAFETY CARTRIDGES, R. Atkin, Wandsworth.
3515. CUTTING GLASS, W. M. Pepper, London.
3516. CUTTING FRET LEAD, W. M. Pepper, London.
3517. LABELLING BOTTLES, &c., G. Wright, Wadhurst.
3518. SHAG or PILE FABRICS, F. y Parellada, Barcelona.

3519. Pipe Joints, A. C. Henderson.—(*J. Brauer and G. de Jean, Paris.*)
3520. Carbonising Coal, J. G. Willans, London.
3521. Roofing Tiles, C. Schlickeysen, Berlin.
3522. Carding Machinery, R. H. Brandon.—(*E. H. Rust, Boston, U.S.*)
3523. Gas, H. Townsend, Bradford.
3524. Valves, G. Waller, Southwark.
3525. Ascertaining the Product of Numbers, A. L. Sparkes, Landford.
3526. Smokers' Requisites, P. Davis, London.
3527. Electric Light, R. H. Gould, Peckham.
3528. Cricket Bat, W. Peacock, London.
3529. Gas Engines, W. H. Watkinson, Charlton.
3530. Lamp Globes, A. Clark.—(*C. de Changy, Paris.*)
3531. Nature Printing, T. Honywood, Horsham.
3532. Velocipedes, E. Burstow, Horsham.
3533. Brakes, A. B. Harding.—(*J. Harding, Chili.*)
3534. Disintegrators, C. Schütze, Berlin.
3535. Regulating Gas, H. Lake.—(*M. Gaillard, Paris.*)
3536. Protecting Submerged Structures, F. M. Lyte, Putney.
3537. Starting Gas Motor Engines, H. P. Holt and F. W. Crossley, Manchester.
3538. Buttons, &c., C. Abel.—(*G. Westheimer, Germany.*)

ABSTRACTS OF SPECIFICATIONS.

Prepared by ourselves expressly for The Engineer *at the office of Her Majesty's Commissioners of Patents.*

1069. Transforming Naphthaline - di - Sulphonic Acids into Amido-Naphthaline - di - Sulphonic Acids and the Manufacture from these Acids of Yellow and other Dyes, *J. C. Mewburn, London.—7th February*, 1883.—(*A communication from L. Freund, Alsace.*) 4d.

This consists in transforming the two naphthaline-di-sulphonic acids into the mono-nitrated substitution products, which, being submitted to reduction, give the corresponding amido - naphthaline - di - sulphonic acids. By combining these with phenols, oxy-phenols, their ethers, homologues, and sulpho-conjugates, yellow dyes are obtained, and with naphthols, their ethers, homologues and sulpho-conjugates, and with di-oxy-naphthaline, ponceau dyes are obtained.

2715. Wedge-shaped Balloons, *G. Wellner, Austria.—31st May*, 1883. 4d.

This relates to a wedge-shaped balloon which will ascend and descend obliquely with the pointed end foremost. A heating apparatus is provided in the car of the balloon for regulating the carrying capacity of the balloon.

2757. Moulding in Dry or Green Sand of all Metals or their Alloys, &c., *S. E. Scanor and J. Hill, Leeds, and J. Butler, Bradford.—4th June*, 1883. 6d.

This relates essentially to building up the mould in sectional blocks, each bearing part of the pattern.

2778. Machinery for Testing Strength of Materials and Structures, and Gauges, Weighing Machines, Dynamometers, and Pipe Joints used therewith, &c., *A. H. Emery, New York, U.S.—5th June*, 1883. 2s. 2d.

The machine is constructed with coupled load beams adapted for use respectively and interchangeably as the bed and platform of the scale, according to whether a strain of tension or compression is to be produced. The beams are connected adjustably to one end of a pair of screws to which the straining apparatus is applied, and are supported on a movable bed sliding on a foundation and provided with springs, which return the bed to its normal position. Any initial pressure can be put on the springs. A double-acting hydraulic press is employed in connection with specimen holders to produce heavy strains.

2851. Flour Mills, *K. J. Dance, Clifton.—7th June*, 1883. 6d.

This consists in applying to flour mills or machinery blowing or exhausting apparatus for the purpose of avoiding explosion from the collection of dust in the stive room, by leading the dust to the furnaces.

3054. Roundabouts or Carousals, *E. G. Brewer, London.—20th June*, 1883.—(*A communication from S. J. Mignot and J. B. Franchelli, Paris.*) 6d.

This relates to a game in which independent tracks or platforms turn freely round a central axis, and are actuated by a system of pawls and ratchet wheels.

3065. Manufacture of Plain and Ornamental Metallic Felloes or Tires, *T. Fox, Sheffield.—20th June*, 1883. 6d.

This consists, First, in forming crescent-shaped tires by rolling a bar with tapered edges and then by shaping tools curving up the edges; and, Secondly, in turning the edges of the tire inwards so as to cause them to hold the rubber tire in position without the use of cement; and, Thirdly, in casing tires with a thin metallic covering.

3070. Gas-motor Engines, &c., *J. Fielding, Gloucester.—20th June*, 1883. 10d.

This relates to the use, for controlling the emission of the exhaust gases from the working cylinder, of a supplementary piston and cylinder; also to a gas engine with three working cylinders and three charging pumps, so connected that neither pump supplies the working cylinder of which it forms a part. Three supplementary cylinders and pistons are provided for the emission of the exhaust gases, and the pumps—which are annular—may be used as air-motor engines or to compress air for starting purposes. A governor is described, in which a dead weight acts in combination with centrifugal balls, the gravitating and centrifugal forces balancing each other at the normal speed of the governor.

3082. Washing Machines, *A. I. Denny, Germany.—21st June*, 1883.—(*A communication from F. Yahnel, Germany.*) 8d.

A trough with a curved bottom is supported in a frame and provided at opposite ends or sides with boards or covers hinged thereto to keep the washing liquid within the same. Curved ledges are fastened at two sides, and to them washing pegs of hard wood are secured. A curved swinging frame actuated by a handle is provided with washing pegs similar to those in the trough, and the clothes are placed between the two sets of pegs.

3098. Oil Burners, *J. C. Morrison, West Ham, and R. Smith, Bromley.—22nd June*, 1883.—(*Not proceeded with.*) 2d.

The burner has two or more cylindrical wicks fitted to the lamp. Toothed wheels round the wick case serve to raise and lower the wicks, to which air is distributed by means of spiral pieces attached to the outer shell.

3100. Incandescent Electric Lamps, *R. Harrison, Newcastle-on-Tyne.—22nd June*, 1883. 6d.

The neck of the globe is formed so as to admit of the use of L-shaped pieces, having limbs within the globe, to which the ends of the filament are connected, the external conductors being connected to the other limbs, which project through the glass.

3102. Telephones, *S. J. Coxeter and H. Nehmer, London.—22nd June*, 1883.—(*Not proceeded with.*) 2d.

The vibrations are caused by the movements of the walls of one or more tubes effected by electro-magnets.

3104. Manufacture of Chlorine, *H. A. Dufrêne, Paris.—22nd June*, 1883.—(*A communication from E. Geisenberger and La Société Anonyme de Produits Chimiques, Paris.*)—(*Not proceeded with.*) 2d.

This relates, First, to the manufacture of a metallic or alkaline chloride by the employment of any suitable substance, such as hydrochloric acid; and, Secondly, to decomposing the chloride thus formed by electricity.

3112. Controlling and Regulating the Flow of Aerated Liquid Beverages, &c., *J. Pumphrey, Birmingham.—22nd June*, 1883.—(*Not proceeded with.*) 2d.

This relates to an instrument for opening bottles with internal stoppers so as to avoid waste and the damage by the escaping liquid, and to allow of any portion of the liquid being drawn off.

3119. Screw Propellers, *F. Bosshardt, Manchester.—23rd June*, 1883.—(*A communication from A. Zednicek, Austria.*)—(*Not proceeded with.*) 2d.

The object is to overcome the undue pressure of the water on screw propellers, and it consists in fixing a casing in the opening where the propeller is situated. The propeller shaft has a thread near its end on to which the propeller fits, having a threaded bush and being arranged to revolve and travel in the casing. The shaft has two rings and springs which limit the travel and act as buffers when the reversing of the engine takes place.

3120. Targets for Rifle Practice, *R. Morris, Blackheath.—23rd June*, 1883. 4d.

The object is to enable rifle practice to be carried on at reduced ranges while retaining the sighting as for ranges of full length, and it consists of a fixed bull's-eye and a movable one which, when adjusted in height on a frame marked with divisions to indicate various ranges, and the rifle being properly sighted and aimed at the fixed bull's-eye, the projectile will hit the adjustable bull's-eye.

3128. Gas and other Pressure Gauges, *Sir D. Salomons, Tunbridge Wells.—23rd June*, 1883.—(*Not proceeded with.*) 2d.

Three tubes communicate with each other at the lower ends; one contains an adjustable piston serving to regulate the level of water in the other tubes, one of which is open to the atmosphere and the other connected with the gas supply, and is furnished with a cock to cut off the supply.

3130. Rings and Travellers of Ring Spinning and Twisting Machines, *J. Wetter, Surrey.—23rd June*, 1883.—(*A communication from H. Dodt, Belgium.*) 4d.

This consists in adding to the ordinary ring a ring of smaller diameter which forms with the ring a groove or rim to receive the head of the traveller, which is bent so as to follow the shape of the rim. The thread need only be taken with one hand or both hands, introduced between the ring and the head of the traveller, and carried directly to the spindle without requiring to put the finger into the ring. The circumference of the ring is provided with ventilating holes, through which the dust given off by the thread can escape.

3131. Apparatus for Telegraphic and Telephonic Communication, *O. Schäffler, Vienna.—23rd June*, 1883. 8d.

This relates to electro-magnetic apparatus for connecting and silencing all stations in one partial circuit by means of a polarised relay without contact springs; to silencing the stations not interested in the correspondence, and to a means of connecting any station without disturbing the others. The complicated nature of the mechanism precludes its being described without the aid of illustrations.

3134. Appliances for Cooling Liquids, &c., *F. T. Bond, Gloucester.—25th June*, 1883. 6d.

The apparatus is in the form of a series of vertical metallic circular chambers, through which the water for heating or cooling is made to circulate from a reservoir placed at a lower level by means of a syphon arrangement of tubes.

3143. Regulating the Pressure of Gas, *H. Devine, Manchester.—25th June*, 1883. 6d.

The gas is led through a chamber, the entrance to and outlet from which are reduced in area by the employment of a series of fixed discs or plates, either perforated or smaller in diameter than the pipe to permit the gas to pass them.

3146. Flushing Apparatus and Waste-not Valves to be employed therein, &c., *M. Syer, J. Gilmore, and W. R. Clark, London.—25th June*, 1883. 6d.

This relates, First, to a valve consisting of a seating in the mouth of the flush supply pipe, normally closed by a flexible disc spring-pressed from a dome, such dome and the disc being air-tight at the edges to form a pneumatic chamber, to which is connected a suction pipe from a bellows operated by the pull, so that when air is exhausted from the chamber the disc leaves its seat and the water is free to flow down the flush pipe. The spring gradually expands the chamber as the vacuum disappears, and the disc is forced to its seat again. An after flushing device is applied to the flushing pipe when adapted to water-closets, and consists of a chamber with a projecting lip to catch enough water to fill the chamber, which has a small aperture opening into the flushing pipe.

3152. Air or other Fluid Pressure or Vacuum Brakes for Railway Trains, &c., *A. E. Evans, Manchester.—26th June*, 1883. 6d.

This consists in arranging a small pipe to pass from the locomotive to the rear vehicle of a train, where it communicates with the train pipe of the brakes, while at the locomotive end it communicates with a pressure or vacuum gauge or tell-tale indicator.

3153. Manufacture of Mixed Textile or Knitted Fabrics or Materials for Packing Goods, &c., *D. C. Miller, Larkhall, N.B.—26th June*, 1883.—(*Not proceeded with.*) 2d.

The object is to provide a material flexible in one direction and more or less stiff in a direction oblique or at right angles thereto, and it consists in introducing within the weft space of any ordinary warp a stiff material, such as laths of wood, pasteboard, or similar material, or flat strips or wires of metal.

3154. Cooking Ranges, *J. McI. Shaw, Glasgow.—26th June*, 1883. 8d.

This relates to cooking ranges which are convertible from a closed to an open cooking range, the main object being to enable a sufficiently long open flue to be drawn out over or towards the fire when the range is to act as an open range, and it consists in making such flue telescopic.

3155. Construction of Velocipedes and Apparatus in Connection therewith, *H. J. Lawson, Coventry.—26th June*, 1883.—(*Not proceeded with.*) 2d.

The object is to enable the rider to more effectively control and vary the stroke of the crank without interfering with the speed of the machine.

3156. Lawn Tennis Nets, &c., *R. S. Moss, Manchester.—26th June*, 1883.—(*Not proceeded with.*) 2d.

This relates to improved means for distending the net, whereby it can be adjusted in height and torsion with the greatest nicety. The net rope is acted upon by a cam fastened to each pole, and which allows the rope to be pulled through in one direction, but locks it when released.

3158. Valve Apparatus for Regulating Fluid Pressure, *C. D. Abel, London.—26th June*, 1883.—(*A communication from G. Westinghouse, jun., Pittsburg, U.S.*) 6d.

This relates to a pressure regulating valve fitted in a passage, through which steam or compressed fluid passes, and on the stem of which valve is a piston of equal area, working in a cylindrical cavity, into which a little of the fluid is allowed to leak by a small hole. From this cavity there is an escape passage, covered by a valve, the stem of which rests on a flexible diaphragm, strained downwards by an adjustable spring, the space under the diaphragm communicating with the pipe that is supplied with the fluid. When the pressure in the pipe is excessive, the diaphragm is pressed up, thereby opening the escape valve, and allowing the fluid in the space under the piston of the regulating valve to escape; the pressure on that piston being then greater downwards than upwards, the piston descends, and closes, more or less, the regulating valve to which it is attached.

3162. Attaching and Fastening Handles to Tea and Coffee Pots, &c., *W. H. Winter, Sheffield.—26th June*, 1883.—(*Not proceeded with.*) 2d.

A metal or other projection is soldered on to the top and bottom sockets, and a screw is passed through a non-conductor, such as ivory, and into the projection, and by means of such screw the handle can be tightened or loosened as required, both at top and bottom.

3168. Apparatus for Indicating the Position of a Ship's Helm, *J. E. Liardet, Brockley.—26th June*, 1883. 6d.

The movement of the rudder to port or starboard effects the closing of one or other of two electric circuits, in each of which is an electric lamp, so that when the rudder is moved to one side or the other, one of the lamps is lighted, while when amidships both lamps are extinguished. Electric bells or gongs are also sounded when the rudder is moved. The circuits also register the movements of the rudder on a travelling surface.

3173. Machinery or Apparatus for Drilling or Boring Holes in Rock, *W. L. Wise, London.—26th June*, 1883.—(*A communication from C. W. Burton, Paris.*) 6d.

The drill may be driven by an electric motor mounted on a carriage fitted with traversing gear, which admits of adjustment to suit the position of the drill.

3176. Machines for Forging Horseshoe Nails, *A. J. Boult, London.—26th June*, 1883.—(*A communication from W. Werts, Philadelphia.*) 6d.

This relates particularly to machines in which an anvil, with a concave face, is combined with laterally operating dies, for forging the nail blank, and with a forging roller carried round by a crank, and acting in connection with the anvil to flatten and taper the shank. The objects are to control the forging roller, and readily change its course in respect to the anvil; to operate the lateral dies by simple mechanism, and to regulate their movement; to provide appliances for cutting the forge nail from the nail rod, and feed the latter intermittently to the machine; and to provide means for heating the nail rod.

3178. Mechanism for Facilitating the Action of Magazine and other Fire-arms, *H. S. Maxim, London.—26th June*, 1883. 10d.

The object is to utilise the recoil of the fire-arm to store up energy in a spring or springs to operate mechanism for extracting the exploded cartridge shells, cocking the arm, transferring the cartridges from the magazine to the rear of the barrel, forcing them into the barrel, and closing the breech.

3182. Galvanic Batteries, *J. R. and J. W. Rogers, London.—27th June*, 1883. 2d.

Two porous cells, the lower portions of which are impervious, are filled with a mixture of graphite and peroxide of manganese; to one cell is added nitric acid, and to the other cell some acid other than nitric acid. The two cells, fitted with carbon plates, are placed one within the other, and are placed in an outer cell containing sulphovinic acid and a zinc rod.

3184. Apparatus for Exhibiting Advertisements, *C. F. Pollak, London.—27th June*, 1883. 6d.

An electro-motor or clockwork mechanism is caused to operate an endless band bearing advertisements, which are exhibited in succession at an opening in a suitable case.

3186. Picks for Mining, &c., *G. W. Elliott, Liverpool.—27th June*, 1883. 6d.

The object is to provide a ready and safe mode of attaching interchangeable picks to one shaft or handle till the picks are of rectangular section tapering from the centre to each end, and a socket or head on the handle has a tapered hole large enough to admit the pick about as far as the centre, where it wedges itself firmly.

3188. Manufacture of Piled Fabrics, *D. Marcon, Paris.—27th June*, 1883. (*Void.*) 2d.

This relates to improvements on patent No. 2623, A.D. 1880, the object being to improve the cloth and facilitate the cutting by allowing more time for same; and it consists in arranging a section or tappet at each side of the loom, which drives three picks with weft and two movements of the lathe or slay without weft.

3189. Metallic Tubes, &c., *R. Heeley, Thurley.—27th June*, 1883. 4d.

The principal object is to produce metal tubes without soldering or brazing, and it consists in making them in two pieces, one of considerably more than half the whole diameter, and having its edges turned round and flanged inwardly, and the other, which completes the tube, has its edges turned and flanged outwardly, and when fitted over the other piece the edges are tightly closed upon each other.

3190. Hampers or Baskets for Transporting Bottles or Carboys of Acid or other Corrosive or Dangerous Materials, &c., *H. Bruner, Widnes.—27th June*, 1883. 6d.

The object is to prevent the breakage of bottles containing acids or other material during transit by providing a special form of baskets consisting of thin elastic wood standards with a base composed of two thin conical concentric rings, between which the standards are fixed at equal distances apart. Wooden hoops placed at intervals in the height of the basket are fixed on the exterior as well as the interior by means of a jointed mould which gives the basket the required contour. The handles are of cane, cord, or cloth impregnated with india-rubber.

3193. Treating Linseed and other Drying Oils, &c., *A. Ford, London.—27th June*, 1883.—(*Not proceeded with.*) 2d.

The oil is placed in a tank capable of being heated and provided with pipes through which air is driven to agitate the oil while heat is applied to the surface. When a temperature of from 130 deg. to 150 deg. Fah. is reached, a solution of diacetate of lead is slowly added and the agitation continued for ten hours, when it is allowed to settle and the settlings drawn off. More diacetate of lead is added, the agitation being repeated. By this means the oil is rendered quick drying and is decolorised. By further agitation varnish can be produced from the oil, or it can be converted into a plastic material capable of being moulded.

3194. Looms for Weaving, *W. Smith and J. Wrigley, Lancaster.—27th June*, 1883. 6d.

The object is to simplify the jacquard motion and to dispense with springs, and also to form a dwell for the shuttle to pass through the shed. Treadles in the form of angle levers are pivotted on the treadle stud, and the top and bottom jacks are coupled to the long end, and the double hooks rest at the top of the angle part, and are acted upon by the chain of pulleys which form the pattern, motion being given to the chain by a peg and star wheel. The grifes are also pivotted on the treadle stud and motion given to them by a wheel on the crank shaft with an enclosed cam on each side, which act upon levers connected to the front and back grifes, and are made so as to allow a sufficient dwell for the shuttle to pass through the sheds.

3195. Rollers for Wringing and Mangling Machines, *W. Lockwood, Sheffield.—27th June*, 1883. 6d.

The object is to produce rollers impervious to wet, and that will not rot or lose their shape, and it consists in forming them of an axle round bar steel, trued by "reeling" and cut to the required length. The body of the roller consists of cement cast upon a core, and may be provided or not with an outside metallic or earthenware jacket or shell.

3196. Apparatus for the Manufacture of Lucifers, *F. H. F. Engel, Hamburg.—27th June*, 1883.—(*A communication from W. Holmström, Sweden.*) 6d.

This relates to apparatus for dipping match splints secured into frames into the ignition composition, instead of applying the same thereto by hand as hitherto.

3197. Fire-arms, *W. R. Lake, London.—27th June*, 1883.—(*A communication from J. H. Brown, New York.*) 6d.

The fire-arm is provided with a hammer with a convex breast and a breech-block with a cam-like rear portion, whose underside extends approximately in the same direction as the upper portion of the breast of the hammer, so that when the block is shifted the hammer is cocked. A sleeve extends through the hammer and trigger plate and forms the pivot for the hammer, and a screw extends into the lock plates through the sleeve and secures all the parts in position. An ejector is combined with the sliding breech block, and a safety catch provided. The barrel is formed with a tapering bore in rear of the rifling, and a cylindrical or differently tapering bore at the breech, the cartridge being correspondingly formed to fit the bore.

3198. Feeding Bottles, *E. Brasier, New Cross.—27th June*, 1883. 4d.

The object is to prevent air being sucked into the bottle when the fluid contents have been withdrawn, and it consists in fitting to the end of the suction tube a valve which will float in the liquid in the bottle, but will fall and close the tube when the bottle is empty.

3199. Preparation of Compounds and Powders for Sanitary Purposes, *H. E. Overbeck, Liverpool.—27th June*, 1883.—(*Not proceeded with.*) 2d.

This consists in the use either alone or in combination with coal tar acid and incorporated with chalk, lime, or other suitable material, of the compounds known as the tar and pyridine bases.

3200. Appliances for Inducing Air or Gaseous Fluids from Chimneys, &c., *H. Burgin, Walthamstow.—27th June*, 1883. 6d.

This relates to a chimney cowl, consisting of a vertical tube fixed to the top of the flue, and around which is a second tube with vertical apertures, each independent of the adjoining one. The outer tube terminates above the chimney proper.

3201. Apparatus for Heating Water or Air, &c., *J. H. Johnson, London.—27th June*, 1883.—(*A communication from Messrs. Guillot, Pelletier, and Co., France.*) 6d.

The apparatus consists, First, of a cylindrical boiler; Secondly, of a fuel heater or hopper; and, Thirdly, a circular plate resting on the upper part of the masonry. At the lower part of the boiler is the furnace with a movable circular grating to support the fuel, and which is fitted with a handle to withdraw the same or impart a partial rotation to shake down the ashes into the pit below. Large vertical tubes traverse the boiler, and are preferably triangular in section, and form a star constituting passages for the fuel to pass automatically to the furnace. Between the large tubes, smaller tubes are arranged to carry off the products of combustion.

3204. Ventilating Water and other Closets, *J. Farrimond and J. Whittaker, Southport.—28th June*, 1883. 6d.

Out-take or upcast ventilating shafts are coated with a non-conductive material, so as to maintain a uniform temperature therein and cause suction and ensure the passages of noxious gases therefrom. A pipe connects the out-take with a foul air receiver situated between the seat of the closet and the pan.

3205. Apparatus for Billiard Marking, *R. Bateman, Birmingham.—28th June*, 1883. 6d.

This relates to a register, in which bands bearing numbers are passed over rollers, and can be actuated to bring the required numbers opposite openings in the case containing them, so as to indicate the state of the game.

3206. Ships' Berths, *E. Hoskins, Birmingham.—28th June*, 1883.

This consists in constructing ships' berths so as to fold up when not in use.

3207. Portable or Table Fountains, &c., *W. Aubert, jun., Balham.—28th June*, 1883. 6d.

This relates to a fountain in which the jet is maintained by the compression of air acted upon by a column of water.

3208. Bobbin Net or Twist Lace Machines, *A. C. Henderson, London.—28th June*, 1883.—(*A communication from J. A. Lateux, Paris.*) 6d.

This relates to improvements in the fining bars and the upper embroidery or spotting bars of "Levers" bobbin net machines, and the object is to cause the rise or fall of the weft threads by one and the same motion. Each thread from the beaux passes through two fining bars pierced with rectangular slides or mortices, about 16 millimetres wide, and placed so that one covers the other about 1 millimetre. The fining bars are each connected by a hook to the jacquard. On leaving the fining bars the thread traverses a fixed stump bar pierced with a specially devised slot corresponding in size with the space separating three carriages. This opening is square, and so pierced that its diagonals are one vertical and the other horizontal.

3209. Self-feeding Pens, *F. Byron, Chesterfield.—28th June*, 1883.—(*Not proceeded with.*) 2d.

The pen consists of a tubular body or holder, an elastic compressor, and an ordinary writing pen. The finger in writing acts upon the compressor and causes ink to pass to the pen.

3210. Propelling and Steering Steamships or Analogous Vessels, *J. Stewart, Blackwall.—28th June*, 1883. 6d.

A propeller and rudder are arranged in the middle of the stern of the vessel as usual, and a smaller propeller and smaller rudder are arranged on each side thereof, but lower down and further forward, the power of the side propellers combined being to the power of the main one about as 2 is to 3. The ship has three keels, the centre one extending the whole length, and the side ones commencing from the midship section running aft. The rudders are all connected so as to move in unison.

3211. Manufacture or Treatment of Porous Pots and Porous Plates for Galvanic Batteries, *T. Coad, London.—28th June*, 1883.—(*Not proceeded with.*) 2d.

To render the articles more homogeneous they are soaked in a suitable carbonaceous fluid.

3212. Door Retention Stop, *W. E. Diehl, Philadelphia.—28th June*, 1883.—(*Not proceeded with.*) 2d.

This relates to a door stop which, when the door is pressed against, will retain the same in its open position, and it consists of a cup attached to the floor or skirting, and an elastic ball attached to the door, the cup being of a shape to retain the ball after it has been forced therein.

3213. Table Trucks for Weighing Bales, Boxes, &c., *F. McEntegart, Liverpool.—28th June*, 1883. 6d.

The improvements consist, First, in the use of a hook on the shaft for slinging the truck instead of the ordinary thimble; Secondly, in an arrangement of a single chain for slinging the shaft end of the truck; Thirdly, in a make-weight or balance pocket at bottom of truck instead of top, thus avoiding shifting the floor boards; Fourthly, a movable lip to be put on for boxes and connected to straps on top of truck; Fifthly, two wheels on the leg instead of the leg touching the ground; Sixthly, a movable spike on top of the truck for boxes; Seventhly, an iron strap under the after part of truck to protect the wood from the bar for slinging after part of truck; Eighthly, an iron strap from the leg stay bolt to the bottom of the leg hook bolt; and, Ninthly, a batten across on front of table to keep bags from falling over on shaft, and to strengthen trucks for bale goods, &c.

3214. Fire-arms, *M. C. De Arguibel, Buenos Ayres.—28th June*, 1883.—(*Not proceeded with.*) 2d.

This relates to the lock of portable fire-arms, and to a novel construction of projectile applicable thereto, or to heavy guns, the objects being to provide a simple strong lock and a projectile of increased penetrating power.

3216. Rag Grinding Machine, *C. Wilson and E. Scargill, Batley Carr, Yorkshire.—28th June*, 1883.—(*Not proceeded with.*) 2d.

This relates to a new method of feeding the rags to the swift, and consists in the use of a series of reciprocating bars with serrated or toothed edges, the alternate bars being caused to advance and recede in rotation.

3217. MACHINES FOR HAULING IN ROPES AND FISHING NETS, *J. Harper, Jun., Aberdeen.—28th June,* 1883. —(*Not proceeded with.*) 2d.

Three grooved pulleys are arranged in a triangle, and the rope of the net passes over and under them. Each pulley is cast with a toothed wheel at the back, with one of which gears a pinion, and is itself in gear with the other two wheels.

3218. APPARATUS FOR MOUNTING OR SUPPORTING ELECTRIC LAMPS, *W. R. Lake, London.—28th June,* 1883.—(*A communication from J. Languereau, Paris.*) 6d.

This relates to the application of an incandescent lamp to the top of a tubular support having the appearance of an ordinary candle.

3220. PERMANENT WAY OF RAILWAYS, *B. Swaine and M. H. E. Albrecht, Leeds.—29th June,* 1883.—(*Not proceeded with.*) 4d.

The object is to prevent the shocks caused by the rolling stock passing over square butt joints of rails, and it consists in substituting for such joints a bevel joint formed by properly shaping the ends of the rails.

3222. HOOKS OR PEGS FOR HANGING OR SUPPORTING GARMENTS, &c., *W. Allison, Glasgow.—29th June,* 1883. 6d.

The hook or peg is formed with a T or other projection at its rear and a flat sole in front, the projection being caused to slide in a corresponding groove formed in the wood or other material to which the hook is to be attached.

3223. DYNAMO-ELECTRIC, MAGNETO-ELECTRIC, AND SIMILAR MACHINES, *L. F. Lamkin, London.—29th June,* 1883. 6d.

This relates to controlling the electro-motive force by moving the brushes. One brush is fixed and the other movable either automatically or by hand.

3224. PIANOFORTE ACTION, *J. J. Robinson, London.—29th June,* 1883. 6d.

The object is to simplify and increase the efficiency of pianoforte actions. The stickers are operated by levers from the tail end of the keys, and each towards its upper end receives through it an adjustable set-off pin, screwed for the required adjustment into a prolongation forming a tail to the lower part of the hammer butt.

3225. WATER-WASTE PREVENTERS, *E. Raitt, Brixton.—29th June,* 1883. 6d.

An oscillating vessel is supported in a cistern, and the supply pipe passes through the upper part of one end of the cistern into the oscillating vessel, and has a closed end, but a narrow opening is made through the lower side near the end, inside the vessel. A casting fits tightly round the end of the pipe, and has an opening corresponding with that in the latter and terminating in a ball valve, the casting being secured to the oscillating vessel and turns round the pipe. A second pipe forms the other support for the vessel, and serves as an overflow pipe.

3226. DRIVING GEAR WITH CONTINUOUS MOTION APPLICABLE TO VENTILATORS, &c., *A. Selim, London.—29th June,* 1883.—(*A communication from P. C. J. Lemaire and A. E. Poly, Paris.*)—(*Not proceeded with.*) 2d.

The driving gear consists of a shaft mounted in a frame and provided with ratchet-wheel clutch and a fly-wheel. The clutch receives an alternating circular motion by an arrangement of hand lever or pedal, and the fly-wheel by the intervention of rollers transforms it into continuous circular motion.

3229. MANUFACTURE OF CHROMATES OF SODA, &c., *E. P. Potter and W. H. Higgin, Bolton.—29th June,* 1883. 4d.

This consists in the manufacture of pure or nearly pure bichromate of soda from monochromate solution by first neutralising the latter to precipitate the silica and alumina, separating the latter, concentrating the solution with separation of foreign salts, adding the requisite amount of acid, filtering out the crystals, and concentrating the solution at a low heat in an oxidising atmosphere.

3230. CONCENTRATION OR PURIFICATION OF COMMERCIAL SULPHURIC ACID, *W. J. Menzies, St. Helens, Lancs.—29th June,* 1883. 4d.

The inventor claims, First, the concentration or purification of commercial sulphuric acid by treating it with nitric acid or other oxidising agent, so as to fully oxidise the arsenic and iron salts, and then precipitating the latter by boiling in an iron vessel, the acid to be concentrated in this not being of lesser strength than 58 Beaumé; and Secondly, in combination with the above, continuing the boiling and condensing the fumes as pure hydrated sulphuric acid.

3233. ELECTRIC ARC LAMPS, *C. Wüest, Zurich.—29th June,* 1883. 6d.

The carbons are fed together by contact rollers operated by a vertical spindle provided with right and left-handed screw threads and driven by a small motor. A resistance equal to that of the arc is automatically shunted into the circuit should the arc fail.

3235. DRESSING FOR PREVENTING AND DESTROYING MAGGOTS AND PARASITES ON SHEEP, &c., *C. Hutchins, Snitterfield.—29th June,* 1883.—(*Not proceeded with.*) 2d.

The dressing consists of one pint of paraffine oil, to which two ounces of quicklime and a quarter of a pint of gas tar are added.

3236. PULLEYS AND WHEELS, *T. Smith, Brockley.—29th June,* 1883. 6d.

The rim is made in two parts and connected to the boss by arms, the boss being also made in two parts, each consisting of a solid segment, projecting pieces, and seats for similar projecting pieces upon the other part. The arms preferably consist of a bar having its outer end split and separated both in the direction of the plane of the wheel or pulley, and in a direction transverse to such plane.

3237. "LOCK UP" LIQUOR, SCENT, AND OTHER SIMILAR CRUET FRAMES OR STANDS, *R. Murray, Brixton.—29th June,* 1883.—(*Not proceeded with.*) 2d.

The bottles are arranged on a revolving base placed over a stationary base, and above them a notched or recessed hood is arranged on a central pillar. By turning the base plate so as to bring the bottles under the unrecessed parts of the hood the bottles cannot be removed, and the frame is then secured by lock and key in this position.

3238. CARTRIDGES, *H. E. Newton, London.—29th June,* 1883.—(*A communication from La Société Anonyme Dynamite Nobel, Switzerland.*) 4d.

The object is to produce a watertight cartridge in which the explosive is in a pulverulent or granulated condition. The explosive is compressed in a cylinder of paper, and the ends protected with discs of paper, the whole being then plunged into a bath composed of paraffin and ozokerit.

3239. ROTARY ENGINES, *W. Frost, Manchester, and T. T. Bond, Luton.—29th June,* 1883. 6d.

As applied to a high-pressure compound engine two cylinders are employed fitted with valve boxes, slide valves, jacketted steam piping, and condensed water cocks, also a sliding division plate lifted by cams and levers a little after the exhaust opens to allow the piston to pass under it, and the division is lowered a little previous to the admission of steam between it and the piston. The cylinders are placed in line and the pistons secured to bosses on the main shaft. The engine cuts off at any part of a revolution when high-pressure steam is admitted to the low-pressure cylinder working double compound, and is cut off when the low-pressure piston arrives at three-eighths revolution. The exhaust in high-pressure cylinder takes place slightly earlier than the three-eighths cut off in the low-pressure cylinder and enters the low-pressure cylinder. The exhaust to the atmosphere from the low-pressure cylinder takes place at about seven-eighths of the revolution.

3240. MAKING A KIND OF FIBROUS LIGNEOUS CELLULOSE SUITABLE FOR PAPER-MAKING, &c., *A. M. Clark, London.—29th June,* 1883.—(*A communication from R. Blitz, Paris.*) 4d.

Wood is reduced to small pieces and treated from four to eight hours under a pressure of 3 to 4 atmospheres, with hydrosulphite of soda, caustic soda, and rancidiate of ammonia dissolved in hydrochloric acid.

3242. TULLE OR LACE MACHINES, *C. D. Abel, London.—30th June,* 1883.—(*A communication from E. Davenière, Paris.*) 8d.

The object is to enable by the combined action of the "fine bars" and the "stamp bars" of tulle or lace machines "stop," "one," "two," to be performed at will in the same motion, by means of mechanical combinations and devices.

3243. BLEACHING KIERS, *R. H. Ainsworth, Halliwell.—30th June,* 1883.—(*Not proceeded with.*) 2d.

The object is to enable a circulation of hot bleach liquor to be kept up in the kier without disturbing the material being treated, and it consists in the arrangement of a vertical pipe and a steam pipe, so as to cause the liquor to be taken from the bottom and thrown upon the top of the material in the kier.

3244. AUTOMATIC ELECTRIC SIGNALLING APPARATUS FOR RAILWAYS, *H. J. Haddan, London.—30th June,* 1883.—(*A communication from H. C. Reher, Hamburg.*) 4d.

This relates to a pedal-contact apparatus, adapted to automatically announce the approach of trains.

3245. MILLSTONES, *J. Wetter, New Wandsworth.—30th June,* 1883.—(*A communication from C. Vincelle and E. Cayla, Algeria.*)—(*Not proceeded with.*) 2d.

To reduce the heat and friction in millstones, the principal groves, which are tangential to the central opening, are made narrow and deep near the opening, and gradually wider and shallower towards the circumference. The principal intermediate grooves may be radial, and are made of such length as to leave a certain space between their inner ends and the main grooves.

3246. OBTAINING SALTS OF AMMONIA FROM COMBUSTIBLE GASES, *J. Addie, Glasgow.—30th June,* 1883. —(*A communication from J. Addie, Spain.*) 4d.

This relates to improvements on patent No. 4758, A.D. 1882, and consists in directly converting the ammonia contained in combustible gases into sulphate of ammonia and recovering the same by a continuous process consisting in, First, charging the gases with sulphurous acid gas to fix the ammonia; Secondly, submitting the gases to the action of a scrubber to dissolve the sulphite formed: and, Thirdly, in oxidising the solution of sulphite of ammonia by forcing air into it.

3247. COOKING RANGES AND OVENS, *J. Carrick, Glasgow.—30th June,* 1883. 6d.

The firegrate is fitted to face sideways and the heat of the fire directed into an enclosed space, wherein cooking operations may be conducted. An encased oven has a sole plate, which extends into or forms the bottom of the firegrate. The oven may be portable and adapted to be inserted in the ordinary grate.

3248. MACHINERY FOR COMBING WOOL, COTTON, FLAX, SILK, &c., *J. H. Whitehead, Leeds.—30th June,* 1883. 4d.

This relates to machines in which drawing-off rollers and leathers draw the fibres from the pins of the combs, the object being to provide means for retaining and readily releasing the roller stands when the leathers or rollers require attention.

3249. PADS FOR HORSE, CART, PACK, AND OTHER SADDLES, COLLARS, &c., *J. A. Morgan, London.—30th June,* 1883.—(*Not proceeded with.*) 2d.

The objects are to prevent chafing and secure a true fit and ease and comfort to both horse and rider, and it consists in the use of a hollow pad capable of being inflated with air.

3251. DRILLING OR PERFORATING ROCKS, &c., *T. R. Jordan, London.—30th June,* 1883. 6d.

This relates to the mechanism for obtaining a rapid to-and-fro movement for percussive action of the drill or other implement, and to imparting to such tool a movement of rotation round its axis and effecting its advance in a line with its axis. A spiral drum or cam is mounted on a shaft, and acts on a pin or stud fixed to the piston-rod, through which the drill passes. The drum or cam is driven by bevel or other gearing. The drill rod has a screw thread, and a ratchet or clutch device with pawls imparts to it the rotary movement and effects the feed.

3252. PURIFICATION OF SEWAGE WATERS, &c., *J. Bock, Germany.—30th June,* 1883. 4d.

This consists in the purification of waste waters by the addition of fibrous material or of fibriferous mud in combination with iron compounds and magnesia salts besides milk of lime, for the purpose of precipitating the fouling particles and fermenting seeds in a compact form, and directly to render the separated substances suitable for manuring purposes. These clarifying substances can be used repeatedly, so that the mud from one precipitation is used for a second precipitation. Sulphurous acid is introduced into the clear solution to eliminate the lime in solution and to form antiseptic and disinfectant bisulphite of lime.

3254. HORSE-NAILS, *J. A. Huggett and J. Swalwell, London.—30th June,* 1883. 6d.

A bar of mild steel, of a sectional form corresponding to two nails laid together end to end with the heads outwards, is slit or divided longitudinally in the manner described in patent No. 5215, A.D. 1881, and by a machine operating by means of a punch and bolster the nails are cut from the divided bar. The main feature of the present invention consists in producing the bevel for the point by squeezing the edge of the bar before the nail is cut from it, at the place where the point of the nail will come. A die is brought to bear on the edge for this purpose.

3255. APPARATUS FOR EXHAUSTING, FORCING, AND PUMPING GAS, AIR, AND OTHER FLUIDS, *W. B. Wright, London.—30th June,* 1883. 6d.

Three or other suitable number of slides or vanes are placed at an angle or tangentially to the spindle or barrel, and are actuated by slippers. Relief ports are provided in the cylinder and are in communication with the usual ingress and egress ports, and arranged so as to prevent compression of the air, gas, or other fluid.

3257. BOILERS OR VESSELS EMPLOYED IN THE TREATMENT OF FIBROUS MATERIALS FOR THE MANUFACTURE OF PAPER PULP, &c., *I. S. McDougall, Manchester.—30th June,* 1883. 4d.

This consists in connecting lead linings to boilers or other vessels by means of bolts passing through holes in the lining and the shell of the boiler, and provided with nuts outside.

3258. PRODUCTION OF DESIGNS UPON ROLLERS OR SURFACES FOR PRINTING, &c., *J. J. Sachs, London.—30th June,* 1883. 4d.

The surface on which the design is to be produced is cleaned, and then exposed to the action of a sand blast, after which the design is engraved thereon or transferred thereto, and bitten into the surface under a vacuum or a partial vacuum.

3261. COUPLING FOR SHAFTS AND STEAM OR WATER PIPES, *J. Jamieson, York.—2nd July,* 1883.—(*Not proceeded with.*) 2d.

This relates to a spherical coupling for shafts and steam or water pipes, and consists in making the ends of the shaft spherical and with a ball-and-socket joint in the centre.

3262. APPARATUS FOR OPENING AND CLOSING VALVES IN CONNECTION WITH HOT WATER APPARATUS, *J. W. Thornton and F. Milan, Huddersfield.—2nd July,* 1883.—(*Not proceeded with.*) 2d.

This relates to heating apparatus made in sections, and consists in operating the valves to shut off any of the sections by means of a hand wheel arranged in front of the boiler.

3263. COMPOSITION FOR STIFFENING FUSTIANS, CORDS, &c., *J. Sellars, Manchester.—2nd July,* 1883. 2d.

The composition consists of a combination of the muriate of barytes and mucilaginous or gummy vegetable matter, either with or without admixture of gelatinous animal matter.

3264. MACHINERY FOR COMBING WOOL, *W. Terry and J. Scott, near Bradford.—2nd July,* 1883.—(*Not proceeded with.*) 2d.

This relates to machines in which the material is fed to the circular comb in tufts by means of nipping jaws inside the circle, and according to one arrangement the jaws are mounted on a fulcrum towards the centre of the circle, and a rising or falling motion imparted thereto by means of a cam and lever.

3266. MACHINE FOR CLIPPING SEAL AND OTHER SKINS, *L. A. Groth, London.—2nd July,* 1883.—(*A communication from G. and F. F. Cimiotti, New York.*) 6d.

This relates to improvements on patent No. 3226, A.D. 1880, and it consists of a knife-edged bar, over which the fur is stretched and fed, a current of air being delivered on the part over the edge of the bar, oscillating guard combs, having auxiliary guard plates, being arranged above the comb, and set so as to retain and protect the shorter wool. Laterally adjustable edge protectors are arranged above the guard plates.

3267. SELF-INKING ENDORSING STAMPS, *G. H. Cooke, London.—2nd July,* 1883.—(*Not proceeded with.*) 2d.

This relates to the mode of pivotting the movable die plate in the frame to allow the moveable type bands to be adjusted through the central opening in the die plate in a more simple manner. The die plate is pivotted on a cranked axle.

3268. RESERVOIR PENHOLDER, *L. B. Bertram, London.—2nd July,* 1883. 6d.

This consists in the use of a central air tube attached to a screw cap fitted over the end of the barrel or ink reservoir, and by turning which a valve at the end of the air tube is opened or closed so as to permit the flow of ink to or cut it off from the pen.

3269. MACHINE FOR FOLDING BROADCLOTH, &c., *H. J. Haddan, Kensington.—2nd July,* 1883.—(*A communication from E. Tatham, New York.*) 6d.

The object is to fold and roll the fabric in one operation, and it consists in providing the folder with a greater number of turning edges for action upon one side of the fold line of the web than upon the other side, and winding up the folded fabric with the side having the greatest tension upon the outer surface of the package.

SELECTED AMERICAN PATENTS.

From the United States' Patent Office Official Gazette.

291,065. GAS MOTOR, *Hiram S. Maxim, Paris, France.—Filed January 16th,* 1883.

Claim.—(1) An air or gas engine comprising, in combination, the following instrumentalities, to wit: a working cylinder and means for exploding therein charges of gas and air, a piston impelled by such explosions, a vacuum chandelier brought into communication with the working cylinder by the movement of the piston, a valve for admitting air into the cylinder when connected with the vacuous chamber, and means for introducing explosive charges into the cylinder, these parts being constructed and combined for co-operative action in substantially the manner set forth. (2) In a gas engine, the combination, with the working cylinder and piston, of a vacuum cylinder of greater capacity, a piston working therein, and an intermediate recess or chamber with which the working cylinder is brought into communication by the withdrawal of its piston, whereby at the end of each stroke the gases are withdrawn from the working cylinder, in the manner described. (3) The combination, with the working cylinder of a gas engine, of a pump for introducing explosive charges into said cylinder, means for positively raising the piston of the pump and then disengaging it, and a spring for forcing it downward, all as set forth. (4) The combination in a gas engine, of the working and vacuum cylinders connected in the manner

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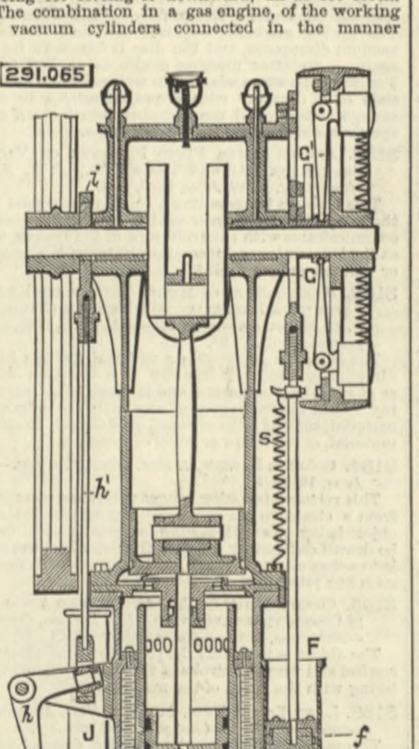

described, the piston working in said cylinders, and the intermediate chambers of communication at and round the ends of said cylinders, as described. (5) The combination, with the working and vacuum cylinders and pistons contained therein, of intermediate chambers of communication at or round the ends of the cylinders, the working cylinder being perforated in substantially the manner described, whereby communication is established between the two cylinders through said intermediate chambers on the partial withdrawal of the pistons, as and for the purpose set forth. (6) The combination, with the working and vacuum cylinders and pistons contained therein, of chambers or vacuous spaces located around the ends of and between said cylinders, and exhaust connected with the said chambers, as and for the purposes set forth. (7) The combination, in a gas engine, of a working cylinder and piston and a vacuum cylinder and piston, an automatic air check valve opening into the working cylinder, and an exhaust valve opening outward, these parts being combined in substantially the manner described. (8) The combination, with the working cylinder of a gas engine, of a pump for introducing charges of air and gas into the cylinder, and a valve located between the cylinder and pump, and provided with a number of perforations, through which the air and gas are forced when the valve is open, as and for the purpose set forth. (9) The combination, with the working cylinder, of the pump F, the perforated valve M, with air and gas inlet valves, and means for controlling the same, as and for the purpose specified. (10) The combination, with the pump F, piston-rod *f*, and plate G, of spring *s* and cam G^1, all as set forth. (11) The combination, with the working cylinder of the chambered piston, the flame chimney, a bell-crank lever connected with the piston, and an excentric for operating the bell-crank lever, all as set forth. (12) The combination, of the bell-crank lever *h*, rod h^1, excentric *i*, piston I, containing a chamber at its inner end, and the flame chimney J, these parts being constructed and arranged in such a manner that the piston I thrusts the flame directly into the interior of the working or explosion cylinder, in the manner described. (13) The combination, with the working cylinder of an induction valve L, perforated valve M, pump F, and valves connecting therewith, and exhaust valve, the parts being constructed in the manner specified.

291,515. ROTARY HARROW, *Julius Hugo Hoof, Quincy, Dak.—Filed August 16th,* 1883.

Claim.—A harrow frame having journalled therein a main shaft, upon which are mounted the usual drive wheels and suitable gear wheels, in combination with a vertically-sliding cross beam, vertical

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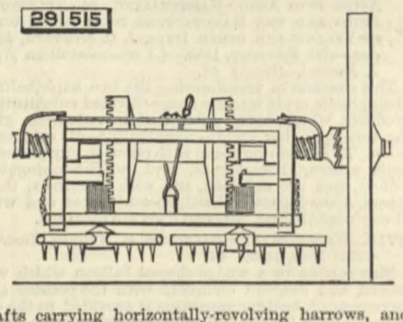

shafts carrying horizontally-revolving harrows, and elongated pinions, said beam having connected thereto an elevating lever, substantially as and for the purpose set forth.

291,566. REGULATOR FOR DYNAMO OR MAGNETO-ELECTRIC MACHINES, *Forée Bain, Chicago, Ill.—Filed September 21st,* 1883.

Claim.—The combination, substantially as herein set forth, with the shaft of a revolving armature, of a brush operating and adjusting device mounted thereon and operated thereby, and means for controlling said operation depending upon the strength of the current generated. The combination, substantially as herein set forth, with the shaft of a

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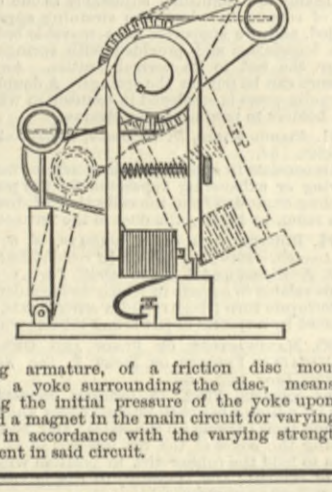

revolving armature, of a friction disc mounted thereon, a yoke surrounding the disc, means for adjusting the initial pressure of the yoke upon the disc, and a magnet in the main circuit for varying the friction in accordance with the varying strength of the current in said circuit.

CONTENTS.

THE ENGINEER, February 22nd, 1884. PAGE

NAVAL ENGINEER APPOINTMENTS.—The following appointments have been made at the Admiralty:—Thomas A. Morris, engineer, to the Coquette, vice Mackney; Charles A. Moore, assistant engineer, to the Swiftsure, vice Spulding; and Edward Gallary, assistant engineer, additional, to the Swiftsure.