THE DANUBE BRIDGE PROJECT.

By ROBERT HUDSON GRAHAM.

NO. V.

IN this closing paper upon the Danube Bridge competition, I shall endeavour to give a comprehensive account of the note upon Culmann's graphic treatment of elastic arches, courteously communicated to me by Messrs. Röthlisberger and Simons. In substance the note agrees very closely with Culmann's original description of his method, but in minor details, and as taken from actual practice, Messrs. Röthlisberger and Simons' communication has the advantage of being more concrete and explicit. Those who are acquainted with Culmann's writings will endorse my statement that, although his methods are excellent, his way of putting a thing is not always happy. Gifted, as he undoubtedly was, with a rare and robust originality of thought, Culmann betrays a perfect heedlessness of style, scattering broadcast the pearls he finds, and leaving to others, with more time at their disposal, the trouble of collecting and retailing his thoughts under more winning and graceful forms. Yet this very heedlessness probably explains why his championship of graphic methods met with so much coldness and opposition from that conservation section of the German professoriate which still plods doggedly on in the old analytical groove. The genial and pre-eminently thorough-going professor of Zürich had no kind of sympathy with what may be called mathematical finesse. In this respect he had much in common with the late Professor Fleeming Jenkin, and yet it is more than probable that, although both were conspicuous leaders in the modern advance towards pure graphic methods, each was imperfectly acquainted with the other's work. For instance, it is absolutely certain that Culmann was unaware of the existence of Fleeming Jenkin's development, in 1869, of Clerk Maxwell's original paper on reciprocal figures, published in the *Philosophical Magazine* of 1864; otherwise he would not have passed from the judgment that Maxwell's paper was vague and superficial, to the inference that Cremona, in his "Le figure reciproche nella Statica Grafica," 1870, must be considered the true author and expounder of the theory of reciprocal figures. In this passage Culmann's allusion to Maxwell, whether it be taken merely as a personal criticism upon the learned Cambridge professor, or more generally as an expression of Culmann's opinion upon the body of English mathematicians at large, cannot be regarded as in any way flattering our national talent. Here is the quotation:—"Und diese Einführung des Nullsystems ist das Werk Cremona's nicht Maxwell's; ebenso rühren alle Anwendungen von Cremona her . . . Weiter als wie irgend wo anders klafft noch die Kluft zwischen dem englischen Gelehrten und Praktiker."—"The introduction of the system of reciprocal figures is due to Cremona, not to Maxwell; and the same may be said of the practical application of the method. . . . Moreover here as elsewhere there yawns a chasm between the English mathematician and the practical scientific man." The best reply to this sweeping criticism, every way unworthy of Culmann, is the fact that Cremona himself has publicly admitted Maxwell's priority, and then the intrinsic evidence in Cremona's book that he had read and profited by Fleeming Jenkin's paper in continuation of Maxwell's original article in the *Philosophical Magazine.* Had Culmann passed these severe remarks upon Maxwell's exposition of the arch theory, instead of upon his theory of reciprocal figures, he might have touched a sympathetic chord; insomuch that the former, apart from the semblance of involving a *petitio principii*, is not in any sense a practical solution of the arch problem. But, as it is, Maxwell has a perfectly defensible claim to the first authorship of the theory of reciprocal figures, to the same extent that Culmann has a right to be regarded as the author of the only graphic solution of the arch problem which will stand the test of rigorous examination. We shall now proceed, after giving one or two definitions, to the description of this method, my own share in which consists only in reducing Culmann's nomenclature to English forms and constructing the figures, with the exception of Fig. 32, from the indications of the text of Messrs. Röthlisberger and Simon's note.

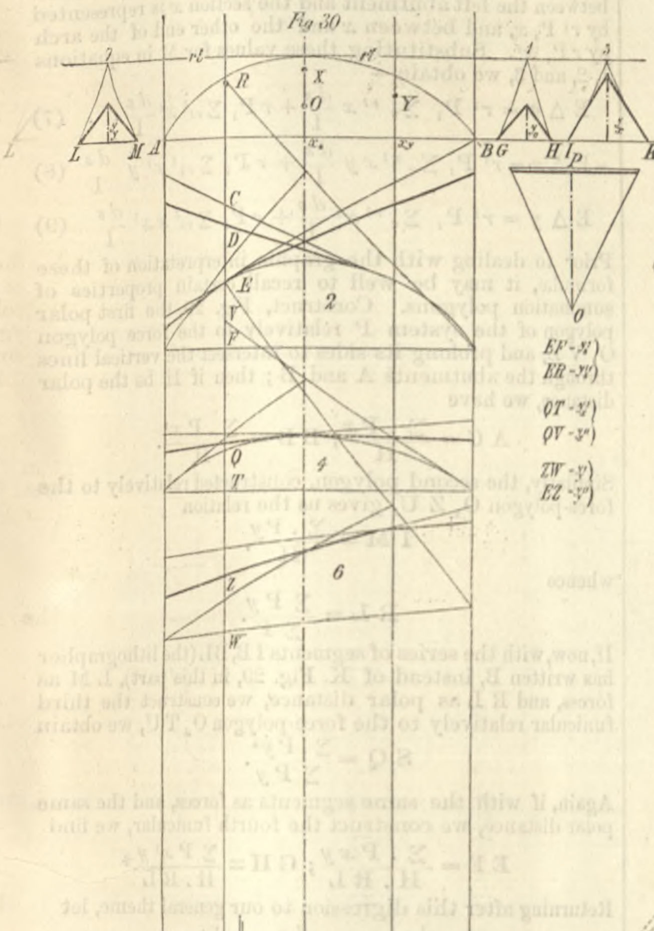


Fig 30

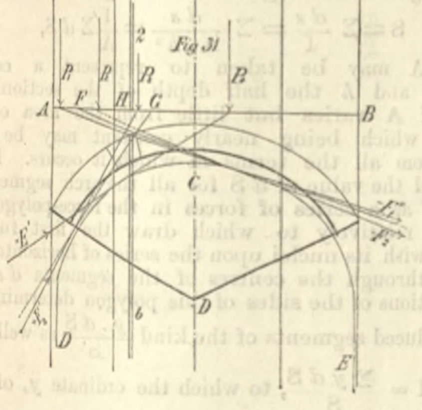
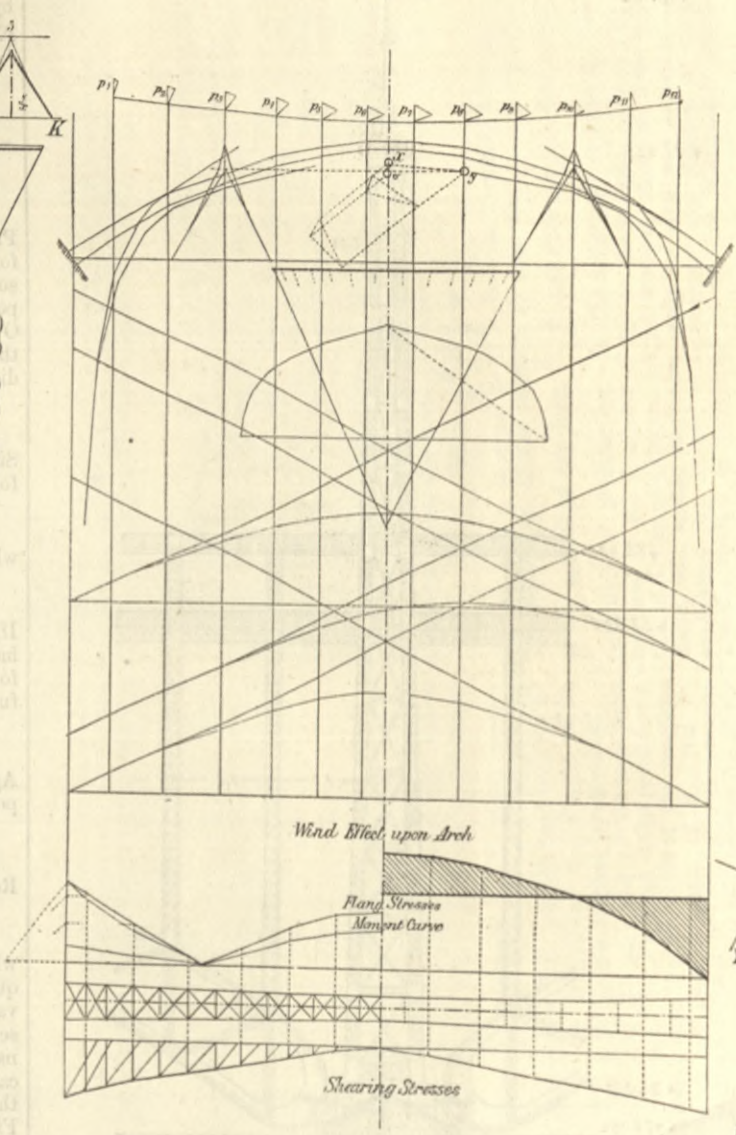


Fig 31

Fig. 32



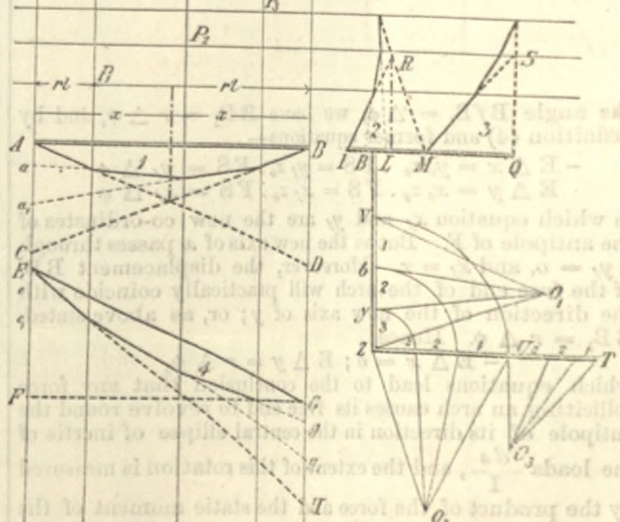


Fig 29

Definitions.—(1) If the point A, Fig. 25, be the pole of the axis Ox and $O'B = OA$; then the point B is called the *antipole* of the axis Ox.

(2) If $\Sigma\, x y\,.\,F$ be the centrifugal moment of a system of forces relatively to a system of axes xy; then

$$\Sigma\, x y\,.\,F = (x_1\, y_1 + K)\,.\,\Sigma\, F,$$

where $x_1\, y_1$ are the co-ordinates of the centre of gravity of the system, and K is the centrifugal moment of the system relatively to a parallel system of axes through the centre of gravity taken as origin.

(3) If the moment of inertia $I = \Sigma\, F y^2 = k^2 . \Sigma\, F$; then k is the radius of gyration of the ellipse of inertia. Suppose, for example, that the ellipse became a circle of inertia of a radius of gyration k, Fig. 25; then, O' being the centre of gravity of the system,

$$\Sigma\,.\,F y^2 = \Sigma\,.\,F y_1^2 + O'\,C^2$$
$$= k^2\,.\,\Sigma\, F + O'\,C^2;$$

wherefore, if $BC = y_p$ and $O'\,C = y_1$, we have

$$y_p = y_1 + \frac{k^2}{y_1}.$$

(4) From Definitions (1), (2), and (3) we infer that the centrifugal moment $\Sigma . x\, y\, F$ of a system of forces is equal to the sum of the forces $\Sigma\,.\,F$ multiplied by the product $x_1\, y_p$, in which x_1 is the abscissa of the centre of gravity, and y_p the ordinate of the antipole of the axis of y; for if, in Fig. 26, G be the antipole of the axis O Y and y_p its ordinate, then by Definition (1) $O'\,E = \frac{k^2}{x_1}$, and by the ordinary properties of the ellipse of inertia $DF = \frac{K}{k}$; whence $EG = \frac{K}{x_1}$ and

$$\Sigma\, x y F = (x_1\, y_1 + K)\,.\,\Sigma\, F \text{ (def. 2)}$$
$$= x_1 \left(y_1 + \frac{K}{x_1}\right).\,\Sigma\, F = x_1\, y_p\,.\,\Sigma\, F.$$

Similarly, when ordinates y replace abscissæ x, we have

$$\Sigma\, y^2\, F = y_1\, y_p\,.\,\Sigma\, F.$$

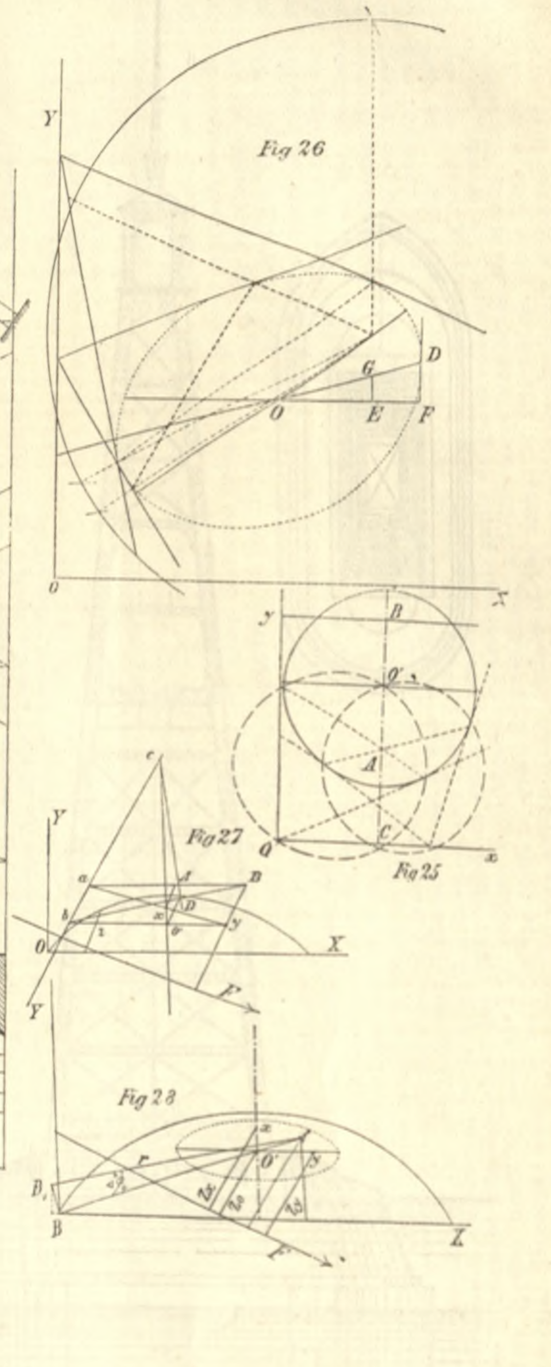


Fig 26. Fig 25. Fig 27. Fig 28.

Culmann's graphic method.—The usual formulæ for the deformations of an arch are

$$\Delta\,\phi = \Sigma\,.\,M\,\frac{ds}{EI} \quad . \; . \; . \; . \; . \quad (1)$$

$$-\Delta\, x = \Sigma\, M\, y\,\frac{ds}{EI} \quad . \; . \; . \; . \; . \; . \quad (2)$$

$$\Delta\, y = \Sigma\, M\, x\,\frac{ds}{EI} \quad . \; . \; . \; . \; . \; . \quad (3)$$

in which $\Delta\,\phi$ represents the change in the angle of the neutral axis to the horizon, $\Delta\, x$ and $\Delta\, y$ the horizontal and vertical displacements of one end of the arch, E the modulus of elasticity, I the moment of inertia, ds the length of an elemental segment, x and y the co-ordinates of a point in the arch. In order to determine the reactions at one of the fixed abutments, we suppose it invariable, so that the arch cannot turn or pivot upon its bedding surface. Under these conditions, one abutment fixed, the other movable, the deformation produced at the free abutment by any vertical load P are first determined, then annulled by a force F, necessary and sufficient to bring the free end back to its primitive position. This force F, resulting from the moment at the abutment and the horizontal thrust, is constant for a determinate load over the entire arch. Let z, Fig. 27, be the variable distance of the centre of gravity of each arch segment from the direction of the force F, and let $M = Fz$. Then, if E be constant, equations 1, 2, and 3 become

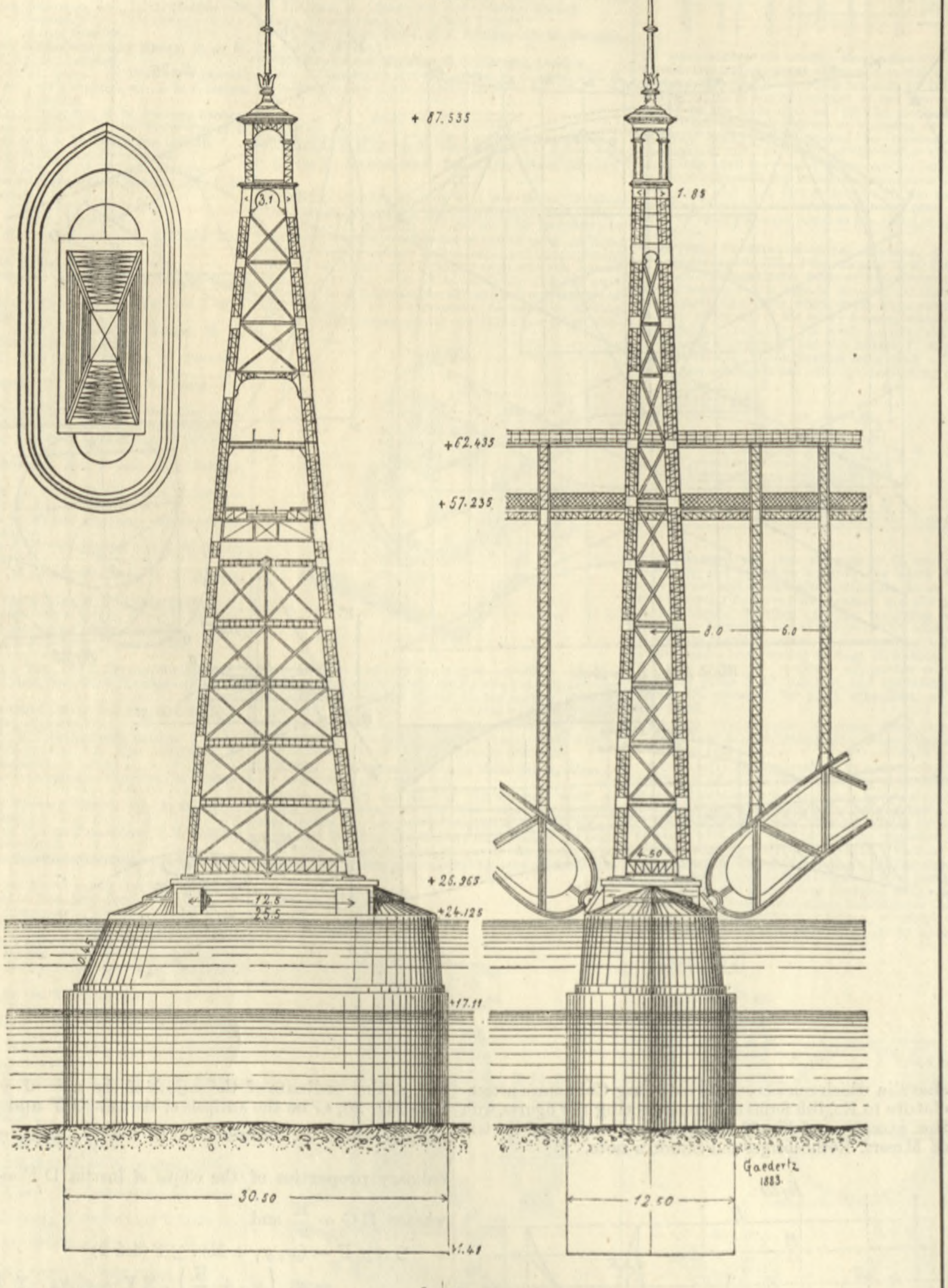
$$E\,\Delta\,\phi = F\,\Sigma\,z\frac{ds}{I}$$

$$-E\,\Delta\,x = F\,\Sigma\,y\,z\,.\frac{ds}{I}$$

$$E\,\Delta\,y = F\,\Sigma\,x\,z\frac{ds}{I}$$

Assume, now that each arch segment is of the fictitious weight $\frac{ds}{I}$, and construct the centre of gravity and central

Fig. 33



ellipse of inertia of these loads.* The term $\Sigma\,z\frac{ds}{I}$ expresses the static moment of the resultant of the loads $\frac{ds}{I}$ relatively to the direction of the force F. Therefore, if $\Sigma\frac{ds}{I} = S$ and z_0 be the oblique co-ordinate of the centre of gravity O^1, we have

$$\Sigma\,z\frac{ds}{I} = z_0\,S.$$

The other two summations are the centrifugal moments of the loads $\frac{ds}{I}$ relatively to one of the axes and the direction of F. Now, let x, Fig. 28, be the antipole of the axis X, y that of Y, and let $z_0\ z_x\ z_y$ be the oblique ordinates of the centre of gravity O^1, the antipole x, and the antipole y respectively. Then by definition (4) we have

$$\Sigma\,y\,z\frac{ds}{I} = y_0\,z_x.\,S,$$

in which equation y_0 represents the ordinate of the centre of gravity. Similarly,

$$\Sigma\,x\,z\frac{ds}{I} = x_0\,z_y.\,S.$$

Thus our equations of deformation become

$$E\,\Delta\,\phi = z_0\,.\,F S \quad . \quad . \quad . \quad . \quad (4)$$

$$-E\,\Delta\,x = y_0\,z_x.\,F S \quad . \quad . \quad . \quad . \quad (5)$$

$$E\,\Delta\,y = x_0\,z_y.\,F S \quad . \quad . \quad . \quad . \quad (6)$$

On the assumption that the free end B of the arch moves to B$_1$, and that no special direction has been given to the axes, it is allowable to suppose that the axis of x passes through f, the antipole of F. Now, if the distance $Bf = r$, the angle $BfB_1 = \Delta\,\phi$, we have $BB_1 = r\,\Delta\,\phi$, and by definition (4) and former equations—

$$-E\,\Delta\,x = y_0\,z_x\,.\,F S = y_f\,z_0.\,F S = y_f\,\Delta\,\phi$$

$$E\,\Delta\,y = x_0\,z_y.\,F S = x_f\,z_0.\,F S = x_f\,\Delta\,\phi$$

in which equation x_f and y_f are the new co-ordinates of the antipole of F. But as the new axis of x passes through f, $y_f = o$, and $x_f = r$. Moreover, the displacement BB$_1$ of the free end of the arch will practically coincide with the direction of the new axis of y; or, as above stated, $BB_1 = r\,\Delta\,\phi$. Hence

$$-E\,\Delta\,x = o\,;\ E\,\Delta\,y = r\,\Delta\,\phi,$$

which equations lead to the conclusion that any force solliciting an arch causes its free end to revolve round the antipole of its direction in the central ellipse of inertia of the loads $\frac{ds}{I}$, and the extent of this rotation is measured by the product of the force and the static moment of the resultant of the loads $\frac{ds}{I}$, relatively to the direction of the given force.

Equations (4), (5), and (6) can be written in the forms

$$\frac{z_0}{\Delta\,\phi} = \frac{-z_x\,.\,y_0}{\Delta\,x} = \frac{z_y\,.\,x_0}{\Delta\,y} = \frac{1}{FS};$$

whence it may be said that the perpendiculars, z_0, z_x, and z_y, let fall upon the direction of F from the centre of gravity O^1 and the two antipoles x and y, are proportional to $\Delta\,\phi$, $-\frac{\Delta\,x}{y_0}$, and $\frac{\Delta\,y}{x_0}$; that is to say, if from these three points we describe circles whose radii are proportional to $\Delta\,\phi$, $-\frac{\Delta\,x}{y_0}$, and $\frac{\Delta\,y}{x_0}$, the tangents common to any two of these circles will intersect in a point on the direction of F. An equivalent construction is given in Fig. 27, where the points of intersection a b and c are determined by drawing straight lines through the ends of the trimetrical co-ordinates xA, O^1 D, and yB. Then the magnitude of the force is found from the equation $F = \frac{\Delta\,\phi}{z_0\,S}$.

Let us now establish the deformations due to the action of any external force P$_1$, assuming $r\,l$ and $r^1\,l$ to be the abscissæ of the point of application P$_1$, x and x^1 those of any segment of the arch, all measured from the left and right abutments, Fig. 29. The vertical reactions arising from the load P$_1$ will be r^1 P$_1$ at the left, and r P$_1$ at the right abutment. The bending moment at any section between the left abutment and the section x is represented by $r^1\,P_1\,x$, and between x and the other end of the arch by $r\,P_1\,x^1$. Substituting these values for M in equations 1, 2, and 3, we obtain—

$$E\,\Delta\,\phi = r^1\,P_1\,\Sigma_0{}^{rl}\,x\,\frac{ds}{I} + r\,P_1\,\Sigma_{rl}{}^{l}\,x^1\frac{ds}{I}\,.\ \ .\quad (7)$$

$$-E\,\Delta\,x = r^1\,P_1\,\Sigma_0{}^{rl}\,x\,y\,\frac{ds}{I} + r\,P_1\,\Sigma_{rl}{}^{l}\,x^1\,y\,\frac{ds}{I}\quad (8)$$

$$E\,\Delta\,y = r^1\,P_1\,\Sigma_0{}^{rl}\,x^2\,\frac{ds}{I} + r\,P_1\,\Sigma_{rl}{}^{l}\,x\,x^1\,\frac{ds}{I}\quad (9)$$

Prior to dealing with the graphic interpretation of these formulæ, it may be well to recall certain properties of summation polygons. Construct, Fig. 29, the first polar polygon of the system P relatively to the force polygon O$_1$ V Z, and prolong its sides to intersect the vertical lines through the abutments A and B; then if H be the polar distance, we have

$$AC = \frac{\Sigma\,.\,P x}{H};\ BD = \frac{\Sigma\,.\,P\,x^1}{H}.$$

Similarly, the second polygon, constructed relatively to the force-polygon O$_2$ Z U, gives us the relation

$$IM = \frac{\Sigma\,.\,P y}{H},$$

whence

$$RL = \frac{\Sigma\,P y}{\Sigma\,P}.$$

If, now, with the series of segments I B, B L (the lithographer has written B, instead of K, Fig. 29, in this part), L M as forces, and R L as polar distance, we construct the third funicular relatively to the force-polygon O$_3$ T U, we obtain

$$SQ = \frac{\Sigma\,.\,P y^2}{\Sigma\,P y}.$$

Again, if with the same segments as forces, and the same polar distance, we construct the fourth funicular, we find

$$EF = \frac{\Sigma\,.\,P x y}{H\,.\,RL};\ GH = \frac{\Sigma\,P\,x^1\,y}{H\,.\,RL}.$$

Returning after this digression to our general theme, let

$$S = \Sigma\frac{ds}{I} = \Sigma\frac{ds}{A\,.\,h^2} = \frac{1}{A}\Sigma\,d\,S,$$

where A may be taken to represent a constant quantity and h the half depth of the section. The value of A varies but little from the area of cross section, which being nearly constant may be eliminated from all the terms in which it occurs. Having calculated the value of d S for all the arch segments, set them off as a series of forces in the force-polygon O P, Fig. 30, relatively to which draw the first funicular polygon with its nuclei upon the series of horizontal lines passing through the centres of the segments $d\,s$. The prolongations of the sides of this polygon determine upon A B produced segments of the kind $\frac{y\,.\,d\,S}{S}$ as well as the sum $GH = \frac{\Sigma\,y\,d\,S}{S}$, to which the ordinate y_0 of intersection of the closing sides is also equal, defining a horizontal line passing through O, the point of application of the resultant of the system d S.

Next construct the second funicular relatively to the force-polygon O P and forces d S; then the prolongations of any two consecutive sides will intercept upon vertical lines through A and B intercepts of the kind

$$\frac{x\,d\,S}{S}\ \text{and}\ \frac{x^1\,d\,S}{S},$$

and the centre O will lie upon the vertical drawn through the intersection of the closing lines. Taking now the segments of G H as a new series of forces and y_0 as polar distance, draw the third and fourth funicular polygons, whereby

$$IK = \frac{\Sigma\,y^2\,d\,S}{y_0\,S}$$

and the sums of the intercepts of the sides of the fourth polygon upon verticals through A and B are

$$\frac{\Sigma\,x\,y\,d\,S}{y_0\,S}\ \text{and}\ \frac{\Sigma\,x^1\,y\,d\,S}{y_0\,S}.$$

The ordinate of intersection y_x of the closing sides of the third polygon is likewise the ordinate of the antipole X of the axis of abscissæ A B relatively to the ellipse of inertia of the system dS. Similarly the abscissæ x_0 of the closing lines of the fourth polygon is likewise that of the antipole X. Lastly, with the intercepts upon the verticals through A or B of the consecutive sides of the second polygon and the polar distance x_0, construct the sixth funicular, whose prolongations determine upon lines through A and B intercepts of the kind

$$\frac{x^2\,d\,S}{x_0\,S}\ \text{and}\ \frac{x\,x^1\,d\,S}{x_0\,S};$$

* There are various ways of constructing the central ellipse; first by finding three pairs of tangents, each set distant from the centre of gravity by the radius of gyration of the system; then by the help of two centres of projection and the perspective transversal drawing any number of tangent envelopes; secondly, by finding five points on the ellipse and using the centre of perspectivity; thirdly, by finding the centre of involution from four tangents and a point of contact. The first is the best method; Culmann adopts the third; I am uninformed as to the method employed by Messrs. Röthlisberger and Simons.—R. H. G.

* Those who encounter any difficulty in mastering central ellipses of inertia and graphic summation will find the first principles of the subject very fully treated in the chapter on Moments in my Graphic and Analytic Statics. It is impossible to go more fully into details of this nature in an article intended primarily for engineers.—R. H. G.

Fig. 34

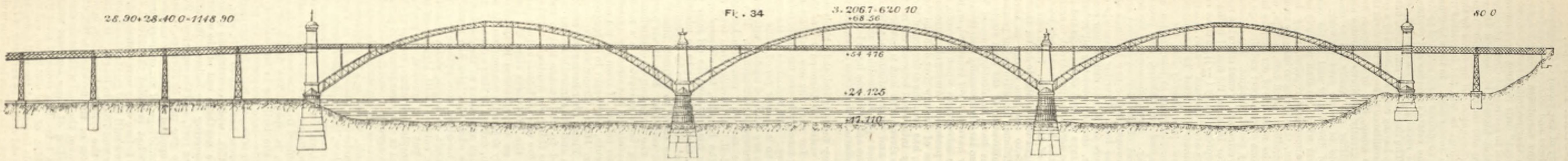
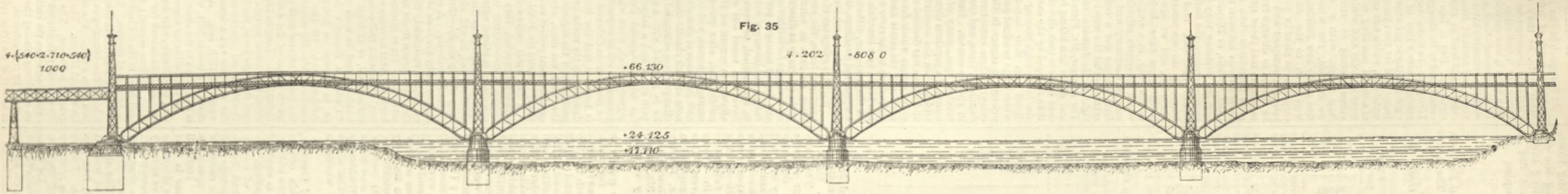


Fig. 35



then x_y, the abscissa of intersection of the closing lines, is also the abscissa of the antipole Y. Its ordinate y_y is found by drawing the seventh funicular relatively to the same series of forces and with the same polar distance.

It is convenient to express the intercept of a polar polygon, in terms of the intercepts which its produced sides determine upon vertical lines through its extremities. Thus, for example, we have in Fig. 30

$$E F = \frac{1}{S}\left[r^1 \Sigma_o{}^{rl} x\, d S + r \Sigma^l_{rl}\, x^1\, d S\right],$$

So also in the fourth funicular

$$Q T = \frac{1}{y_o S}\left[r^1 \Sigma_o{}^{rl} x y\, d S + r \Sigma_{rl}{}^l x^1 y\, d S\right],$$

and in the sixth polygon

$$W Z = \frac{1}{x_o S}\left[r^1 \Sigma_o{}^{rl} x^2\, d S + r \Sigma_{rl}{}^l x x^1\, d S\right]$$

Now E F, Q T, Z W, expressed in this form, are the factors of P_1, in equations 7, 8, and 9, divided respectively by S, y_o S, and x_o S. If therefore we make E F $= y^1_z$, Q T $= y^1_x$, W Z $= y^1_y$, these equations reduce to

$$\frac{E \Delta \phi}{S} = o = P^1 y^1_z + z_o . F, \quad . \quad . \quad . \quad . \quad (10)$$

$$\frac{-E \Delta x}{y_o S} = o = P_1 . y^1_x + z_x F, \quad . \quad . \quad . \quad . \quad (11)$$

$$\frac{E \Delta y}{x_o S} = o = P_1 y^1_y + z_y F,$$

whence

$$\frac{z_o}{y^1_z} = \frac{z_x}{y^1_x} = \frac{z_y}{y^1_y} = -\frac{P}{F}$$

Thus the direction of F can be fixed by the method of trimetrical co-ordinates already explained, and then its magnitude deduced from the preceding equations. The resultant of the component F and the vertical reaction at the abutment due to P_1 will give the resultant reaction F^1 arising there from all causes.

Equation (7) divided by S can be expressed in the equivalent form—

$$\frac{E \Delta \phi}{S} = r^1 P_1 \Sigma^l_o \frac{x\, d S}{S} - P_1 \Sigma^l_{rl} (x - r l) \frac{d S}{S};$$

in which

$$\Sigma^l_o \frac{x\, d S}{S} = x_o ; \Sigma^l_{rl} (x - r l) \frac{d S}{S} = \overline{E R} \quad \text{(Fig. 30)}$$

The second relation can be deduced from the value of the elementary intercept

$$\overline{C D} = (x - r l) \frac{d S}{S}.$$

Let the segments of the fourth and sixth, analogous to E R or y^1_z of the second polygon, be termed Q V $= y^{11}_x$, E Z $= y^{11}_y$; then

$$\frac{E \Delta \phi}{S} = o = x_o r^1 P_1 - m \cdot \frac{y^{11}_z P_1}{m} + z_o F,$$

$$o = x_o r^1 P_1 - m \cdot \frac{y^{11}_x P_1}{m} + z_x F,$$

$$o = x_y r^1 P_1 - m \cdot \frac{y^{11}_y P_1}{m} + z_y F,$$

where m is a factor to be determined for each P, and the other terms have the meanings formerly defined; hence the above equations may be regarded as equations of moments of the forces $r^1 P_1$, F, and their resultant $\frac{P_1}{m}$ relatively to the three centres O, X, and Y. We can therefore find the resultant reaction F^1 by employing y^{11}_z, y^{11}_x, y^{11}_y as trimetrical co-ordinates of its direction. In practice this is by far the simplest construction.

First we find the intercepts y^{11}_z, y^{11}_x, and y^{11}_y for any force P_1 applied at $r l$ and for an equal force applied at the point $l - r l$, complementary of the span; then the directions of the reactions F^1 and F^{11} will meet on the line of action of P_1, and P_1 resolved along the directions F^1 and F^{11} will give the magnitudes of these reactions. Repeating this construction for all the loads P upon the arch, we obtain, by passing a curve through the successive intersections of F^1 and F^{11} upon the lines of action P, a curve named the curve of intersection of the reactions, or more simply the curve of intersections. The directions of the reactions F^1 and F^{11} determine a second curve called the curve-envelope of reactions, or more simply, the curve-envelope. These two curves enable us to find the independent reactions arising from any external force P.

It is only necessary, in fact, to draw from the point where the direction of P meets the curve of intersections A B, Fig. 31, a pair of tangents to the curve envelope D C E, and then resolve P along the directions of these tangents. By aid of the same curves, we may also discover the dangerous load for any section of the arch—say, the apex of the trapezoidal division, Fig. 31. Draw through this apex a pair of tangents to the curve envelope, determining an intercept F G upon the curve of intersections. Eliminating that part of the arch to the left of the section $\alpha \beta$, it will be found that all external forces applied between A and F produce left-handed moments about the apex; whilst all external forces applied over the interval F G produce right-handed moments. Hence the dangerous load for the point in question must be distributed over A F and B G. By means of force and polar polygons the reactions F^1 and F^{11} can be compounded, and the magnitude and direction of their resultants determined.

To determine the thrust due to temperature, we assume, as before, that after deformation the arch remains unchanged in character, one of the abutments being free to move. The free end will move in a straight line; consequently its centre of rotation lies at infinity, the antipolar of which will be the diameter of the central ellipse conjugate of the central vertical axis. This conjugate gives the direction of the reaction F_t necessary to annul the deformation of the free end of the arch. Its magnitude is found from the general equations by making P $= o$, $\Delta x = \epsilon \tau l$, where ϵ is the coefficient of expansion, τ the difference of temperature, and l the span. Wherefore—

$$F_t = \frac{E \Delta x}{y_o z_x . S} = \frac{E . \epsilon \tau l}{y_o z_x \cdot S}$$

Observe that z_x is equal to O X, because F_t passes through O. The repartition of the reaction F_t over the several segments of the arch is of the form $\frac{F_t . y}{h}$, and does not give rise to any peculiarity of construction. In the same way account may be rendered of the compression due to deadweight. The description of Culmann's elegant graphic method, which we here conclude, will enable engineers easily to read and interpret its application by Messrs. Röthlisberger and Simons to their Danube design, as developed in the last illustration accompanying this article.

The Cail project.—In preface to a description of the Cail project, we may mention that, although we have placed it last in order, it does not follow that we rank it lowest in merit. This company presented several designs; namely, a high-level braced mixed metal arch, or a low-level parallel swing girder system, for the Danube; together with similar types for the Borcea. The Danube project consists of four 202-metre arch spans and one small 20-metre independent parallel approach span, on the right bank of the river. The central pier foundations are laid at 1·41 above zero or 15·7 metres below low water datum. The caisson dimensions, Fig. 33, are 30·5 by 12·5 metres at base, 25·5 by 9·5 metres at high water mark, and 16 by 6·5 at bedding surfaces. In plan the piers form a Gothic arch on the up-stream side, and rake at 0·45, or 45 per cent. The left abutment foundation is sunk to the same level as the base of the river caissons, but that on the right rests upon the bed of limestone rock, which rises almost sheer from the water edge. The earth pressure is 6·22 kilogrammes per square centimetre. The arch ribs and main girder flanges of this project are of steel, but the cross girders and other minor parts are shown in iron. The bedding surfaces of the arches lie 2·84 metres above flood water. The neutral axis of the arch is circular, struck with a radius of 157·56 metres, and rising 33·39 metres. The rib depth is constant, being 6 metres, rounded at the ends to hinged bearings, 2 metres deep. The rib trellis is simple, composed of vertical struts and radial diagonals. The struts supporting the platform, Fig. 33, are built up, as usual, upon four corner angle irons. Wind bracing passes over the rib flanges, and between the main struts. The footway is raised 5·2 metres above the permanent way, which is on a line with the crown of the lower rib. In order to stiffen the struts against longitudinal deflection, they are connected at their top ends by a series of longitudinal girders—a very commendable precaution. The cross girders are trellis, each 0·55 metre deep and 5·2 metres span. The working limits for steel were assumed at 9·9 kilogs. per square millimetre in the top, and 9·3 kilogs. per square millimetre in the bottom flanges. In the cross girders and minor parts the limit was reduced to 5·77 kilogs. per square millimetre. Long iron columns, 58·57 metres high, rise upon the piers 87·535 metres above zero datum. The Balta approach is 2898·5 metres long, of which 1000 metres is in viaduct, with four continuous sections, each composed of two central 71-metre and two end 54-metre spans. The girders are straight, filled in with a cross lattice. The Borcea is crossed on the high level by two 202-metre arched spans, similar in type to those over the main channel. The total tender for the two high-level projects was £904,680.

THE IRON AND COAL DISTRICTS OF ALABAMA.

No. IV.

In looking at this new country of the South as a field for capital and enterprise, one cannot help feeling that it is peculiarly suitable for Englishmen who are acquainted with metallurgical and engineering trades, even more than for people similarly suited from the Northern States. However much the fact may be regretted, there is not yet that perfect peace and goodwill between North and South which was hoped for. Although political allusions are out of place here, they may be briefly referred to as affecting the industrial situation. After the war the Northern, or Republican party, felt confident that the negro voters, sympathising with the victorious people who had freed them, would ensure to the latter a perpetual supremacy, and the white "carpet-bagger" politicians, who moved south to gather up what was left in the ruined Slave States, verified this theory to the utmost for some years. But apart from the respective merits of the two parties—which it is not desirable to discuss here—human nature proved to be about the same in the South as elsewhere, and it was not to be expected that the white population of English blood would allow themselves to be permanently ruled by the more numerous negroes. The natural supremacy of race has now asserted itself; but during the struggle a Northerner who sought to establish himself in the Southern States, and who manifested Republican proclivities, had an unpleasant time of it. But though this was the case while the country still smarted under the memory of defeats and losses, and was doubtful of the future, the bitter feeling is fading away now that the residents in the country have regained their natural position, confirmed, as they deem it, by the election of Cleveland as president, and they can afford to welcome their countrymen from the North who came among them. But some of the bitterness is now felt on the other side; the Northerners have so long deemed themselves superior to the poor proud Southerners, that those of them who do not personally know the country are loth to acknowledge the coming change in the centre of gravity, and like still to tell the intending emigrant from Europe that by going South he will be venturing among a lawless, unenergetic, and thriftless people. But the more far-seeing and impartial of the visitors from the North as well as from Europe who have explored these regions, and who have seen in the exhibition at New Orleans and in the districts themselves the changes and developments wrought during the last five years, recognise that the old order of things has passed away, and that the war veterans are being superseded by a younger generation ready and eager to avail themselves of the newly-developed mineral resources. Englishmen who may come here free as they are from the party animosities of the civil war are especially welcomed. Not only is capital needed here, but skill. Engineers and mechanics are much wanted, and are valued highly, and those in England who are seeking either employment or a permanent home will find a better chance now in the South than either in the Eastern or Western States. And those who can combine the two, who can take a few hundred or thousand pounds with them, or, what is better, leave the funds at home to follow them when they have learnt the way of the country, have a career before them which England cannot offer, and which, even in our most enterprising colonies, is not easily to be found. And however much the development of mineral resources here may, when an export trade is established, damage English interests in foreign and colonial markets, such an event will only occur when free-trade is established, and the benefit accruing to the whole human race when reciprocal commerce is permitted is certain to bring compensating advantages to those who may anticipate loss. And even to those in England who may find scant comfort in such general compensation for the direct damage they may suffer, it may be said that the competition with English goods is not likely to occur very soon, for in the United States the doctrines of protection are still too firmly held to be altered quickly. The Chinese wall which the American manufacturers have succeeded in building around them, while it ensures them all the trade of their own country, shuts them out from that export commerce of the world on which England so much depends, and so long as this state of affairs continues the United States, great as they are, cannot harm us. But it may certainly be expected with a view to the future, that English capital and skill, especially when possessed by young men, will more and more move westward to what appears likely to be the centre of the English-speaking race.

Before concluding this series of articles on Alabama which have grown out of a visit to the Exhibition at New Orleans, a few lines may be written about the neighbouring State of Georgia, which, though without the enormous coal resources of Alabama, has also a mineral wealth which is likely soon to be developed. For in this State, as in Alabama, there appears to be an awakening to the true interests of the country, and the revival is more marked in some districts than in others. Atlanta, the capital of the State, has been entirely rebuilt since the war. With wide streets, stone built houses, legislative chambers, busy factories, and among its hotels one of the finest in the United States, there is every sign of wealth and progress. Lancashire will find a keen rival here, for situated as Atlanta is in the centre of the cotton-growing districts, with iron mills and engineering factories growing up in the neighbouring States, and with ready access to the Atlantic and Gulf ports, the cotton manufactories already established are likely to grow rapidly. Georgia is in many respects the leading Southern State. Free from the burden of public debt that overshadows some of her neighbours, with untainted credit, she is likely to make the best of her internal resources. Bad farming has impoverished greatly some of her lands, but in others skill and capital are being wisely used. Artificial fertilisers are applied more than in any other State, and there are laws to prevent adulteration in these manures that might be adopted with advantage in England, and the manufacture of them is likely to become a great trade. Hitherto the superphosphates have been made in the northern towns from Carolina phosphates and with sulphuric acid made from imported Sicilian brimstone. But the close vicinity of these phosphates, the discovery of coprolite phosphates in Georgia itself as well as sulphur pyrites, from which sulphuric acid can be made more cheaply than from brimstone, has led to the manufacture at home of the fertilisers formerly brought from a distance.

Iron making is likely to grow up, and though competition with Alabama is hardly possible in ordinary iron, yet there are great facilities for the higher grades of charcoal iron. Rich iron ore is abundant, the pine forests afford fuel for many years to come, and a manufacturing population, and easy access to the sea for export, will probably ensure a market. Money and skill are alone wanted.

Near the town of Cartersville in Georgia may be seen to-day the ruins of smelting furnaces and rolling mills, situated on the edge of a forest by the side of a rapid river. The forest afforded an unlimited supply of charcoal fuel, and the river current gave all the power for the blast engine and the rolling mills. Were it not that the massive stone built furnace still stands as evidence of the past, one would doubt the story of this place, for the victorious northern armies, under Sherman, deeming it too valuable as a military resource, utterly destroyed it, and sent north everything of iron that the place possessed, not only the mills and the engines, but the very rails on the five-mile line of railway to the neighbouring town. The pine trees and ferns are growing up among the old foundations of the puddling furnaces and rolling mills, and in this strange medley of ruin and forest one is reminded of the unearthed relics of Mexican temples.

AMERICAN STEAM PRACTICE.

THE following tables we quote from the *Mechanical Engineer*. They are said to be collated from recent practice. The figures are of interest:—

Indicated Horse-power obtained per square foot of Grate, in recent Engineering Practice.

Vessel.	I.H.P.	Surfaces. Grate.	Surfaces. Heating.	Surfaces. Cond'ng.	Ratios. G. to H.	Ratios. Tubes to grate.	I.H.P. per sq. ft. Grate.	I.H.P. per sq. ft. Heating.	I.H.P. per sq. ft. Cond'ng.
Parisian	6020	544	13176	9624	1:27·9	—	11·06	·396	·625
Gallia	5300	538	13000	8300	1:24·9	1:4·7	9·85	·468	·638
Devastation	6637	742	17806	6710	1:24·	1:5·3	8·94	·378	·989
Mexican	3400	330	10000	5500	1:30·3	1:4·85	10·3	—	—
Inchonal..	1559	107	3800	1900	1:35·	1:4·6	12·4	·349	·698
Aberdeen	2631	252	7128	5270	1:33·	1:4·29	12·53	·370	·500
Illinois	1977	272	—	4786	—	—	7·27	—	·413
Servia	10350	1050	27000	15000	1:25·7	1:5·5	9·86	·383	·690
Arizona	6357	780	19500	12540	1:25·	—	8·08	·324	·503
Monarch..	2283	247	7803	5050	1:31·	—	9·22	·293	·456
Normandie	8006	808	21405	11682	1:26·4	—	—	—	—
Normandy	2520	195	4706	2937	1:24·1	1:6·64	—	—	—
Isle of Dorsey	618	42	1650	792	1:39·3	1:4·6	12·3	·374	·780
Lady Torfrida	1020	77	1887	1978	—	—	—	—	—
Tartar	5558	378	11606	—	1:30·7	—	—	—	—
Orestes	856	102	3570	1693	1:35·	—	—	—	—

Memorandum of Quantity of Circ. Water and Air Pump Capacity.

Vessel.	I.H.P.	Surface Condensing.	Rel. vol. A.P. to L.P.C.	Cir. water per sq. ft. cond'ng surface. Cub. ft.	Cir. water per sq. ft. cond'ng surface. Lbs. of water.
Orestes	856	1693	1:54·8	—	—
Mexican	3400	5500	1:27·5	·121	7·75
City of Richmond .	3430	10018	1:20·7	·143	8·9
Itata..	1550	3863	1:22·8	·207	12·9
Inchonal..	1559	1900	1:46·2	·142	8·9
Aberdeen	2631	5270	1:24·3	·078	4·9
Illinois	1977	4786	1:22·2	·191	11·9
Moor..	4536	5490	1:25·	·093	5·8
Normandie	8006	11682	1:20·3	—	—
Normandy	2520	2937	1:23·8	—	—
Tartar	5558	11606	1:27·2	—	—
Lady Torfrida ..	1020	1978	1:20·4	—	—
Isle of Dorsey ..	618	792	1:39·3	—	—
Boadicea..	—	14570	1:21·6	—	—
Czar	—	5708	1:30·	—	—
San Francisco ..	—	9900	1:33·	—	—
Monarch Line ..	2283	7803	1:36·4	—	—

TIMBER IN THE STRAITS SETTLEMENTS.—Mr. Howard Newton, assistant municipal engineer, of Singapore, has published a series of notes and experiments on the different kinds of timber in ordinary use in the Straits Settlements. The pamphlet contains observations on the forests adjoining our colonies in the Malay Peninsula, and the need already of conservation. The trees are felled in large numbers for ordinary use, and the jungles are cleared and exhausted by the Chinese gambia and pepper planters. Twenty specimens of woods are then described in detail, and finally an account of the mode in which the experiments were conducted and elaborate tables of the results follow. The breaking weights of some of the timbers tested were as follows:—1850 lb., 1836 lb., 1656 lb., 1374 lb., 1286 lb., and 1284 lb. Notes on the toughness, fracture, deflection, &c., are also given. It is curious to notice that some of the finest trees near Singapore—in the Johore forests—have no botanical equivalents. Mr. Newton specially mentions a tree called by the Malays the *ballow*, which grows from 60ft. to 100ft. in height, with a diameter of 3ft. to 6ft. It is a close-grained, tenacious, hard, heavy wood, very valuable for building. It is called popularly Johore teak.

TRADE GUILDS IN GERMANY.—Twenty large trade guilds in Germany have been proposed to the Federal Council for participating in the Workman's Insurance. These guilds are as follows:—(1) mining guilds, representing 1862 undertakings, with 334,589 miners; (2) printers' guilds, with 1580 undertakings and 38,482 workmen; (3) paper makers' guilds, 1149 undertakings and 42,842 workmen; (4) guilds of trades using paper, 1214 undertakings and 41,808 workmen; (5) chemical industries' guilds, 2599 undertakings and 68,298 workmen; (9) millers' guilds, 24,801 undertakings and 73,439 workmen; (7) victuallers' guilds, 1896 undertakings and 24,666 workmen; (8) beetroot sugar manufacturers' guilds, 456 undertakings and 91,517 workmen; (9) spirits, yeast, starch, and cheese makers' guilds, 5645 undertakings and 31,576 workmen; (10) distillers' guilds, 2778 undertakings and 37,399 workmen; (11) tailors' guilds, 2094 undertakings and 64,480 workmen; (12) silk weavers' guilds, 360 undertakings and 25,577 workmen; (13) leather industry guilds, 1750 undertakings and 13,136 workmen; (14) sewing machine makers' guilds, 812 undertakings and 34,152 workmen; (15) pianoforte and other musical instrument makers' guilds; 362 undertakings and 11,784 workmen; (16) glass industry guilds, 791 undertakings and 35,084 workmen; (17) bricklayers' guilds, 6203 undertakings aud 99,884 workmen; (18) potters' guilds, 666 undertakings and 42,635 workmen; (19) gas and water men's guilds, 976 undertakings and 14,394 workmen; (20) chimney sweeps' guilds, 2729 undertakings and 4403 workmen. The above figures serve to prove how large is the total number of workmen enrolled in the various trade guilds of Germany.

RAINFALL AND DESICCATION IN SOUTH AFRICA.—Mr. Gamble, the Colonial (South Africa) Hydraulic Engineer, in his official report prepared for the late Parliament, thus refers to the subject of desiccation, on which, from his varied experience, he is entitled to speak with some authority. "I have been investigating," he says, "old records and books of travel with the view of endeavouring to discover how far the statement is true that South Africa is drying up. There is little doubt that many springs and streams are not so constant as they used to be, but is the cause of this a deficient rainfall, or some failure of the rain to reach the underground strata from whence the springs are fed? Rainfall records do not reach back very far: the longest register is that kept at the Royal Observatory for forty-five years. This shows no falling off of rainfall in this neighbourhood. Travellers seventy and a hundred years ago described the Karroo and its droughts in much the same terms as we do now; I cannot believe that any considerable climatic change has taken place in historic times. But I have no hesitation in saying that the reckless cutting down of bush and trees both by natives and by white men, as well as the burning of bush and grass so extensively practised, has prevented the rainwater from sinking in to feed the springs. I have seen numbers of places that used to be 'riet vleys' in the memory of man, and were in that condition suitable for feeding springs, which are now bare 'vloors' intersected by deep gullies. Of these the rainwater flows without sinking in. Over-stocking leads to the same result. The only remedies are fencing and planting on an extensive scale, and, where practicable, the making of artificial lakes."

A GREAT SUGAR FACTORY.

AT this epoch in the history of the colony of Georgetown, when we hear so much of hard times and scarcity of work for willing hands to do, he that obtains permission from the attorney of Plantation Diamond to visit that magnificent estate—to which in future the appellation "Great" will be much more appropriate than when it was merely used to distinguish Great Diamond from Little Diamond—and acquaint himself by personal observation with the extensive alterations and improvements now in progress there, may account himself fortunate. If he travel by the river steamer and land at the stelling, he will find it a rather ricketty structure. But it has seen better days. In times by-gone large vessels used to lie alongside to deliver cargo and load produce for Liverpool. In those days the estate's supplies and produce were conveyed over a line of rails running from the end of the stelling right into the sugar store. The line of rails still exists, but is no longer used for that purpose, having been superseded by a spacious water-way, which not only facilitates transport and saves the cost of a second handling of the goods, but, by a judicious arrangement of locks and sluices, greatly facilitates drainage also. A visitor landing at the stelling can hardly fail to observe a large sawpit, with a couple of frame saws at work. Here, we are told, the whole of the timber used in the construction of the new buildings—at which we shall presently arrive—were sawn to the exact dimensions required, ready for the carpenters to place in position, thus saving an immense amount of labour in transport and re-handling. And here, perhaps, we may be allowed to diverge from the main line of our purpose in order to observe that these questions of transport and drainage are of more importance than many people imagine. The difference in these respects between a riverine and a coast estate is a rental in itself. While, at Diamond for instance, the cost of inland transport and drainage may be represented by (—); on coast estates, especially where the buildings are "far back"—as at Industry, La Bonne Intention, and Enmore—it must be enormous. At Diamond the sea-punts now pass directly into the dock at the works, and we are informed that as many as ten heavily laden barges have been passed in, unladen, and passed out to the river, in a single day. Such, moreover, is the security which the system affords, that of the thirteen hundred and odd tons of machinery and ironwork for the new buildings shipped from Glasgow not a bolt was lost. A further advantage of the system is that the wood-cutters are able to deliver their cordwood right at the furnace mouth, thereby obviating all re-handling. The manager, Mr. Fleming, says the cost of the locks and sluices, and of the iron lifting bridge across the public road, to enable the cane punts to pass direct to the buildings, has already been more than recouped by the saving of labour alone. Small cane growers also in the neighbouring villages will be able to deliver their canes direct from their bateaux into the cane carrier—an advantage which ought to afford an additional incentive to our peasant proprietors to engage in the cultivation of the main staple of the colony. These considerations have, no doubt, influenced Messrs. Sandbach, Tinne, and Co. in so largely increasing their investments in riverine estates. But we have not yet exhausted, or, indeed, touched upon, many of the advantages which Diamond, as the centre of a populous district, possesses. Among other unconsidered trifles, when the construction of the new river dam and the locks and sluices was decided upon, has been the extinction of the mangrove swamp which formerly intervened between the residential portion of the estate and the river. The land is now empoldered right down to the river edge, and we are informed that the change has been a very beneficial effect upon the health of those resident on the estate, for, although the saline swamp lay to leeward of the hospital and dwellings, the malaria arising from it extended beyond the area of the marsh itself.

With the exception of a very fine hospital, and a highly superior overseers' house, the casual visitor to Diamond will at the first blush see little to admire; for even the new buildings are as plain externally as dissenting meeting-houses used to be before the modern rage for æsthetics arose. The residences of the manager and deputy manager pertain to a former period, while the coolie ranges and labourers' cottages are huddled together without regard to symmetrical, or even picturesque, arrangement. They might have been tossed out of the car of a mammoth balloon, and allowed to remain as they fell. A traveller from town on the public road, after passing the hospital, the overseers' and the managers' houses, will find on his left-hand the old sugar works, now in process of demolition, and may, if he be so minded, take note of their chaotic character. It is said to be impossible for a stranger, once entangled in the maze, to extricate himself unless he is provided with a pocket compass. How it was possible to turn out of such a labyrinth the large output of excellent sugar for which Diamond has long been celebrated is a mechanical mystery which, when what remains of the structure is razed to the ground, it will be impossible to solve. If room for the relics can be found in the Colonial Museum, they ought to be preserved. It is recorded that the late Mr. Henry Clementson, on being conducted over the works by Mr. Field, after having duly admired the perfection of the organisation and the admirable manner in which the work was done, observed to his cicerone that to make the establishment perfect only one thing was wanting. "And what is that?" queried Mr. Field. A fire was the laconic and caustic reply.

A few yards eastward of the old works stand the new. As already intimated, they are as unpretentious in appearance as people of consequence usually are in demeanour, and in no way calculated to attract attention, except by their extent. But if the typical stranger cross the trench and enter at the doorway in the northern end, he will observe what will "give him pause." The *coup-d'œil* is simply—there is no other word sufficiently expressive—dumbfoundering. A roof 330ft. in length, with a span of 60ft., supported by five rows of iron columns 34ft. high, covers an area of 19,800 superficial, filled, but not crowded, by machines of the most diverse forms and complex structure, erected at different altitudes. Yet so symmetrical is the arrangement, so perfect the harmony, that no sense of incongruity or weirdness—the indefinite but unpleasant half-consciousness of something abnormal, if not demoniacal, or at least Titanic, which so often oppresses those unaccustomed to such spectacles—is excited. If, as Pope says, "Order is Heaven's first law," the designer ought to be, or to become an hierarch among celestialised architects and mechanicians. On the northern front and on the eastern and southern side—the weather frontages—the building is sheathed, as the roof is covered with galvanised iron; the western side, *i.e.*, the leeward face of the building, is open. The floor is of concrete throughout. Longitudinally the building is nominally divided—though no actual partition exists—into two sections, the mill-house and the sugar house, the former 90ft., the latter 240ft. in length. On the windward side the mill-house has a lean-to 12ft. wide, and at the opposite end a lean-to 45ft. wide covering the sugar store, which is 105ft. long. At the northern end of the western side there is a lean-to 35ft. wide covering the boilers. The mill-house is 34ft. high to the shoes of the roof, and the sugar house 26ft.

In the mill-house a new side gap mill by Mirrlees, Watson, and Co., of Glasgow, who have supplied all the new machinery and also all the ironwork for the buildings, of the ordinary three-roller type, has been erected; and what is called the old mill, *i.e.*, the mill used in the old buildings before they were dismantled, is now in process of erection. The new mill is of great size and power, the rollers being 34in. in diameter and 78in. in length. It is driven by a horizontal reversing engine, the cylinder being 28in. in diameter and 48in. stroke. The diameter of the fly-wheel is 16ft. 4in., and its weight 15 tons. The weight of the mill without the engine and gearing is 56 tons. The handling of these immense weights has been greatly facilitated by a travelling crane of great strength, extending across the entire width of the mill-house, and mounted on a railway running the whole length of the mill-house, and supported by iron columns. The old mill is by Forrester, of Liverpool. It also is of the three-roller type; the rollers being 32in. in diameter and 66in. in length, and is driven by a six-column beam engine, the diameter of the cylinder being 26in., and the stroke 4ft. 6in. Adjoining the mill-house is a spacious dock, capable of accommodating a large number of reserve punts, into which the cane carrier projects. The megass from both mills will be carried up to an overhead railway and deposited on the firing stage, the furnaces being adapted for burning green megass. There are six steel multitubular boilers 7ft. 6in. in diameter, 12ft. long, intended to be heated by megass, and one Lancashire boiler to be heated by coal. Other coal boilers will be erected, but only one is yet in position. The boilers are intended to be worked at a pressure of 75 lb. to the square inch, and have been tested up to 150 lb. Each has 23ft. of grate surface.

On leaving the mill, the cane juice will pass first into the sulphur box, where it will be treated with sulphurous acid gas, and then be pumped up through a juice heater to clarifiers. The plunger of the liquor pump is of 15in. diameter, and the stroke can be adjusted to either 14in., 16in., or 18in. There is a montejus into which the juice heater and pipes can be drained. There are twelve 800-gallon clarifiers, the scum from which goes into a large gutter leading to the scum tanks; the juice into another gutter, leading either to the subsiders or the triple effet supply tanks, each holding 5000 gallons. If white sugar is being made, it will go to the subsiders; if grey sugar, direct to the triple effet, without subsiding. From the subsiders the juice will pass along another gutter to the triple effet. The scum from the clarifiers goes down to the scum tanks, whence it is pumped up to the filter presses, which are of the description known as centre screw. There is a battery of eight. From the filter presses the juice goes to the triple effet.

It may be mentioned that all the gutters in the building are of cast iron and are lined with enamel—a great safeguard against acidity. The triple effet consists of three pans, each 9ft. 3in. in diameter—by far the largest in the colony—giving 9600 square feet of heating surface, 3200 in each pan. And there are isolating valves, by means of which any one or any two of the pans can be shut off, and the other or others used as either a double or single effet. In fact this kind of arrangement extends throughout the entire works. In the event of an accident anywhere, the part of the works affected can be shut off instantaneously; either mill, the triple effet, the vacuum pans, or either of them, can be isolated, and the remainder be worked independently.

The vacuum pump for exhausting the triple effet has a plunger of 30in. diameter and 30in. stroke. The steam cylinder is of 24in. diameter. From the triple effet the juice is taken—by a pump attached to the vacuum pans—to four re-heaters, where it is brought to the boiling point, and any scum that may rise is taken off. From the reheaters the syrup passes either direct to the vacuum pan supply tank, or if it require further subsidence, to the subsiders, and, after subsidence, thence to the vacuum pans. There are two pans of 9ft. 6in. diameter, each capable of delivering ten tons at a strike, and two vacuum pumps of 24in. diameter and 24in. stroke, cylinder 16in. diameter; and by means of sluice valves either pan can be worked with either pump, or both pans with one pump. The pans are of iron. In each pan there are 670ft. of 4in. worm. From the vacuum pans the *masse cuite* is discharged into cooler trucks. There are twenty trucks for *masse cuite*, each holding enough to make three tons of dry sugar. There are six 30in. Weston's centrifugals, with the pug mills peculiar to Demerara. A travelling band under the centrifugals carries the sugar into the hopper of the elevator, and the elevator carries it up into the sugar store. The engine to drive the centrifugals has a cylinder 12in. in diameter, and a stroke of 24in.

There are three independent pumps for feeding the boilers, each of which can draw water either from the navigation trenches or from the hot water tank, which receives the condensed water from triple effet, vacuum pans, &c., and deliver either to the boilers or to the elevated tank holding 15,000 gallons, which supplies water to pipes which convey it to every part of the building at which it can possibly be required. The taps are so arranged that no water-carrying will be required; everything can be washed down by simply turning a handle. The boilers can also be filled by gravitation from the elevated bank without using the pumps. Below the elevated water tank is another large tank—9600 gallons—for storing molasses. From this tank the molasses can go either to the molasses reheaters, and thence to the vacuum pan supply tanks, to make molasses sugar or direct to the distillery.

The chimney is 132ft. high, from the top of the footings, and of 5ft. bore; and the boiler flue is a very massive piece of work. The foundations of the building consist of transverse baulks of greenheart, overlaid with concrete; 30,000 cubic feet of timber were used in the foundations. There are 23,000 square feet of concrete flooring, in the construction of which and of the brickwork a thousand barrels of cement and 300 puns. of lime were used. In the chimney, boiler flue, and other brickwork, 850,000 bricks are embedded. The total weight of the ironwork in the building—including machinery—exceeds 1300 tons. These figures will afford a slight, though probably an inadequate, idea of the substantiality of the work.

The distillery, which is in very good preservation, is retained, and the intention is to work the department entirely on its own merits. The molasses tank is at a sufficient elevation to allow the molasses to gravitate to the distillery.

At present there is no provision for maceration or double crushing, Mr. Russell being of opinion that, with sugar at present prices, it will not pay to spend money to extract the last drop of juice from the cane. For the first grinding, therefore, single crushing only will be had recourse to.

Plans of the new works were, of course, prepared by the engineers here—Mr. Robert Dodds, consulting, the late Mr. Taylor, resident, and other engineers in the colony; and most people will be inclined to give credit to Mr. Russell for a considerable share in the work. But in the hands of Messrs. Mirrlees, Watson, and Co., the original designs were considerably amplified, and every appliance for improving the process of manufacture and saving labour which the great experience of that eminent firm enabled them to suggest was introduced. Work in the colony was commenced on 27th April last year, and the new navigation arrangements were completed just in time to receive the first shipment of machinery which arrived. Since then the weekly expenditure for labour alone in connection with the works has exceeded 1000 dols., the total amount of what is called the "expense account," to date, being 216,000 dols. This includes Messrs. Mirrlees, Watson, and Co.'s account for the machinery, £28,800 sterling; and adding cost of labour, say 56,000 dols., the total expenditure in round numbers is 270,000 dols., which, it is expected, will be increased to 280,000 dols. before the work is finished. But even that sum by no means represents the total amount of the extraordinary expenditure which has been incurred on pln. Diamond during the last twelve or eighteen months. While the works have been in progress the field hands have not been idle. Golden Grove had to be connected by aqueducts, and drainage and navigable canals improved, preparatory to the extended cane culture that would be required to provide provender for the new works. And already a large area of smiling canefields has taken the place of swamp and jungle. But, while the main product has had due attention, the small industries have not been neglected. Along the public road leading to Craig Village there are continuous lines of cottages, delightful in the variety of architecture they present. And around these cottages are gleeful groups of chubby children, of every race of which the very-much-mixed community of British Guiana is built up; and well-kept gardens, with out-fields of plantains, suggestive of Barbadoes rather than of Demerara. A new empolder has been taken up, the greater part covered with a luxuriant growth of dark green plantains, a heavy crop of maize having just been gathered, giving every token of a prosperous and contented peasantry. Gangs of labourers are now at work on the construction of dams with a view of extending farming operations right through the Lamaha Canal, which is now the eastern boundary of Sandbach, Tinne, and Co.'s magnificent block of East Bank Estates; and, judging by present appearances, the whole will soon be a waving plain of the Demerara staff of life. Behind Grove the land is already empoldered as far back as Farm and Diamond waterpath. With all this evidence before us of united action and concentrated effort and energy on the part of the estate's authorities—backed, of course, by the absentee's capital, the investment of which is another name for faith in the colony—and the resident population, we could not help asking why the farmers had thrown their energies so fully into the cultivation of the estate's land, while equally fertile land in Craig Village lies neglected, a veritable swamp. The answer was: "The same law is at work as in the case of Sandbach, Tinne, and Co.'s faith. The farmers, feeling that they have a just landlord, who has dealt with them on the live-and-let-live principle in the past, and, knowing that their tenure is secure, willingly put forth their energies; and we see the results in manifest prosperity and contentment." We may add, however, that while efficient drainage and an abundant supply of pure water is provided for them, the cultivators have no roads to maintain, no dams or water-courses to keep in order, nor any village rates to pay. The "Governor Irving Tax" of 2 per cent. does not affect them.

The ride round Grove, up the old Diamond waterpath, through some primeval woods, is very pleasant; there are so many natural curiosities to arrest the attention. Ferns of many forms, calladiums, palms of endless variety, handsome creepers and drooping vines, all combine in a picture which for beauteous forms and richness of colour it would be hard to surpass. When we reach Prospect, the northern boundary of Diamond proper, the far-famed cane-fields of Farm lie spread out before us. Even now, at the end of a protracted drought, they look fresh and vigorous. We confess that when first told that the pearl of Demerara sugar estates had changed hands, and become the property of the proprietors of Diamond, we could not help heaving a sigh of regret; for however much such gigantic works as those we have been describing may aid the cane-sugar people in their contest with beet, it is impossible not to regret the disappearance from the bead-roll of the colony of resident proprietors of the stamp of those who made Farm famous, and whose names have become household words throughout the colony.

In those who like to look upon something more picturesque than a broad expanse of flat cane fields, the felling of the grand old fathers of the forests, such as we see falling before the woodman's axe and hear crashing through the undergrowth, causing mother earth to quake as if with fear or shiver with regret, may induce a feeling of sadness. But while there are hungry mouths to fill and bare backs to cover, wailing, puling babes to pacify, and yearning mothers to comfort and console, suffering to relieve, and the gaunt spectre want to banish from the land, we must consent to sacrifice the beautiful to the beatific, subordinate the merely ornamental to that which is of real practical utility, and honour those who, endowed with energy, capital and faith, let fall the golden rain, the real cornucopia, or emblem of abundance from which comfort, contentment, and happiness—unmistakeable indications of which are often now to be found on Diamond—flow in no niggard stream. The hard times of which we hear so much in town, and from other parts of the colony, have not spread to the Sandbach section of the East Bank of the Demerara river; and no wonder, for, besides the 1000 dols. a week spent on labour in connection with the new works, during the last twelve months fully 600 dols. a week have been expended in empoldering new land and other field work, independent of the ordinary work of the estate; thus raising the hebdomadal sum disbursed in wages to more than 3000 dols., instead of 1500 dols.—the average amount before the new works and consequent reclamation of land were undertaken. The resident population of the estate, including women and children, is about 1800; but during the last year it has been found necessary to supplement the local labour power by employing gangs of men from the neighbouring villages, and even from town. Many of the porters, bricklayer's labourers, "tradesmen" so-called, and men of that class, who have been employed, reside in Georgetown, and not a few are said to have walked to and fro daily. When the long-looked-for rains come down in their might, and there is sufficient water in the navigation trenches to float laden punts, the big works will be set in motion, and we hope then to have an opportunity of improving our acquaintance with the *modus operandi* of sugar making on a large scale, with the aid of the most perfect appliances which science and art combined have yet been able to produce.

We ought to have mentioned at an earlier stage of this rambling and, we fear, somewhat incoherent narrative, that the erection of the buildings and machinery was effected mainly under the immediate personal superintendence of Mr. Taylor, a gentleman of considerable experience, who unfortunately succumbed in February last to an attack of malarial fever, after ten months' unremitting labour. To him, his successor, Mr. Berthon (from Mirrlees, Watson, and Co.'s), assigns all the credit for the successful accomplishment of the work, averring that when he arrived all the more important parts of the work were substantially complete. But the statement must not be accepted too literally; for, as we have said, the old mill is now only in process of re-erection, and a great deal has been done during the last month or six weeks, it being necessary to have the new machinery ready to start when the periodical rains set in. They are now ready to begin at a moment's notice, though a good deal of ornamental work, such as the padding and lagging of the triple effet and vacuum pans, painting, &c., remains to be done. The manager, Mr. Fleming, and Mr. Dodds, the consulting engineer, must have had an arduous and anxious time of it, especially in the absence of Mr. Russell, who at such work is *facile princeps*. All deserve hearty congratulations on the success which has crowned their efforts. *Omnia vincit labor.*—*The Argosy, Demerara.*

WAVE MOTIONS.

The ships of the United States Navy have been engaged for some time in making observations of the dimensions and speed of deep-sea waves. These recorded observations are not so complete and numerous as is desired, and any assistance in this respect will do much to advance one important branch of the science of naval architecture. The observations made where a ship falls in with a single series of approximately regular waves are most valuable, and should be accompanied by full records of the attendant circumstances.

One method of measuring the wave lengths consists in towing a log line astern of a ship and noting the length of line when the chip floats on the wave crest next abaft that on which the stern of the ship momentarily floats. The ship should be head-on, or allowance made for the departure of the log line from the head on position. To measure the wave heights, when the ship is in the trough of the sea, and for an instant upright, the observer takes up a position such that the successive average wave ridges, as viewed by him from the trough, just reach the line of the horizon without obscuring it. The height of the eye above the water level correctly measures the height of the waves. To measure very high waves the observer may have to ascend the rigging, while for waves of less height a station on one of the decks may suffice, or some temporary expedient devised for placing the observer near the water level. It is desirable to select a position as nearly amidships as possible, but if it becomes necessary to take a station near the bow or stern, allowance must be made in estimating the height of the eye above water for the deeper immersion which may be caused at the instant by pitching.

The longest recorded wave measured a-half a mile from crest to crest, with a period of twenty-three seconds. Waves having a length of 500ft. or 600ft., and periods of ten to eleven seconds, are the ordinary storm waves of the North Atlantic. In regard to the heights of waves, the most trustworthy measurements show from 44ft. to 48ft. to be a remarkable height. Waves having a greater height than 30ft. are not commonly encountered. The Hydrographic Office has blank forms for recording these observations, and would be glad to furnish them to any shipmaster who takes sufficient interest in the subject to make observations whenever the opportunity occurs.

TRIAL OF A PAIR OF HORIZONTAL COMPOUND TANDEM ENGINES.

(*Concluded from page 37.*)

Efficiency.—The next question to be considered is that of the efficiency of the engines; and this is easily ascertained. The actual quantities of heat supplied by the boilers and converted into useful work are given in line 4 of Table IV., and line 17 of Table V. The quotient of the second divided by the first gives the ratio of heat utilised to heat supplied. Thus actual efficiency = $\frac{\text{heat utilised}}{\text{heat supplied}}$. The efficiency of a perfect heat engine—that is, one in which all the heat is supplied at the highest temperature and discharged at the lowest—is the quotient of the difference of the two temperatures, or the range of temperature, divided by the higher in degrees Fahrenheit plus 461, the zero of Fahrenheit's thermometer being 461 degrees above the point of absolute cold or zero. Denoting the highest and lowest temperatures, viz., those of the boilers and condenser, by t_1 and t_2 deg. Fah., the efficiency of a perfect engine would be $\frac{t_1 - t_2}{t_1 + 461}$. This, though less than 1, is the best result that is theoretically possible, and is therefore the proper standard to which the actual performance should be compared. The values of t_1 and t_2 are given in lines 75 and 76 of Table VIII. at the end. The efficiency relatively to that of a perfect engine working between the same limits of temperature is therefore = $\frac{\text{actual efficiency}}{\text{efficiency of perfect engine}}$. The figures expressing these efficiencies are given below for each cylinder separately, and for both conjointly. In the case of the non-condensing cylinders the lower limit of temperature is, of course, the temperature of the receiver, which is also the higher limit for the condensing cylinders.

TABLE VII.

	Efficiencies.	Fri., June 13, 1884.	Wed., June 18, 1884.
1	Absolute, small cylinders	·052	·073
2	,, large ,, ...	·061	·035
3	,, both ,, ...	·121	·109
4	Of a perfect engine, small cylinders..	·084	·168
5	,, ,, large ,, ...	·213	·135
6	,, ,, both ,, ...	·280	·281
7	Relative, small cylinders	·619	·446
8	,, large ,, ...	·282	·260
9	,, both ,, ...	·431	·388

This temperature was not observed, but it is assumed to be between the exhaust temperature in the small cylinders and the admission temperature in the large. Thus we see that on Friday only 12 per cent., and on Wednesday 11 per cent., of the heat supplied was utilised, or 43 and 39 per cent. of what might have been utilised had there been no condensation in the cylinders and no back pressure. The writer has often wondered whether a material of low conductivity and heat absorbing power—possibly toughened glass—might not be substituted for iron in the construction of the cylinders of steam engines. That so large a proportion of the heat that might be utilised—for to utilise the whole is a physical impossibility—should be wasted to a great extent for want of a proper material for the cylinders, seems hardly creditable to modern science, when the vast extent of the steam power of civilised nations is considered.

The boilers.—Though not less important than the engines, the performance of the boilers cannot be criticised with the same detail, owing to the absence of the necessary data, particularly the quantity of air admitted, and the temperatures in the furnaces and chimney. A boiler, being a heat machine, is subject to the same law as an engine, the efficiency of a perfect generator being again expressed by the fraction $\frac{t_1 - t_2}{t_1 + 461}$, where t_1 and t_2 are the temperatures which would be produced in the furnace and chimney by perfect combustion without excess of air. The actual efficiency, however, can be calculated by dividing the number of thermal units transmitted to the water by the calorific value of the fuel which evaporates it. As in the case of the engines, it is expressed by the fraction $\frac{\text{heat utilised}}{\text{heat supplied}}$, remembering that by heat supplied we mean, not the actual heat developed in the furnaces—for we have no means of ascertaining this—but the potential heat of the fuel, or its calorific value. On this basis the efficiency of the boiler appears to have been 0·599 on the Friday and 0·555 on the Wednesday. We cannot make similar calculations for the economiser, because we do not know the quantity of heat supplied to it, owing to the waste gases from four boilers, besides those used for the trials, passing through it. The figures relating to the evaporation, as well as the data from which they were calculated, are given in Table IX. at the end.

TABLE VIII.—SUMMARY.

	Engines.	Fri., June 13.	Wed., June 18.
1	Diameter of cylinders, small .. .. in.	26	20
2	,, ,, large .. .. ,,	52	52
3	Stroke of pistons .. .. ft.	6	6
4	Diameter of piston rods, small cylinders, front in.	6	6
5	,, ,, ,, ,, back ,,	5	5
6	,, ,, large ,, front ,,	5	5
7	,, ,, ,, ,, back ,,	0	0
	Volumes:		
8	Small cylinders, combined vol. excluding clearance.. .. ..c.ft.	42·248	42·248
9	Small cylinders, volume cut off, excluding clearance.. .. .. ,,	10·178	10·093
10	Small cylinders, volume cut off + $\frac{1}{9}$ remainder clearance.. .. .. ,,	13·741	13·666
11	Small cylinders, volume cut off + $\frac{2}{9}$ remainder clearance.. .. .. ,,	17·305	17·238
12	Small cylinders, volume cut off + $\frac{3}{9}$ remainder clearance.. .. .. ,,	20·868	20·811
13	Small cylinders, volume cut off + $\frac{5}{9}$ remainder clearance.. .. .. ,,	27·995	27·957
14	Small cylinders, volume compressed clearance ,,	6·080	6·080
15	Small cylinders, volume clearance mean of both ends .. .. ,,	2·440	2·440
16	Space between cylinders .. .. ,,	130·000	130·000
17	Large cylinders, combined vol. excluding clearance.. .. .. ,,	176·160	176·160
18	Large cylinders, volume cut off .. .. ,,	34·430	118·550
19	Large cylinders, volume cut off + $\frac{1}{9}$ remainder clearance.. .. .. ,,	50·178	—
20	Large cylinders, volume cut off + $\frac{2}{9}$ remainder clearance.. .. .. ,,	65·926	—
21	Large cylinders, volume cut off + $\frac{3}{9}$ remainder clearance.. .. .. ,,	81·674	—
22	Large cylinders, volume cut off + $\frac{5}{9}$ remainder clearance.. .. .. ,,	113·170	—
23	Large cylinders, volume compressed clearance ,,	19·387	19·387
24	Large cylinders, volume clearance mean of both ends .. .. ,,	8·84	8·84
25	Relative volumes of cylinders .. .. ,,	1:3·99	1:3·99
26	Duration of experiment .. .. min.	497	497
27	Number of revolutions per minute	36·8	36·9
28	Duration of admission, small cylinder, fraction of stroke..	0·2409	0·2389
29	Duration of compression, small cylinder, fraction of stroke..	0·144	0·144
30	Duration of admission, large cylinder, fraction of stroke..	0·1954	0·6730
31	Duration of compression, large cylinder, fraction of stroke..	0·110	0·110
32	Total ratio of expansion	1:14·66	1:14·68
33	Value of γ in PV^{γ} C, = small cylinders	0·954	1·041
34	,, ,, ,, large ,, ...	0·945	0·994

	Engines.		Fri., June 13.	Wed., June 18.
	Absolute pressures:			
35	Of atmosphere	lbs. per sq. in.	14·58	14·66
36	,, steam in boilers	,, ,,	101·38	101·96
37	Small cylinders at end of admission..	,, ,,	91·87	91·22
38	,, ,, $\frac{1}{9}$ of expansion ..	,, ,,	67·95	66·10
39	,, ,, ,, ..	,, ,,	55·40	53·18
40	,, ,, ,, ..	,, ,,	46·81	44·62
41	,, ,, ,, ..	,, ,,	36·34	33·82
42	,, ,, end ,, ..	,, ,,	27·34	24·27
43	,, ,, ,, of expulsion ..	,, ,,	22·33	11·50
44	,, ,, ,, of compression	,, ,,	63·13	38·66
45	Large cylinders at end of admission..	,, ,,	18·93	7·97
46	,, ,, $\frac{1}{9}$ of expansion ..	,, ,,	12·65	—
47	,, ,, ,, ..	,, ,,	10·08	—
48	,, ,, ,, ..	,, ,,	8·49	—
49	,, ,, ,, ..	,, ,,	6·65	—
50	,, ,, end ,, ..	,, ,,	4·79	5·50
51	,, ,, ,, of expulsion ..	,, ,,	2·28	2·42
52	,, ,, ,, of compression	,, ,,	5·38	5·12
	Mean absolute pressures:			
53	Small cylinder, during admission ..	,, ,,	94·78	94·25
54	,, ,, ,, 1st 9th of expansion	,, ,,	78·66	77·66
55	,, ,, ,, 2nd ,,	,, ,,	62·43	61·55
56	,, ,, ,, 3rd ,,	,, ,,	50·11	47·91
57	,, ,, ,, 4th & 5th ,,	,, ,,	41·70	39·44
58	,, ,, ,, whole expansion	,, ,,	44·72	42·48
59	,, ,, ,, expulsion ..	,, ,,	22·80	11·52
60	,, ,, ,, compression..	,, ,,	33·23	18·60
61	Large cylinder, ,, admission ..	,, ,,	20·38	8·22
62	,, ,, ,, 1st 9th of expansion	,, ,,	15·00	—
63	,, ,, ,, 2nd ,,	,, ,,	11·39	—
64	,, ,, ,, 3rd ,,	,, ,,	10·22	—
65	,, ,, ,, 4th & 5th ,,	,, ,,	6·90	—
66	,, ,, ,, whole expansion	,, ,,	7·92	6·49
67	,, ,, ,, expulsion ..	,, ,,	2·38	2·51
68	,, ,, ,, compression..	,, ,,	2·96	2·99
69	Small cylinder, during whole stroke..	,, ,,	56·78	54·85
70	Large ,, ,, ,, ..	,, ,,	10·36	7·57
	Mean effective pressures:			
71	Small cylinder, during whole stroke..	,, ,,	32·47	42·47
72	Large ,, ,, ,, ..	,, ,,	7·91	5·01
73	Temperature of engine-room	deg. Fah.	88	89
74	,, injection	,,	79·6	77·5
75	,, ejection	,,	106·6	106·8
76	,, steam in boilers ..	,,	328·65	329·00
77	Total water through engines	lbs.	131098	141790
78	Dry saturated steam per stroke	,,	3·4765	3·7497
79	Priming water ,, ...	,,	0·1075	0·1160
80	Total weight of mixture ,, ...	,,	3·5840	3·8657
	WORK DONE.			
81	Indicated horse-power, small cyl.	I.H.P.	440·91	578·04
82	,, ,, large ,, ...	,,	447·44	284·30
83	,, ,, both ,, ...	,,	888·35	862·34
84	Total horse-power	T.H.P.	957·59	934·89
85	Ratio indicated to total horse-power..		0·928	0·922
86	Absolute work per stroke, small cyl ..	th. un.	447·45	432·16
87	,, during admission, sm. cyl.	,,	180·00	177·38
88	,, ,, 1st ninth of expansion	,,	52·73	51·76
89	,, ,, 2nd ,,	,,	41·50	41·15
90	,, ,, 3rd ,,	,,	33·29	31·93
91	,, ,, 4th & 5th ,,	,,	55·68	52·57
92	,, ,, whole expansion ..	,,	267·45	254·78
93	,, ,, expulsion	,,	153·89	76·39
94	,, ,, compression	,,	37·68	21·09
95	,, per stroke, large cyl... ..	,,	340·42	248·74
96	,, during admission, l'ge cyl.	,,	130·89	181·75
97	,, ,, 1st ninth of expansion	,,	44·67	—
98	,, ,, 2nd ,,	,,	33·43	—
99	,, ,, 3rd ,,	,,	30·02	—
100	,, ,, 4th & 5th ,,	,,	39·25	—
101	,, ,, whole expansion ..	,,	209·53	66·99
102	,, ,, expulsion	,,	69·81	73·31
103	,, ,, compression	,,	10·70	10·81
104	Effective work per stroke, small cylinders	,,	255·88	334·68
105	,, ,, large ,,	,,	259·91	164·62
	CONSUMPTION.			
106	Feed-water per I.H.P. per hour..	lbs.	17·82	19·86
107	,, ,, T.H.P. ,, ...	,,	16·53	18·31
108	Dry saturated steam per I.H.P. per hour ..	,,	17·29	19·15
109	,, ,, T.H.P. ,, ..	,,	16·04	17·66
110	Fuel per I.H.P. per hour	,,	1·69	2·05
111	Pure combustible per I.H.P. per hour	,,	1·59	1·86
112	Fuel per I.H.P., supposing feed to boilers to be at 250 deg.		1·78	2·15
	ACTION OF METAL, SMALL CYLINDERS.			
113	Internal heat of steam left from previous stroke	th. un.	539·11	284·18
114	Absolute work of compression	,,	37·68	21·09
115	Total	,,	576·79	305·27
116	Internal heat of mixture at end of compression	,,	453·65	268·96
117	Heat absorbed by metal during compression	,,	123·14	36·31
118	Internal heat of mixture compressed in clearances	,,	453·65	268·96
119	Heat received from boilers per stroke ..	,,	4256·51	4591·94
120	Total	,,	4710·16	4860·90
121	Internal heat of mixture at end of admission	,,	3508·72	3510·33
122	Heat available for work of admission ..	,,	120·144	1350·57
123	Absolute work of admission	,,	180·00	177·38
124	Heat absorbed by metal during admission	,,	1021·44	1173·19
125	Internal heat of mixture at end of admission	,,	3508·72	3510·33
126	Internal heat of mixture at end of expansion	,,	3684·40	3396·90
127	Increase of internal heat during expansion	,,	175·68	–113·43
128	Absolute work of expansion	,,	267·45	254·78
129	Heat given out by metal during expansion	,,	443·13	141·35
130	Total heat available for work of expansion—(117 + 124 – 127)	,,	968·90	1322·93
131	Absolute work of expansion	,,	267·45	254·78
132	Heat given up by metal during expulsion—Exhaust waste	,,	701·45	1068·15
	ACTION OF METAL, LARGE CYLINDERS.			
133	Internal heat of steam left from previous stroke	,,	202·82	215·21
134	Absolute work of compression	,,	10·70	10·81
135	Total	,,	213·52	226·02
136	Internal heat of mixture at end of compression	,,	152·56	148·46
137	Heat absorbed during compression	,,	60·96	77·56
138	Internal heat of mixture compressed in clearances	,,	152·56	148·46
139	Heat received from small cylinder—(126 + 132 – 113)	,,	3846·74	4180·87
140	Total	,,	3999·30	4329·33
141	Work of expulsion from small cylinders..	,,	153·89	76·39
142	Total	,,	4153·19	4405·72
143	Internal heat of mixture at end of admission	,,	2711·32	3219·92
144	Heat available for work of admission ..	th. un.	1441·87	1185·80
145	Absolute work of admission	,,	130·89	181·75
146	Heat absorbed by metal during admission	,,	1310·98	1004·05
147	Internal heat of mixture at end of admission	,,	2711·32	3219·92
148	Internal heat of mixture at end of expansion	,,	2888·43	3244·12
149	Increase of internal heat during expansion	,,	177·11	24·20
150	Absolute work of the expansion	,,	209·53	66·99
151	Heat given out by metal during expansion	,,	386·64	91·19
152	Heat available for work of expansion—(137 + 146 – 149)	,,	1194·83	1057·41
153	Absolute work of expansion	,,	209·53	66·99
154	Heat given up by metal during expulsion—Exhaust waste	,,	985·30	990·42

TABLE IX.—SUMMARY.

	Boilers.		Fri., June 13.	Wed., June 18.
1	No. of boilers, 30ft. by 7ft.		3	3
2	Grate surface	sq. ft.	99	99
3	Heating surface, internal flues	,,	1281	1281
4	,, conical tubes	,,	173	173
5	,, side flues, external	,,	867	867
6	,, bottom ,, ...	,,	309	309
7	,, total in boilers	,,	2630	2630
8	,, economiser	,,	5760	5760
9	,, total	,,	8390	8390
10	Average boiler pressure..	lb. per sq. in.	86·8	87·3
11	Temperature of feed to economiser ..	deg. Fah.	97·12	78·80
12	,, ,, boilers	,,	298·2	292·9
13	,, of steam produced.. ..	,,	328·6	329·0
14	Total weight of fuel used	lbs.	12708	14930
15	,, to replace ashes drawn out at dinner time	,,	236	252
16	Net weight used while working..	,,	12452	14678
17	Weight of ashes produced	,,	1017	1610
18	Calorific value of fuel per lb.	th. un.	15349	15349
19	Weight of water fed into boilers..	lbs.	131908	142631
20	,, fuel burnt per sq. ft. of grate per hour..	,,	15·19	17·91
21	Weight of fuel burnt per sq. ft. of boiler heating surface	,,	0·572	0·674
22	Weight of water evaporated per lb. fuel from temperatures in line 12 at those in line 13 per lb. fuel	,,	10·59	9·72
23	Do. do. per lb. pure combustible ..	,,	11·29	10·71
24	Equivalent evaporation from and at 212 deg., supposing dry steam to be produced, per lb. fuel	,,	9·72	8·97
25	Do. do. per lb. pure combustible ..	,,	10·36	9·88
26	Water evaporated per sq. ft. boiler heating surface per hour	,,	6·06	6·55
27	Number of thermal units absorbed by boiler per minute		235302	256004
28	Number of thermal units absorbed by economiser per minute		53372	61447
29	Percentage of evaporation done by economiser ..		22·69	24·00

APPENDIX.

Note 1.—The quantities of steam and water received from the boilers are found by dividing the total feed, less the drainage from the steam pipe—see line 77, Table VIII.—by the number of revolutions, there being two engines, and dividing the quotient into two parts in the proportion of 97 to 3, the water carried over being estimated at 3 per cent. The other figures are got by calculating the volumes in cubic feet occupied by the steam, multiplying these volumes by the specific weight of steam at the particular pressure to find the weight of steam, and deducting this weight from the total present to find the weight of water.

Note 2.—As we do not know precisely the pressure prevailing in the receiver, we cannot calculate the quantity of water evaporated exactly; but a near approximation may be made by taking the terminal pressure in the small cylinders and the mean admission pressure in the larger as the pressures at the beginning and end of the evaporation. Let M be the total weight of steam and water discharged from the smaller cylinders; m, the final weight of steam at the final pressure; q, the quantity of heat in 1 lb. of water at this pressure; ρ and r, the internal and total heat of evaporation of 1 lb. of steam at the same pressure; W, the work of the admission to the larger cylinders. Then the final distribution of the heat may be expressed by $Mq + m\rho + W$, or by $Mq + mr$. Which is the more correct the writer will not stop to inquire, but following the plan adopted in calculating the heat supplied by the boilers—see Note 1—will suppose the steam in the pipe to contain the total heat proper to the pressure, and express its distribution by $Mq + mr$, so that we have the following equation for determining m: $Mq + mr$ = total heat discharged from smaller cylinders, as given in line 15 of Table IV. Taking the values of M from line 80 of Table VIII., and those of q and r from the pressures given in lines 42 and 61 of the same table, and completing the calculation, we find that m was 3·3295 lb. on the Friday, and 3·5961 lb. on the Wednesday; and subtracting from these values the weights of steam in line 12 of Table II., we arrive at the quantities of water evaporated, viz., 0·7262 lb. on the first day and 1·0960 on the last.

Note 3.—For our present purpose this hypothesis is sufficient. The writer calls it an hypothesis because no satisfactory explanation has yet been given of the way in which so large a quantity of heat can be absorbed in the short time the admission lasts. It seems quite as probable that the heat is abstracted by water remaining permanently on the cylinder ends and pistons in the form of dew. Of course the deposition of this dew upon the metal is the result of absorption of heat by the latter, though of a much smaller quantity than would be required if the cylinder were dry, and thus the high conductivity and heat-absorbing power of the iron are the primary causes of the loss, though not perhaps in the way supposed in the report. Possibly something might be done with a thermo-electric current and a galvanometer to throw some light upon what is certainly at present an obscure subject.

Note 4.—The figures in line 4 are got by multiplying the weights in line 3 of Table II. by the total heats of steam and water at the boiler pressure in line 36 of Table VIII. The other figures in columns 2 and 7, by multiplying the weights in columns 3 and 8 of Table II. by the total heat of water at the pressures in lines 37—44 of Table VIII., the work due to the expansion of the water being neglected; and those in columns 3 and 8, by multiplying the weights in columns 1 and 6 of Table II. by the internal heat of steam at the above-mentioned pressures. The sum of the two products gives the internal heat of the total weight of steam and water present. Adding to this the work tabulated in lines 86—105 of Table VIII., and subtracting the total from the whole quantity of heat present, we arrive at the figures given in columns 1 and 6.

Note 5.—The figures in line 4 are the values of $(M - m)\,q$ and $m\,(q + r)$—see Note 2. Those in the other lines are calculated in the same way as the corresponding figures in Table IV.

Note 6.—On looking at the figures relating to the expansion in the smaller cylinders, and at the values of the index γ in line 33 of Table VIII., we notice a remarkable difference between the Friday and Wednesday, which at first sight might raise doubts as to the accuracy of the diagrams taken on the latter day; hence it becomes necessary to examine the causes of the difference, and to suggest some explanation. The diagrams were taken generally in the writer's presence by two of the company's inspectors well able to indicate correctly, and to avoid the errors which frequently occur through careless manipulation of the instruments. He feels confident, therefore, that they were correctly taken. The general design of the indicator motion has been explained in the report. The defects to which such a motion are liable are slipping of the endless cord upon the pulleys and stretching of the strings connecting the indicator to the revolving spindles. The amount of slip did not exceed one revolution of the pulleys on either day, so that it could not have had any appreciable effect upon the diagrams. The stretching of the connecting cords on the morning of the day of the preliminary trial was considerable—so great, indeed, as to make the diagrams useless for any but the roughest calculation; but after copper wires had been substituted it could not have been of importance. Moreover, as its effect would be to shorten the admission line, and thus reduce the value of γ, the high value obtained for that index on the Wednesday cannot be attributed to this cause. Nor was the error introduced by the direction of these cords, since the indicator was fixed at the same level as the pulleys from which the motion was derived. There seems, therefore, no reason to attribute the peculiarity of the Wednesday's expansion curves to faults in the instruments or operators, and some other reason for it must be sought. On calculating the value of γ for all the diagrams taken from the smaller cylinders on the Wednesday, it was found (1) that they were in all cases slightly higher in the mornings after starting than during the rest of the day; (2) that the highest values were obtained from the front end of the cylinder of the right-hand engine, and the lowest from the back end; and (3) that the values varied with the duration of the period of compression, being greatest when the compression was least. The following are the figures:—

	Values of γ on Wednesday, 18.	Right-hand engine.		Left-hand engine.	
		Front.	Back.	Front.	Back.
1	Value of γ—Morning	1·093	0·964	1·088	1·080
2	,, Afternoon	1·073	0·951	1·051	1·063
3	,, Mean..	1·082	0·957	1·069	1·071
4	Duration of compression	0·120	0·200	0·136	0·152

It would therefore seem that γ, and consequently all the figures relating to the expansion, since they are deduced directly from the curves, depend in some way upon the temperatures prevailing in the cylinders. If this be so, it is easy to understand why the curves should be essentially different on the first and second days, for although the initial pressures and ratios of expansion were practically the same, the mean pressures and temperatures during the exhaust and compression were altogether different. These temperatures were in fact the following:—

	Temperature of steam in small cylinders in degrees Fahrenheit.	Friday, 13.	Wednesday, 18
1	Mean during expulsion	234·94	199·87
2	At beginning of compression	233·82	199·11
3	At end of compression	295·85	265·07

Now, considering the duration of the exhaust we may, I think, assume that the temperature of the metal at the beginning of the compression was about the same as that of the steam, and was therefore about 35 deg. lower on the Wednesday than on the Friday. To see what conclusion this assumption leads to, take first the figures relating to the Friday from Table IV. These show that the quantity of heat absorbed attained its maximum at or near 0·325 of the stroke, or when about one-ninth of the expansion was completed. At this point the temperature of the metal reached that of the steam, and was therefore about 301 deg., this being the temperature due to 68 lb. pressure, the pressure at this point. The rise in the temperature of the metal from the beginning of the compression was therefore 301 deg. – 234 deg. = 67 deg. Now suppose all the 1182 thermal units absorbed up to this point to have passed into the metal, and taking the specific heat of iron at 0·113, the weight of metal heated would be $\frac{1182}{0·113 \times 67} = 152\text{lb.}$ On the Wednesday the lowest temperature was 199 deg., and the number of units absorbed up to the same point as before being 1303, the temperature of the metal would be raised through $\frac{1303}{0·113 \times 152} = 74$ deg., and its temperature after one-ninth of the expansion had been completed would be 199 deg. + 74 deg. = 273 deg., a temperature corresponding to a pressure of 44 lb. per square inch only. As at this point the pressure of the steam was 66 lb., it is evident that before equilibrium could be attained and heat begin to be restored the metal must have received more heat, and the pressure and temperature of the steam must have fallen. That is to say, the maximum temperature at which the flow of heat began to be reversed would occur later in the stroke, and would be lower than on the Friday. And on turning to the tables we find this was the case, the flow from the metal having hardly begun at two-ninths of the expansion on the Wednesday, while the re-evaporation of the water formed during the compression and admission was but 0·0042 lb. at three-ninths, as against 0·0228 lb. at two-ninths on the Friday. The reason why condensation continues after the flow of heat has been reversed is that for some time after the heat absorbed has passed the maximum the rate of flow is very slow, the difference of temperature between the metal and the steam being very small, so that the work of the expansion is carried on mainly at the expense of the internal heat of the steam. For the sake of simplicity the argument has been based on the assumption that all the heat shown in the tables as entering the metal really did so. It is quite possible, however, that it may have been absorbed by water remaining after the exhaust as a fine dew upon the cylinder ends and pistons. If this were so it would not invalidate the reasoning, though it would alter the figures given, owing to the specific heat of water being much higher than that of iron. It must not be supposed that in writing the above the writer wishes to treat the subject in any way *ex cathedra*; to do so would be presumptuous. All he has attempted to do has been to show that the unusual value of γ on the Wednesday does not necessarily imply error in the diagrams, but is consistent with what are generally supposed to be the laws regulating the distribution of the heat in the cylinder of a steam engine. He may also mention that he has found similar values for γ under similar circumstances in another case.

M. L.

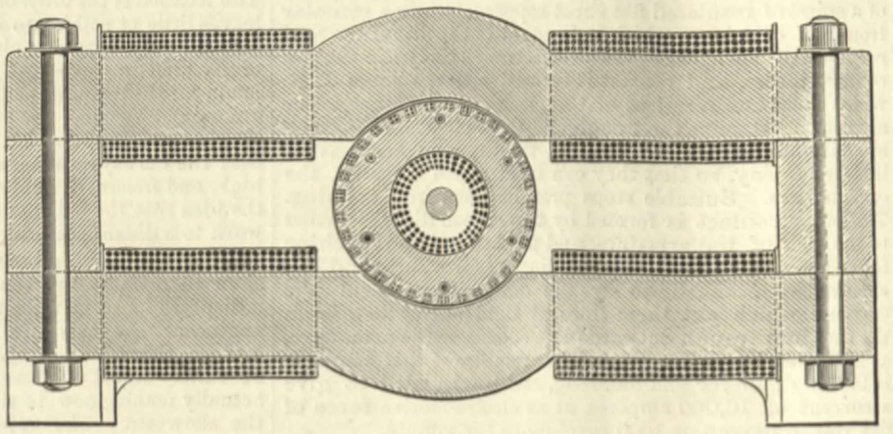
FARNHAM WATERWORKS.—The Farnham—Surrey—Waterworks Company is about to sink a deep well into the lower greensand formation, to reach which the upper greensand and gault will have to be penetrated. Messrs. Le Grand and Sutcliffe's artesian tube well system has been adopted, and the work is to be commenced this week.

PRODUCTION OF GYPSUM IN THE UNITED STATES.—In the Atlantic States, from Maine to Virginia, 65,000 long tons of land plaster and 60,000 tons of stucco—total, 125,000 tons—were made in 1884, of which nearly all was from Nova Scotia gypsum. The statistics for Michigan have not been reported, but the production did not vary greatly from that in 1883, in which year it was 60,082 short tons of land plaster and 159,100 barrels, of 300 lb., of stucco. In Ohio, 4217 short tons of land plaster and 20,307 barrels of stucco were produced. There was also a small production in other parts of the country; but the total amount of domestic gypsum used is not known.

ELECTRICAL ENGINEERING AT THE INVENTIONS EXHIBITION.

No. VII.

BEFORE leaving the subject of Messrs. Paterson and Cooper's dynamo we must give the additional information promised in our last article. The annexed sketch shows a longitudinal section through the large Phœnix dynamo, which is classified by the makers as a 42 unit machine. According to this nomenclature one unit is the standard fixed by the Board of Trade, viz., the electrical energy of 1000 volt ampères or watts equal to 1·36-horse power. The weight of copper on the armature is 175 lb., that on the field magnets 992 lb.; total, 1167 lb. With some makers it is customary to judge dynamo machines by the relation between the weight of copper on the armature and their electrical output. We do not think this is a fair basis of comparison, because no account is taken either of the speed or of the density of current which is allowed to flow through the armature wires. It will easily be seen that the larger the speed the greater is the output obtained with a given weight of copper, and similarly the more the wire is strained by allowing a heavy current to flow, the greater is the output. The latter is essentially a question of heating; and if all makers were to agree that the output they state can be obtained continuously during a run of, say, fifty hours, no objection could be raised as far as strength of current is concerned. There remains, however, the question of speed, and to obtain a fair basis of comparison the weight of copper on the armature should not be compared with the output *per se*, but with the ratio of output to speed. Thus, in the present case, 1 lb. of copper on the armature produces 240 watts in the external circuit

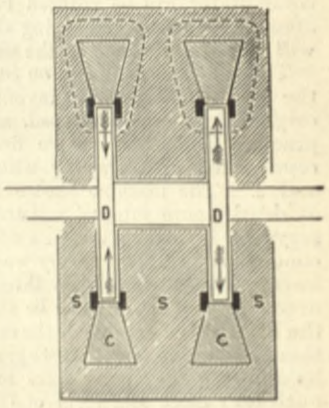


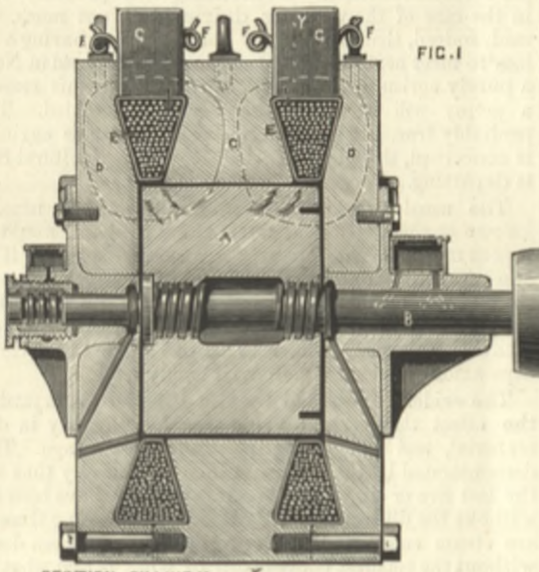
PATERSON AND COOPER'S DYNAMO.

full range of output. The curves also prove an interesting fact, first pointed out by Mr. Esson in the columns of the *Electrician*, viz., that dynamos regulate about equally well at widely varying speeds. For want of space we cannot enter in detail into this question, although it has considerable practical importance, but we must refer our readers to our contemporary for a full explanation of the fact.

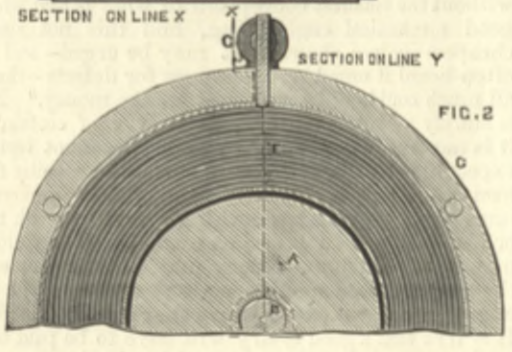
Professor George Forbes' non-polar dynamo.—At the west end of the North Court is exhibited a most remarkable machine intended for the electro-deposition of copper by means of a very large current flowing through a bath of copper sulphate. A smaller machine of a similar character is exhibited in the East Arcade, as also a number of drawings showing full size sections of Professor Forbes' machines. Before we can enter into a detailed description of these we must say a few words about the general principle of these unipolar, or, as Professor Forbes prefers to call them, non-polar machines. The latter term seems the more appropriate of the two, as no external magnetism can be detected when the machine is at work. No such thing as one isolated magnet pole can be found in nature; there must always be two poles of opposite sign, although only one of them may be directly utilised. In Professor

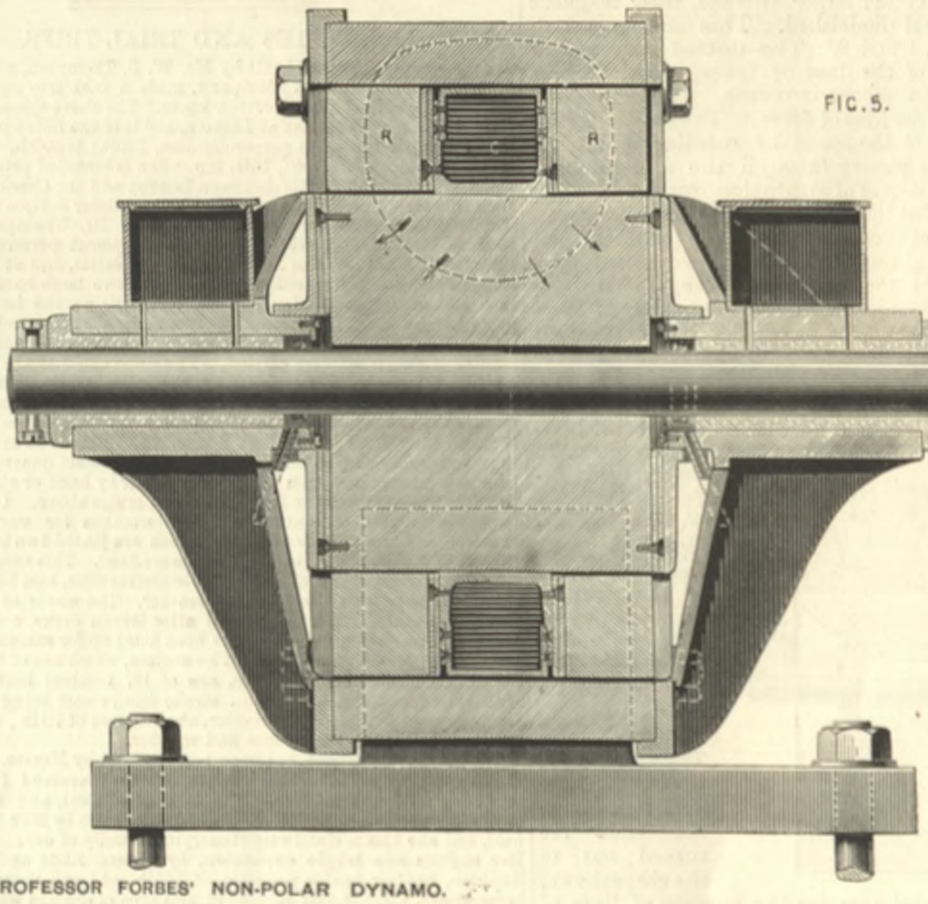
of the magnetic circuit, and to further intensify the magnetic action between the two poles. The arrangement shown in our sketch produces a current only along one vertical radius of the disc; but if we were to place a number of magnets all round the disc, and arrange a corresponding number of rubbing contacts, equal currents could be taken off along these radii; and if the magnet were made in the form of a ring-shaped shell, currents could be taken off along the whole circumference. This is in substance what Professor Forbes has done. In his machine the shell is an electro-magnet excited by a circular coil placed in the bend of the yoke, and the disc is made of iron of considerable thickness, partly to obtain a large surface of contact, and partly to reduce its internal resistance. In the first machine constructed on this principle the disc was made so wide that it became a cylindrical bar. Two coils were placed over it, leaving a space of about 1in. in the middle for the contact. The shell is in the form of a cylinder about 13in. long and 5in. in diameter. The bearings of the bar—which is the armature—formed one pole, whilst the other pole was the rubbing contact in the middle. This machine will be found on stand 1324 in the East Arcade. The next step taken by the inventor was to construct a double machine according to his patent No. 3115, 1883. We give a longitudinal section of this dynamo in the annexed sketch, omitting, however, all constructive details. Two discs D D are mounted upon the same spindle, and revolve within a duplicate cylindrical shell of soft iron S. Rings of trapezoidal cross section are turned out of the shell, into which are placed the insulated exciting coils *c c*. The lines of force created by the current in these coils surround them in closed curves as indicated by the





SECTION ON LINE X





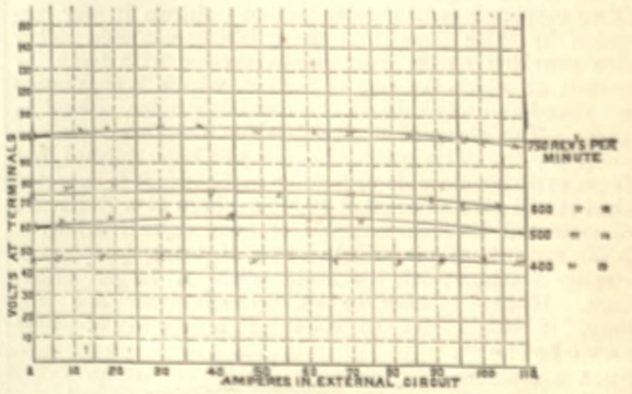
PROFESSOR FORBES' NON-POLAR DYNAMO.

the armature is driven at a speed of 500 revolutions. At 1000 revolutions the output would be 480 watts, at 250 revolutions it would be only 120 watts, and so on. To obtain a fair basis of comparison, the speed should be assumed to be equal in all cases—say, 1000 revolutions. Against this it might be urged that as the speed has been fixed in each particular case by the maker, and that the machines must be driven at that speed, it is useless to know what the machines could do at 1000 revolutions. The question of practical importance is, what will they do at the speeds for which they are designed. Our answer to this objection is that users of dynamos prefer those which require low speeds, and that therefore even from a purely commercial point of view it is right that machines should be judging not only by the weight of copper on the armature per 1000 Watts, but also in relation to the speed. We would even advocate going a step further, and judge machines with regard to weight of copper on armature and field magnets as compared to their normal output when running at 1000 revolutions. Taken on this basis, each pound of copper on Messrs. Paterson and Cooper's machine produces 72 watts, or nearly one-tenth of an electrical horse-power.

Through the courtesy of this firm we are able to place before our readers some characteristic curves of their 11 unit Phœnix dynamo. It will be seen that up to 50 ampères there is a slight rise of electro-motive force, which circumstance makes the machine suitable for regulating at the far end of its main circuit, but only between the limits of 0 and 50 ampères. At larger currents there is a decided drop of electro-motive force, and the machine cannot be considered as a perfect regulator throughout its

Forbes machine, however, both poles are utilised, and as both are well within the body of the machine, which consists almost entirely of wrought iron, none of their magnetic force is wasted externally, as is the case more or less with all other dynamos. The subject of unipolar dynamos is not new, about thirty patents having been taken out within the last few years; but the difficulties of rubbing contacts at high speeds have always stood in the way of their practical application. Not the least of the merits of the machine under consideration lies in the successful manner in which this difficulty has to all appearances been overcome. In the beginning of these articles it was pointed out that the electromotive force in all dynamo electric machines is due to the cutting of lines of magnetic force by a conductor, the direction in which the electromotive force is set up being at right angles to the direction of movement and also at right angles to the lines of force. If a metal disc be fixed as per annexed sketch between the poles of a horseshoe magnet and rotated in the direction of the arrow, an electromotive force would be created in direction downwards from the axis to the circumference, and by arranging rubbing contacts on the axis and at the lowest point of the disc a current could be taken off. Other things being equal, the current will be strongest if the poles are arranged to come very close to the disc, and in some cases it might be advantageous to make the disc of soft iron in order to reduce the resistance

dotted lines, and since the direction of the current is opposite in the two coils, the lines cut the first disc in opposite sense to the second, setting up in one disc an electro-motive force inwards and in the other disc outwards. The current flows from the outer circumference of the first disc towards its centre, then along the axis to the centre of the second disc, and thence outwards to its



CURVES OF PHŒNIX DYNAMO.

circumference. The rubbing contact is at the periphery of each disc, and at first it was attempted to use mercury for this purpose, the mercury being retained between india-rubber rings, as shown. It was expected that under the influence of centrifugal force the mercury would form a band of about equal thickness all round the circumfer-

-ence, and thus establish the best possible contact. Experiment proved, however, that mercury behaved more like a solid belt than a liquid band, adhering for a considerable distance closely to the disc but not touching the casing, and in other places leaving the disc and flying out to the casing. It was also found that the liquid friction of mercury was by far greater than is commonly assumed, and in consequence of this considerable heating took place. These difficulties fairly recognised, Professor Forbes cast about for a remedy, and discovered that iron and carbon form a splendid contact, which will work at high speed without heating, and without appreciable wear. Engineers will, perhaps, be less surprised at this than electricians, for they have long known that, with polished shafts, bearings consisting mostly of carbon in one form or other can be made to wear for years without any lubrication whatever. Professor Forbes has therefore adopted carbon contacts, not only in all of his machines, but he also proposes to use them in all cases where rubbing metal contacts have hitherto been employed, especially for the brushes of dynamo machines. If he succeeds in this he will deserve the thanks of all makers and users of dynamos. At present the commutator is that part of a machine which wears most, and in many cases it is costly to replace; but if by the employment of carbon brushes the wear of the commutator can be reduced to a fraction of its present amount, the cost of keeping dynamos in running order will be reduced almost in the same proportion.

The diagrams exhibited on Stand 1324 give, so to speak, the whole history of the invention. They show how the original idea was developed, assuming more and more a practical shape. Thus we find the next improvement represented in a drawing which we reproduce in Figs. 1 and 2. The machine shown in the above sketch has evidently more internal resistance than absolutely necessary; for by making the discs wider we could increase their conductivity without in any way lessening the number of lines of force which pass through them. It is not even necessary that the machine be any heavier, as we can widen the discs at the expense of the central mass of iron between them. Imagine, now, that we gradually widen the two discs by allowing their inner faces to approach more and more until they meet and form one continuous cylinder. We shall thus obtain not only a maximum of conductivity, but also the additional advantage of having transferred the two inner air spaces to the circumference of the cylinder, where, on account of the larger surface, their magnetic resistance is somewhat diminished. This arrangement is represented in Figs. 1 and 2. The dotted curves show again the character of the lines of force, and the arrows indicate the direction of the currents, which in every point are vertical to the lines of force. The electro-motive force is proportional to the speed of rotation, and to the total number of lines passing through the armature. If we assume the same degree of saturation for different size armatures, we find that the electro-motive force is proportional to the square of their diameter. The machine just described, although being a great improvement upon the former type, has the defect of being liable to an enormous side-thrust consequent upon inequality of magnetic attraction on the two end faces of the armature. It is practically impossible to so place the armature that the clearance on either side should be mathematically equal, and hence a certain amount of side pressure must always exist, which necessitates the employment of a thrust bearing as shown. To remedy this defect Professor Forbes has designed a modified arrangement of the cylinder machine which will be understood from Fig. 3. We again omit all constructive details. The armature A is 6in. diameter and 9in. long; the ends are turned out to the shape shown, so as to afford an equal area for the passage of lines of force at all points. What in an ordinary dynamo would be called the field magnet, is represented here by the shell S containing the two exciting coils C C. The cross section of these is trapezoidal as before, in order to leave as near as may be an equal area of soft iron round these coils for the passage of the lines of force. Part of the shell consists of two soft iron rings R R, which are insulated from the body of the shell and form the terminals of the machine. Two copper rings of angular section—shown in our diagram by thick lines—form the rubbing contacts. They are provided on the inner circumference with teeth, by means of which the ring of carbon, which is continuous all round and which forms the contact proper, is held in place. The air space or clearance between armature and shell is $\frac{1}{16}$in. This machine has not yet been finished, but from experiments made with other machines it is expected that it will give a current of 5000 ampères at a difference of potential between terminals of two volts if driven at 2000 revolutions per minute. For lighting purposes a similar machine could be made with a larger armature. If the cylinder be 4ft. in diameter and 4ft. long, it would give 60 volts at a speed of 1000 revolutions. Such a machine would, however, be too cumbersome in comparison to the output that could possibly be required of it, although not too cumbersome as compared with the output it could give. It is also doubtful whether, at a speed of 12,500ft. a minute, even carbon contacts will stand. The inventor proposes, therefore, to obtain higher electro-motive forces not by increasing the size of his machines to unwieldy proportions, but by making compound armatures as shown in Fig. 4. The different cylinders are to be insulated from each other, and each is to be provided at the ends with rubbing contacts also insulated from each other. The contact 2 would be connected to 3, 4 to 5, and so on, the current entering the armature at 1 and finally leaving it at 10.

FIG. 3.

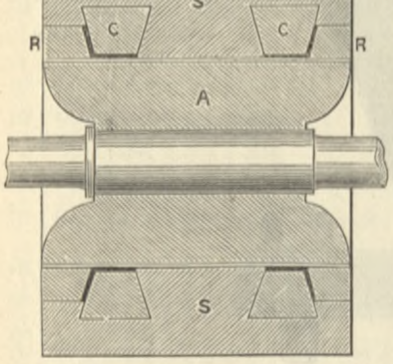
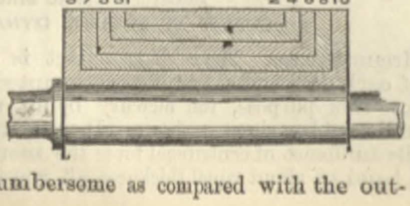


FIG. 4



Another form of the non-polar dynamos is shown in Fig. 5. Only one exciting coil C is employed, consisting of a spiral of insulated flat sheet copper laid into a circular trough of cast iron, which is fastened to the armature and revolves with it. The sides of this trough carry the carbon contact plates, and contact is insured with the rings R R, which form one terminal of the machine, by the magnetic attraction between the trough and these rings. The rings are insulated from the body of the machine, and have a little end play, so that they can be attracted towards the carbon discs. Suitable stops prevent them from turning. The other contact is formed by two carbon discs fastened to the ends of the armature, and the body of the machine forms the other terminal. The lines of force surround the exciting coil, as shown by the dotted curve, and the currents which cut these lines at right angles flow from the cast iron trough outwards to the ends of the armature, as indicated by the arrows. The armature of this machine is 9in. in diameter and 8in. long, and is calculated to give a current of 10,000 ampères, at an electro-motive force of one volt, if driven at 1000 revolutions per minute.

PASSENGER ENGINE—GREAT SOUTHERN AND WESTERN RAILWAY OF IRELAND.

In our impression for June 26th we gave some illustrations of one of several fine engines constructed by Mr. J. Aspinall, at Inchicore, Dublin, for the Great Southern and Western Railway of Ireland; at the same time we gave full dimensions. We now publish as a supplement a sectional engraving of the engine, and on page 50 we give two cross sections. The principal dimensions of the engine are:—Cylinders, 18in. diameter; stroke, 24in.; diameter of driving wheels, 6ft. 6in.; total heating surface, 1051 square feet; grate surface, $18\frac{3}{4}$ square feet; weight in working order, 39 tons 10 cwt.

LAUNCHES AND TRIAL TRIPS.

The steamer Avoca, built by Mr. W. B. Thompson, at Dundee, for the Cork Steamship Company, made a trial trip on 1st July, showing a speed of over thirteen knots. The above vessel has been built to the highest class at Lloyd's, and is of the following dimensions: Length between perpendiculars, 260ft.; breadth, moulded, 34ft.; and depth of hold, 15ft. 8in. She is intended primarily for the conveyance of cattle between London and the Continent, and with this view she has been built on the cellular bottom principle. The engines and boilers, which are from Mr. Thompson's Tay foundry, are placed well aft, this arrangement permitting of a better utilisation of the holds for carrying cattle, and at the same time ensuring good ventilation from the two large hatchways at each end of main hold. The poop extends to the fore end of boiler hatchways, and accommodation under the after end has been provided for officers and engineers, and on the poop deck a large number of sheep will be carried. The space under the bridge deck amidships is wholly occupied by the cabin, which is tastefully panelled in pitch pine, and contains roomy and comfortable quarters for the captain and first-class passengers. On the bridge deck is placed the wheel and chart house, with entrance to saloon. In the wheel-house is placed Higginson's patent steam quartermaster, by which the vessel can be steered either by hand or steam, and from the wheel-house or from the flying bridge above. Under the forecastle is placed Harfield's steam windlass for working the anchors. At the after end of this deck are placed two iron lighthouses, in which the ship's side lights are fixed. This arrangement places the lights clear of all possible obstructions, and beyond all risk of extinction in the heaviest weather. The whole of the fore and main holds, fore, main, and after 'tween decks, and all the available space on main deck, has been fitted up for carrying cattle to the number of about 600. The engines, which are of the compound surface-condensing type, are of 187 nominal horse-power, with cylinders 31in. and 62in., stroke 48in., steam being supplied from one steel double-ended boiler, at a pressure of 90 lb., and from a donkey boiler for the cranes and winches.

The s.s. Actor, which has been recently built by Messrs. Raylton Dixon and Co. for Liverpool owners, left the Cleveland Dockyard on Friday for her trial trip. She is built of steel, and her principal dimensions are 260ft. over all by 34ft. beam by 23ft. depth of hold, and she has a deadweight carrying capacity of over 2100 tons. Her engines are triple expansion, by Messrs. Blair and Co., of Stockton, having boiler pressure of 160 lb., and will indicate 700-horse power, the proved success of this type of engines warranting the expectation of great economy in the consumption of fuel. After her trial trip the vessel proceeded to Liverpool.

On the 2nd inst. Messrs. Oswald, Mordaunt, and Co. successfully launched the Condor at Southampton. She is a fine iron barque of 1300 tons net register, and of the following dimensions:—Length, 229ft. 7in.; breadth, 37ft. 3in.; depth of hold, 21ft. 6in. The vessel has been built for Mr. G. Petrie, London. Accommodation is provided for captain and officers in full poop, and for petty officers and crew in large iron deckhouse amidships.

Bradford Technical College, Engineering Department.—A very interesting series of visits and excursions to engineering works for the students has been carried out during the past month, the programme being as follows:—May 15th, Sowerby Bridge, Messrs. F. Berry and Sons; May 28th, Leeds, Messrs. Kitson and Co. and Messrs. J. Fowler and Co.; June 2nd, Doncaster, Great Northern Railway Works; June 3rd, Lowmoor Ironworks; June 4th, Bradford, Messrs. Thwaites Bros.; June 9th, Hull, Earle's Shipbuilding Company and Wilson Liners; June 11th, Leeds, Messrs. Greenwood and Batley and Messrs. Smith, Beacock, and Tannett; June 16th, Manchester, Ashbury's Carriage Works, Sir J. Whitworth and Co., and Messrs. Crossley Brothers; June 17th, Bowling Ironworks; June 18th, Liverpool and Birkenhead, Laird Bros. and Cunard s.s. Etruria and Pavonia, and James, Jack, and Co.; June 25th, Manchester, Sharp, Stewart, and Co., W. and J. Galloway and Sons, and Smith and Coventry; June 30th, Crewe, London and North-Western Railway Works. The above excursions were in charge of Mr. G. F. Charnock, chief assistant of the engineering department. The session was brought to a close by a special two days' excursion to London for the Inventions Exhibition, in which about 100 students from all departments of the College took part on Friday and Saturday last, the 10th and 11th inst. On Friday the party was entertained to luncheon by the Worshipful Company of Clothworkers. The classes during the last session have been highly successful, the average number of regular day and evening students being twenty-four and 100 respectively.

STEAM ENGINES AT THE ROYAL AGRICULTURAL SOCIETY'S SHOW.

The Royal Agricultural Society's Annual Show is being held this year in Moor Park, Preston, a very admirable site in some respects. Preston is a town of 100,000 inhabitants, and was at one time known as "the town of the three P's," which, being done into English, meant "Poor, Proud, Preston." Whence the title was derived we do not know. It is a straggling, dirty manufacturing place, possessing without any exception the most filthy cabs and flys it has ever been our evil fate to meet with. The location of the town on the tidal river Ribble, however, leaves little or nothing to be desired; and Avenham Park, if small, is one of the most charming of all the charming places of its kind in existence. Great preparations have been made for the reception of the Prince of Wales. Triumphal arches and Venetian masts have been put up without the smallest consideration for economy. One triumphal arch near the railway station is an enbattled structure, some 50ft. high, and framed of timber sufficiently strong to suggest the idea that the builders determined to hand down their work to a distant posterity.

Since the Royal Agricultural Society held an annual show there has never been got together under its auspices a display of machinery so totally devoid of interest for the engineer. Not only are many exhibitors absent, the articles shown are comparatively few in number, and absolutely devoid of all novelty. In one sentence, there is actually nothing new in the "implement department" of the showyard. The application of a very small exhaust injector to a little vertical engine, and a swing fire door to a traction engine by Messrs. Robey and Co., stand out prominently as novelties—things to be kept in mind and made note of. It is not necessary that we should attempt to explain this paucity of novelty. It is not that there is less ingenuity or less need for improvement; we have only to deal with the fact. No doubt a large class of engineers have discovered that nothing is to be gained by taking novelties to the annual shows of a society which has indirectly, if not directly, discouraged improvement for years back. No prizes are offered this year. Save a few silver medals, which will not all be awarded, no prizes will be given except a few pounds for improved whipple trees and harness. Something will probably be done in the case of the working dairies, but not much. It is said, indeed, that the Society contemplates having a heavy loss to meet next year, as its show will be held in Norfolk, a purely agricultural county, and that for this reason not a penny will be spent that can be avoided. This is probably true. It is also true that, as far as engineering is concerned, the glory of the Royal Agricultural Society is departing.

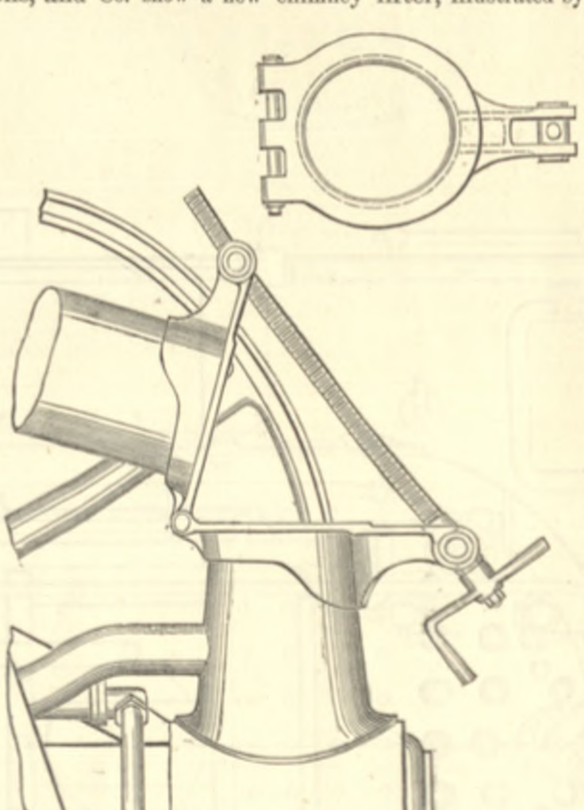
The usual well-known firms exhibit their usual well-known engines. To deal with them in detail would be to repeat much that has already appeared—some of it years ago—in The Engineer. Instead of doing this we fancy that something may be gained if we say a little in the way of criticism concerning the engines exhibited. We shall mention no names. There is an old adage about throwing caps among a crowd which will apply here.

The evidence presented by the Preston Showyard is to the effect that certain firms reached finality in design, material, and workmanship some years ago. This is demonstrated by the circumstance that at any time within the last five or six years the same engines have been shown without the difference of a bolt or nut. Among these there are steam engines in the yard which have been designed without the smallest conception of what is and what is not good mechanical engineering, and this not among the cheapest engines shown. It may be urged—and we have often heard it urged as an excuse for defects—that "after all much could not be expected for the money." Now this is simply a current fallacy. It is true of certain things; it is not true of design. A purchaser cannot legitimately expect to get 100ft. of heating surface in a boiler from one firm, while he gets only fifty from all other makers for the same price. But this has nothing at all to do with the good or bad qualities of a design as a whole. The various parts may be of good form. They may be at once pleasing to the eye and mechanically right; and they will not cost more to make, but less, because they are carefully designed. It is true that a good salary will have to be paid to a good works manager, but the cost will be saved twice over. The truth is that the makers of cheap and bad steam engines make less profit than those who sell low-priced and good engines. In ninety-nine cases out of the hundred the man who designs a bad engine does not know how to turn out work cheaply. It will, for example, be found on examination that nearly all the bad engines have been made by hand instead of by machinery; and this follows because it is practically impossible to make a very bad engine except by hand. The man who really studies economy will consider first what tools he possesses, and having done this he will next design all his work in such a way and of such forms that his tools can be used to the fullest possible extent, and if he does not possess certain tools he will buy them. To cite an instance. It is easy to find in the showyard dozens of joints, as between the end of an excentric rod and the valve spindle, which have been got up by hand, and badly got up. They are mostly of forms very inconvenient for the milling tool; squares and sharp corners into which a milling tool cannot be got, being highly popular. Any fitter can get these up with a vice, a file, and a square. If curves of the proper type were used these things could be got up by the milling tool for less than the bare cost of files wasted on them under the system we deprecate. Again, it has recently become the fashion to use tubular guide bars—extensions, so to speak, of the cylinder. These were introduced because they lend themselves easily to the cheapest of all machine work, that of the lathe. But instances may be found in the showyard where the tube is used without any intelligent perception of its proper *raison d'être*, and separate flat guide bars have been bolted in. It is impossible to conceive a situation less adapted for a flat guide than the inside of a tube in which it has to be adjusted. Some of the engines shown do not appear to have been designed at all; they have been "thrown together." Cylinders, for example—we are speaking now of vertical engines—are carried far out from the side of the boiler on a huge foot. Two awkward pedestals stand below carrying a thin crank shaft, with the crank a couple of feet away from any bearing right in the middle. The valve chest has bolted to it a throttle valve box; to this in turn is bolted a stop valve box; lastly comes the steam pipe, with a multiplicity of joints. A moment's thought would have shown that if the crank was put close to one of the bearings, the cylinder could, for obvious reasons, be got much closer up to the boiler, metal would be saved, and the whole job would have been better in every respect. Let any of our readers who have the opportunity contrast vertical engines by the first-rate firms with those by inferior makers, and note the difference. We can assert positively that the bad engines cost their makers about as much as the good engines cost the firms who produce them. The worst of the whole business is that the inferior makers never seem to learn anything. They walk round a showyard, inspect their neighbours' goods, and come away as ignorant as they went. To this there are one or two notable exceptions, men who by never wasting a chance have really come to the very first rank in engine building from very small and very bad beginnings. These firms deserve success, and they will command it. It is not our purpose to write a treatise on the designing of steam engines, and when we have said a few words on a vexed question we will leave this aspect of the Preston Show. It is constantly said that foreigners beat us in design because of technical education. Now, our experience is that foreigners do not beat us at all in this respect, and as regards the smaller class of engines, vertical and horizontal, to say nothing of portable engines, they are simply nowhere, a result which is, we think, largely due to the fact that labour is so cheap on the Continent that there is nothing like the same rigorous determination to do without it manifested abroad that is to be found at home.

There are some features in the engines shown at Preston which are worth notice, although they are not strictly novelties. One of these is a modification of their spring wheel brought out by Messrs. Aveling and Porter, of Rochester. The normal spring wheel of this firm has recently been illustrated in our pages, and it will suffice to say here that the wheel consists of an outside tire made trough-shaped in section by two circumferential angle irons. The spokes of the wheel are secured to two outer rings, which just fit within the trough, and the inner wheel and the tire are connected by powerful coiled tangential springs, so arranged that every second space between two spokes has two springs in it, and the alternate space no spring. Thus, in a sense, there are two springs pulling in opposite directions to each other on the end of every second spoke. In the new wheel there is one spring to each spoke. We do not say that this is the best spring wheel that can be made, because we do not pretend to the gift of prophecy, but we do say that in our opinion it is the best elastic traction engine wheel now in existence. Comparisons are odious, it is said, yet they will be drawn; and those of our readers who remember that we have spoken in high terms of McLaren's spring wheels will ask if we have changed our minds; our reply is simply that we have not. We hold to all that we have said of the McLaren wheel, but the Aveling wheel is better, because it is more elastic. It has a play of an inch or an inch and a-half, while the McLaren wheel has a play of only a quarter or half an inch. Both are in the showyard and can be compared. We know nothing—we do not care to know in this connection—what the comparative cost of the two systems is, and we do not pretend to say which will last longest in regular hard work. We speak of both as mechanical devices, intended to secure a certain result, and from this point of view the Rochester wheel is the better of the two. At present these are the only two elastic wheels in the market concerning which anything need be said. Spring engines are shown both by Mr. Foden and by Messrs. Fowler. The latter firm has taken up the manufacture of the Aveling and Porter wheel, under license from the firm. Messrs. Fowler exhibit a traction engine, with all four wheels used as drivers, under we believe Maynard's patent. We fear that this must be classed with many inventions which make their appearance now and then at shows and exhibitions, produce a sensation for a time, and die out. The trailing wheels of the four-coupled engine are driven by a pitch chain from the crank shaft, leading downwards and backwards, on the near side of the engine. The leading wheels, which are much smaller than the main driving wheels, are fitted on an axle, which does not revolve, and the middle of which is carried in a somewhat complex arrangement, consisting of a cast iron ring or cylinder, about 2ft. in diameter, in which is put a set of "Jack-in-the-box" gear, the vertical pinions of which are on cast-iron sleeves to which the road wheels are bolted. They are driven by a pitch chain leading downwards and forwards from the crank shaft, on the off side of the engine. The result of the whole is that the leading wheels have a species of universal joint motion, so that the steering is not interfered with; but the leading end of the engine is virtually carried on a bearing, revolving at the same rate as the road wheels, and about 2ft. in diameter. The friction must, of course, be very great. It is claimed that this engine will draw very much more than an engine of equal weight with but a single pair of drivers. Time will show whether the advantage gained is worth the cost, complication, and friction. If the invention will succeed in any one's hands it will in those of Messrs. Fowler, whose name alone is a tower of strength to an invention of this kind. Three or four other firms in addition to those we have named show traction engines, which, however, call for no comment.

Among the semi-fixed or undertype of engines we found nothing new, a great deal that was good. Opinions and practice seem to be divided as to the best way in which to build engines of this type. For example, Messrs. Marshall, Sons, and Co., and Messrs. Hornsby and Son each show compound engines of great strength and weight, while Messrs. Ruston and Proctor exhibit an under-type engine, very much lighter in proportion in every part, but beautiful in design and faultless in workmanship. The Marshall engine is nominally 16-horse power, the Hornsby engine is 25-horse power, the Ruston and Proctor engine is 12-horse power, with cylinders 7in. and 11in. in diameter. The price of this engine is £350, that of Messrs. Hornsby £620, that of Messrs. Marshall £410—that is to say, the first costs £29 3s. 4d. per nominal horse-power, the second £24 16s., and the third £25 12s. 6d. It is certain that either the powers have been calculated on a different basis in each case, or that different factors of safety are allowed, or different speeds have been adopted by the makers. These three engines deserve attention, as being typical of the best modern production in design and workmanship. Messrs. Robinson and Co., of Rochdale, show an under-type non-compound double-cylinder engine, with wrought iron frames and three bearings for the crank shaft, which has some small peculiarities in the arrangement of the cylinders, not easily rendered intelligible without drawings. This is a very strong and well-made engine, much, we think, the best engine ever shown by the firm. Close to it is an engine for driving a flour mill, by Messrs. Stevenson, engineers, of Canal Foundry, Preston; it has a 10½in. cylinder, 20in. stroke, and is fitted with Price and Stevenson's patent Corliss cut-off gear. As we shall illustrate this gear in an early impression, we shall reserve our description of it. Steam is supplied by a small marine boiler, which forms a conspicuous object at that end of the showyard.

Of portable engines there is the usual display. One new firm sends engines of much merit—namely, Messrs. J. T. Marshall and Co., of Sandiacre, Nottingham. We refer to an 8-horse power engine and a little 1½-horse engine, its prototype in miniature. In both we have good design and workmanship. It is evident that whoever designed these engines was brought up in a thoroughly sound Lincolnshire school. It is impossible to mistake the brand, if we may use the phrase. Messrs. Barrows and Stewart continue, we see, to make what is really the simplest engine that it is possible to build. As an example of the longevity of a good design we may cite the wrought iron frame portable engine of Messrs. E. R. and F. Turner, of Ipswich, now many years before the public. A great many other well-known firms are exhibitors of engines and boilers, such as Ransomes, Sims, and Jefferies; the Reading Ironworks Company; Allchin, Linell, and Co.; Brown and May; Clayton and Shuttleworth; Farmer, Robey, and Co.; W. Foster and Co.; R. Garrett and Sons; Gibson and Robinson; &c. &c. Of some of these engines we shall have more to say in early impressions, though not in connection with the Preston show. Messrs. Marshall, Sons, and Co. show a new chimney lifter, illustrated by



MARSHALL'S CHIMNEY LIFTER.

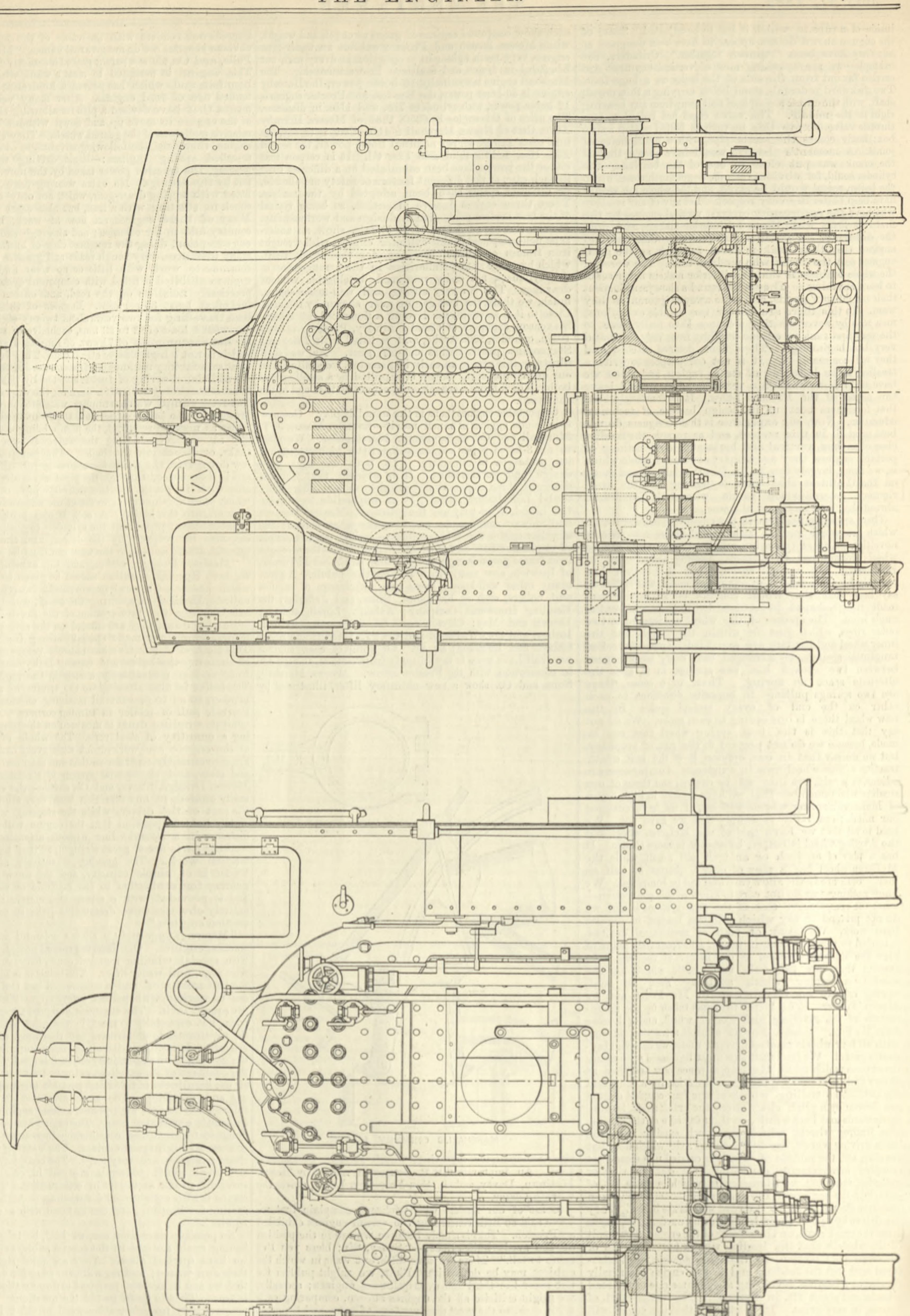
the accompanying engraving, which requires no explanation. An improved 6-H.P. domestic motor, by Messrs. Hathorn, Davey, and Co., Sun Foundry, Leeds, drives the working dairy.

Some of our readers will, perhaps, complain that we have said so little concerning the steam engines exhibited at Preston. That is simply because we are in the position of the needy knife-grinder—"Story, Sir; bless you I've none to tell." There are three different ways in which the subject may be dealt with. First, we might publish for the second or third time descriptions of engines; secondly, we might criticise all the engines shown, comparing each with each, to the great disadvantage of some and the great benefit of others; thirdly, we might pen a general laudation of all. To the first scheme there are the manifest objections that, in the first place, we should repeat ourselves; and that in the second, no written description of machinery can be profitable reading unless it is accompanied by adequate illustrations. Against the second plan, it may be urged that the merits and demerits of steam engines are very much matters of opinion, and that the soundness of that opinion can only be proved by tests such as the Royal Agricultural Society no longer carry out. As for the third system, all that can be said in its favour is that it is highly popular with one section of the press. We fancy that a few specimens—*bonâ fide*, be it observed—will serve to impress our readers with the value of the system. For obvious reasons we do not give real names. "Messrs. Hawl, Pulle, and Co. show a patent geared locomotive on springs. This engine is designed to meet a want which has long been felt, and which has proved a hindrance to the extended use of road engines. After many years' experiments, they have devised a plan for allowing the hind axle of the engine to move up and down without altering the relative positions of the geared wheels. They claim for this engine, therefore, the following advantages over any other so-called spring engines:—Rigid driving wheels, rigid gearing, the tractive power taken by the horn-blocks, and not by the springs. No extra wearing parts. It is also fitted with spring draw-gear, which not only takes off the shock in starting with a load, but also eases the engine. Many of these engines are now at work, both in this country and in the colonies; and although they are, without exception, doing the roughest class of haulage, over, in many instances, very rough roads and granite stones, they continue to work with little or no wear and tear. The engine exhibited is fitted with compound cylinders, and is practically noiseless on the road, and effects a saving in fuel of at least 30 per cent. Engines of this class have been travelling for two years about twenty-eight miles per day with a load of 22 to 23 tons, exclusive of wagons, with the low consumption of 7½ cwt. of English Lambton nuts, which is not a high class of steam coal. They have received most satisfactory testimonials from owners of these engines. An additional saving of fuel is effected by part of the exhaust steam being utilised for warming the water in the tanks. The feed pump, which supplies water to the boiler is so arranged as to pump either into the front tank or into the boiler as may be required, the pump being kept continually at work circulating the water between the two tanks, or direct into the boiler. The pump is placed so low down that the water flows directly into the clack-box, and is then forced through the pipes as required. A suitable cock is placed on the delivery pipe of the pump, which enables the driver to direct the water either into the tank or into the boiler. A cock is also provided on the exhaust steam pipe from the cylinder to the tank. This can also be worked by the driver, and the amount of exhaust steam sent into the tank can thus be regulated."

"Messrs. Dragge, Shove, and Co. exhibit a traction engine. Special attention should be given to this engine, which possesses several improvements worthy of special notice. Instead of securing the crank, countershaft, and axle bearings, to a prolongation of the fire-box shell, as is ordinarily done, they are carried on the side plates of the tender, which are made specially strong for the purpose. This method of construction entirely removes all danger of straining the boiler and causing leaky seams down the front, and is undoubtedly a step in the right direction. The boiler is also attached to the tender in an improved manner, so as to prevent all straining of steam joints by the side pull of tender in turning corners. A very convenient winding drum is mounted on the main axle holding a quantity of steel rope. The whole of the details of the engine are worked out with great care, the levers are conveniently together so that one man can easily drive and steer, and the special system of steering adopted by Messrs. Dragge, Shove, and Co. enables the engine to be easily guided in any direction with very slight effort on the part of the driver, while the steering wheels are so rigidly held in position that the engine will proceed any distance in a straight line without attention. All the working parts are of great strength, as they need to be for traction work. The gearing is entirely of steel, the tender is of ample capacity, and the draw-bar is self-guiding for connection to the machine or wagon drawn, and is provided with a strong and elastic spring which entirely obviates those destructive jerks so common with traction engines."

"Messrs. Tugge and Co. show a splendid assortment of traction engines. One deserves special notice. It is fitted with special winding forward drum, fifty yards of steel wire rope, and water lifter. The boiler is made entirely of the best mild steel, and is constructed and tested so that it can be worked with perfect safety up to 200 lb. pressure per square inch. The engine is designed for general purposes, but especially to meet, in the most perfect manner, the requirements of farmers and thrashing machine proprietors. It is fitted with all the latest improvements, and the gearing is made entirely of crucible steel. It combines the qualities of an excellent ordinary traction engine with all the handiness of fixed and portable engines for thrashing and grinding. The same firm also show a single-cylinder horizontal high-pressure steam engine, fitted with automatic expansion gear. The engine has been specially designed to meet the considerably increasing demand for economical high-speed engines. The wearing surfaces and steam passages are very large. The bed-plate, slide bars, and crank shaft pedestals are cast in one piece, thus ensuring great accuracy in construction. This type of engine is also constructed for winding, or with drums and gearing for hauling, and can be fitted with a condenser if required."

No possible exception can, we hold, be taken to makers issuing such notices to the general public as those which we have quoted above. They are quite right to praise their own wares; and we will even go so far as to add that that we are in no wise prepared to dispute that every word is true. This is quite beside the question. These statements supply no information worth printing in our pages, or worth perusal by our readers, and we consult the best interests of all concerned when we refuse to fill our pages with matter of this kind. It is, we think, to be regretted that one section of the technical, or *quasi* technical, press sees fit to pursue an opposite course. Those who best know THE ENGINEER are most fully aware that we never hesitate to expend time, trouble, or money in bringing before the world of our readers anything which commends itself as new and good. But we hold that it is not only expedient to say what an engine can do, but to explain properly how it is done, and we may call attention to the fact that there is scarcely one device named above as valuable, which is not also old and well known.



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

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

(For description see page 48.)

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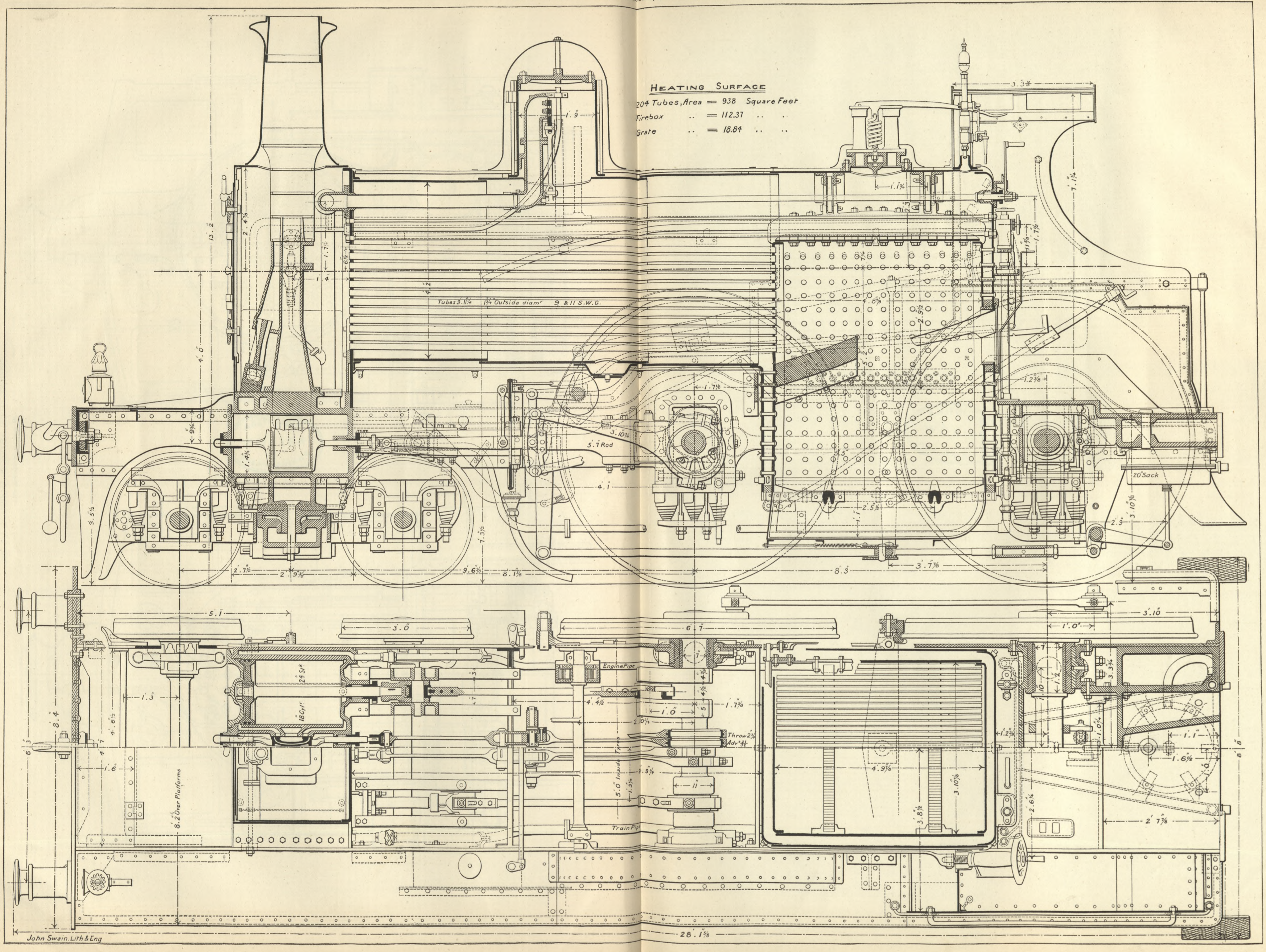
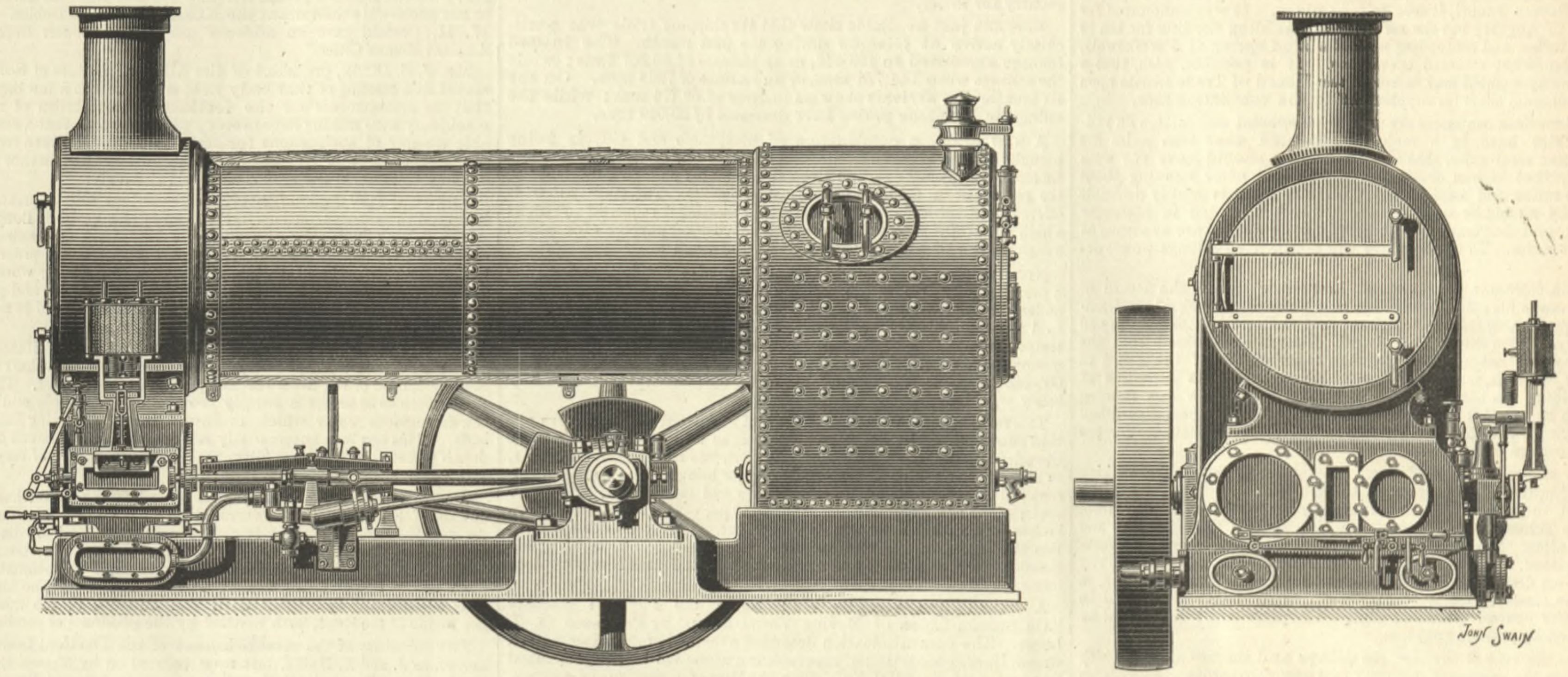


ROBEY'S SEMI-FIXED ENGINE, WITH RICHARDSON'S ELECTRIC REGULATOR.



THE above illustrations show one of Richardson's regulators as applied to an engine developing 25-horse power. Fig. 1 shows side elevation with stand and valve gear in section. Fig. 2 shows front elevation. A A are two solenoids, within which are suspended iron cores B. To the plate C connecting the two cores is bolted the buckle D, which is prolonged into the guide rod E, and which carries within it a short connecting-rod F joined to the long arm of a lever G, the short arm of which rests upon the plunger H, and presses upon the upper

FIG. I

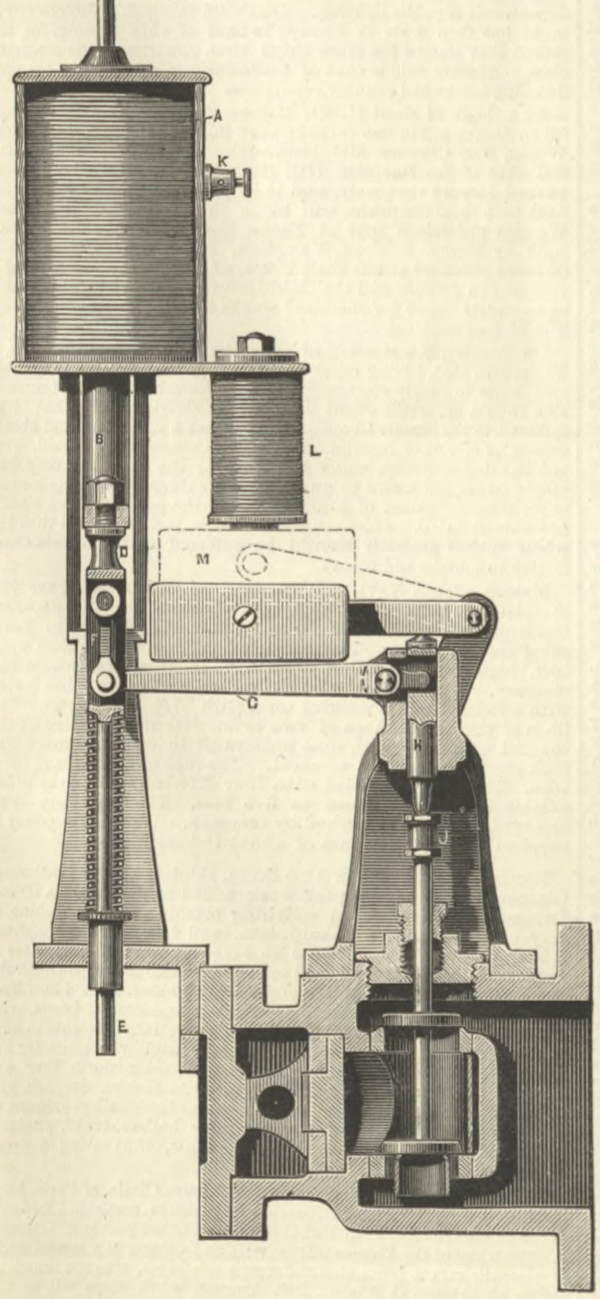
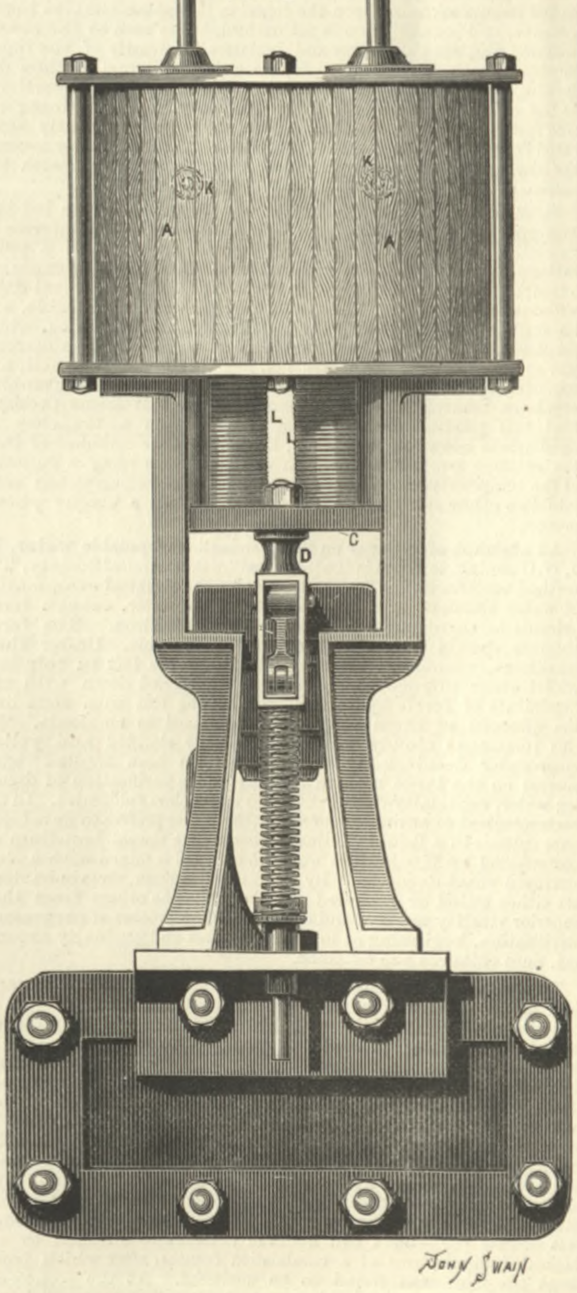


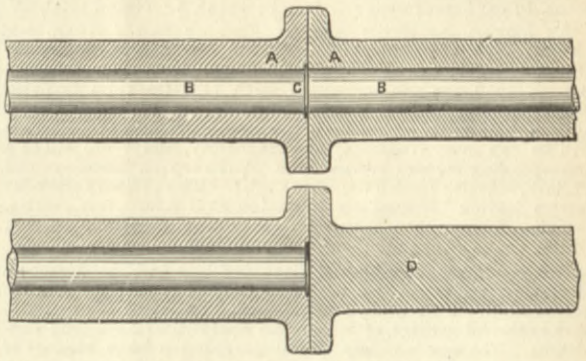
FIG. 2



end of the stalk of the double beat valve I. There is a screwed nut J upon the upper end of this valve spindle, by which its length, and therefore its position with regard to the cores of the solenoid, can be adjusted. The electric current enters by the terminals K K, and in so doing excites the coils and causes the cores B to rise within them, lift up the lever G, and press down the valve I upon its seat, thus reducing the admission of steam. Great care has been taken in proportioning these parts so that steam admission is as instantaneously regulated as possible in unison with the variation in the amount of work being done. We are informed that the apparatus is so delicate that the slightest change in the current if it be for arc lighting, and in the electro-motive force if it be used for incandescent lighting, is at once felt and responded to with a speed and delicacy which leaves nothing to be desired. The apparatus is so simple that there is no reason why it should not continue working for many months without attention. It will be seen that while such a form of regulator may be perfect in its action so long as the electric current is passing through it, yet if by any means the connecting wires were broken by a displacement of a lamp or by accidental rupture of the circuit, the engine would be left without control and would run away. To prevent this a very simple device is adopted; *l l* are the coils of a small electro-magnet with soft iron cores, which magnet is in circuit with the cores of the solenoid, and hold in suspension the weight M, which acts as its armature. When the apparatus is in action this weight is in the position shown by the faint lines close to the cores, where it is held so long as there is any current circulating through the magnet. The moment such current is broken from any of the before-mentioned causes, the electro-magnet loses its power, the weight falls into the lower position, and the lever to which it is attached presses upon the upper part of the plunger H, and thus closes the valve and stops the engine.

ARROWSMITH'S PROPELLER SHAFT.

THIS invention is intended to prevent damage to, or loss of, screw steam vessels in case of the breaking of the propeller shaft. It is proposed to have a hollow driving shaft, containing an inner one. A is the hollow driving shaft; B, inner shafts; C, disc to keep inner shaft in place; D, solid shaft. The inner shaft is not to be keyed so as to bear any torsion, its duty being to keep a broken shaft in line, the broken shaft revolving with it. The inner shaft may be solid or hollow. Its most obvious and least expensive application is for a length next to the engines, and another in the stern of the vessel, extending through



the stern tube. These parts have the greatest strain, and are, therefore, most liable to fracture. The extra cost of its application in a new vessel, or in replacing on old shaft, is small, when Messrs. Whitworth's shafts are adopted. Should the driving shaft break, set screws can be inserted on each side the fracture, and sufficient power transmitted through the inner shaft to drive the screw so as to keep pace with a vessel under sail, or even to propel it so as to give steerage way. Mr. Arrowsmith's address is St. Mary's Gate, Manchester.

TILBURY DOCKS.—The contract for the very large quantity of iron coverings in the twenty-four sheds about to be erected at these docks has been secured by Messrs. John Lysaght, who, it will be remembered, were the contractors for the supply and erection of similar ironwork for the whole of the large sheds in the Royal Albert Docks some two or three years since.

THE SOUTH-EASTERN RAILWAY WORKS, ASHFORD. — The Society of Engineers visited the Ashford Works of the South-Eastern Railway Company on Wednesday, the 8th inst. The visitors numbered about seventy, who went to Ashford in special saloon carriages, and were very hospitably received. At Ashford they inspected the saw-mill, carriage-building shop, wagon shop, machine and smiths' shop, rolling mill, and locomotive department generally, and afterwards went by special train to Folkestone and Dover. The larger number remained at Folkestone, many of whom visited the newly extended harbour. Twenty-three dined together at Wedderburn's West Cliff Hotel, where Messrs. Stirling and Wainwright, locomotive and carriage superintendents, were the guests of the evening.

PLANS FOR NEW STEEL STEAM CRUISING VESSELS FOR THE UNITED STATES NAVY.—The Secretary of the Navy has issued the following advertisement and notice concerning the construction of new steel steam cruising vessels for the United States Navy:—"Invitation is hereby extended to all engineers and mechanics of established reputation, and all reputable manufacturers of vessels, steam engines, boilers, or ordnance, having or controlling regular establishments and being engaged in the business, all officers of the navy, and especially all naval constructors, steam engineers, or ordnance officers of the navy, having plans, models, or designs of any vessels, or any part thereof, of the classes authorised by the Naval Appropriation Act of March 3rd, 1885, to submit such plans, models, and designs to the Secretary of the Navy. These vessels are to be constructed on the best and most modern design, having the highest attainable speed and in the manner and conformity to the conditions and limitations provided for the construction of the new cruisers in the Acts of August 5th, 1882, and of March 3rd, 1883, except so far as said Acts provide for and define the duties of the Naval Advisory Board. Said plans, models, and designs should be submitted within the period of sixty days after May 15th, 1885, and should be transmitted to the Navy Department, Washington, D.C. Should any such plan, model, or design be adopted or used, a liberal compensation will be paid therefor. The department will, upon application, forward copies of so much of the Naval Appropriation Acts as relates to said vessels, and will answer all letters of inquiry and furnish all desired information on the subject."

RAILWAY MATTERS.

The death is announced of Mr. Horace Walker, J.P., of Sheffield, a director of the Great Eastern and East Lancashire Railways, and of several important iron, steel, and colliery undertakings in the South Yorkshire district.

The great event of modern engineering enterprise, the opening of the Severn Tunnel, is soon to take place. It was announced for the 1st of August; but the necessity of doubling the line for ten to twelve miles, and contending with the land spring at Portskewett, have somewhat retarded operations. It is possible, also, that a slight postponement may follow if the Board of Trade insists upon a mid-channel shaft for supplementing the ventilating fans.

An American contemporary says:—A special committee on railroad axles have by a majority reported that iron axles are safer than steel axles, that all the cranks should have the webs hooped, that as iron cranks appear to fail after running about 200,000 miles, and steel after 170,000 miles, it is highly desirable that they should be taken off and never again used in passenger engines, and that crank axles properly constructed are as strong as straight axles. To what country the committee belongs we are not told.

Major-General Hutchinson, inspector under the Board of Trade, made his official inspection last Saturday week of the tramway line running from Birmingham to Dudley *viâ* Smethwick and Oldbury. The Smethwick Local Board complained that the company had not complied with the instructions of the Board in making the line, and the inspector announced his intention of withholding his certificate for that portion of the line running through Smethwick until the requirements of the Local Board had been complied with. He, however, granted his certificate for the other portions of the line.

It is stated that the Russian Government has been making secret inquiries in Teheran as to whether the Shah would be inclined to permit a Russian company to build a railway from Tiflis to Teheran. Russia wants the line to run through Baku and Resht, along the shores of the Caspian; but the Persian Government wishes, for important strategical reasons, to have the railway laid down direct inland from Teheran to Tiflis. A direct line, in case the Russians use it to convey an army to Persia, would be under the control of Persia, while a Caspian coast line could be protected by Russian gunboats.

With the view of checking the delays and inconveniences which arise from the practice of requiring railway companies to carry large quantities of luggage in excess of all reasonable personal requirements, the metropolitan railway companies have agreed to adopt a reduced scale of charges, and to enforce them in all cases where the luggage exceeds the stipulated weight per passenger. The weights allowed free are:—First-class, 120 lb.; second-class, 100 lb.; third-class, 60 lb.; and above these weights the companies will charge for distances above 300 miles, 1d. per lb.; 150 to 300 miles, ¾d. per lb.; 50 to 150 miles, ½d. per lb.; under 50 miles, ¼d. per lb.

The accidents on the United States Railways, in May, are classed by the *Railroad Gazette* as to their nature and causes, as follows:—Collisions: rear, 19; butting, 4; crossing, 2; total, 25. Derailments: broken rail, 1; broken frog, 1; broken bridge, 2; spreading of rails, 2; broken axle, 2; broken truck, 1; broken draw-bar, 2; accidental obstruction, 1; cattle, 2; wash-out, 1; misplaced switch, 2; open draw, 1; rail removed for repairs, 1; purposely misplaced switch, 1; dynamite exploded on track, 1; malicious obstruction, 2; unexplained, 11; total, 34. Other accidents: boiler explosion, 1; broken wheel, not causing derailment, 1; car burned while running, 1; total, 3. Grand total, 62.

An express day service between London and Antwerp will commence on the 25th inst., when the Great Eastern Railway Company will run a special continental train from Liverpool-street Station at 9 a.m. In connection with this train its fast steel paddle steamer Adelaide will leave Harwich—Parkeston Quay—at 11 a.m., arriving at Antwerp the same evening. The service will be run every Wednesday and Saturday, and there will be a corresponding morning service from Antwerp on Tuesdays and Fridays, reaching London the same night. The ordinary week-day service leaving Liverpool-street Station at 8 p.m. every evening, reaching Antwerp and Rotterdam early the following morning, will be run in addition to the new day service.

The opening of the Hull and Barnsley line and the Alexandra Dock, on the 16th inst., is expected to largely benefit not only the port of Hull, but the South Yorkshire coal trade, by the reduction of the rates of carriage, of which the coalowners have long complained. The new company intend carrying a large tonnage of coal from the West Riding to Hull, and thence by sea to the Thames. The Nottingham and Derbyshire coalowners expect also to benefit by the opening of the new dock at Boston. Coal is carried by sea to London at something under 2s. a ton for every 100 miles, and the railways charge from 4s. to 5s. per 100 miles. There must be room for reduction here, and the opening to the two new docks may precipitate a concession to the grievously harassed Yorkshire coalowners,

A dispatch from Kansas City, Mo., June 16th, says:—"A train appeared on the top of the steep incline on the new cable road, near the Union Depôt, yesterday afternoon, and dashed down at a fearful rate of speed. The train was composed of two cars and a grip car, and was filled with passengers, who when they saw the train beyond control, endeavoured to escape, but remained in the cars, as to jump from the train would have been almost certain death. As the train proceeded it gained in speed. At the end of the plane at the depôt it collided with another train. Four men who were on the grip car were seriously injured. One had both legs amputated, and will die. The road has been in operation only two days. The accident was caused by the gripman becoming excited and losing control of the grip."

The tendency of the railways in the United States has been to combine into systems forming some of the longest lines of continuous railway administration in the world. The whole railway mileage in the United States and Canada is about 120,000 miles, and nearly half, or 57,954 miles, is in the hands of fifteen companies, which in turn represent the amalgamation of a greater number of corporations. The magnificent distances traversed by these railways are as follows:—Missouri Pacific, 6045 miles; Chicago, Milwaukee, and St. Paul, 5804 miies; Chicago and North-western, 5645 miles; Pennsylvania, 4807 miles; Union Pacific, 4748 miles; Central Pacific, 4194 miles; Canadian Pacific, 3948 miles; Wabash, St. Louis, and Pacific, 3507 miles; "Vanderbilt" roads, 3066 miles; Grand Trunk, 2950 miles; Atchison, Topeka, and Santa Fe, 2799 miles; Southern Pacific, 2789 miles; Baltimore and Ohio, 2737 miles; Northern Pacific, 2549; Louisville and Nashville, 2366 miles; total, 57,954.

Asking whether in case of accident it is better, should couplings hold or break, a correspondent, "J. M. G." writes as follows to an American contemporary:—"One day last winter I was a passenger on a train, the baggage and express car of which left the track and went down the bank, dragging with it the smoker, which was next behind it. The near coupler of the smoker gave way, and the car in rear of the smoker, with the others behind it, remained on the rails. Hence the breaking of a coupling operated to save a part of a train from derailment. In the instance specified below the holding of a link had the effect of preventing a wreck. On February 23rd, 1885, as train No. 31 of the Erie and Pittsburg-road, Donlin, conductor, reached a point 1½ miles north of Albion Station, an axle in the forward truck of a loaded box-car broke just inside the wheel. The wheel fell between the rails with journal side up, and was caught and held by the sand-board, or lower bolster, of the following truck. The dismembered truck went into the ditch, leaving its end of the car hanging on its coupling. The link of this coupling carried the disabled car, and hauled the train behind it, with the detached wheel skating along the icy road-bed, as far as Albion, where the break was discovered."

NOTES AND MEMORANDA.

It is said that a rich find of silver chlorides has been made on the surface of the Broken Hill claim at Silverton, New South Wales, which is said to run through a lode over 20ft. wide. The chlorides have been found for a distance of nearly half a mile. A great many claims have lately been pegged out along this line of country for miles.

Returns just available show that the shipping trade was particularly active at Glasgow during the past month. The inward tonnage amounted to 126,646, or an increase of 30,387 tons; while the sailings were 144,701 tons, or an increase of 7968 tons. On the six months the arrivals show an increase of 68,174 tons; while the sailings in the same period have decreased by 23,049 tons.

A new alloy, a combination of manganese and tin, is being brought out by Messrs. Billington and Newton, of Longport. The tin and manganese are said to be amalgamated under a new process, the result of a series of costly experiments. The new alloy is offered as suitable for bearings in which shafting is required to run at a high speed, for steam ship propellers, and other purposes for which a high degree of tenacity and closeness of grain are requisite.

Nitrogen is solidified at a temperature of − 214 deg. and under a pressure of 60 atmospheres, its critical point being − 146 deg. under the pressure of 35 atmospheres. By carrying the rarefaction to 4 mm. of mercury, the author has succeeded in obtaining a temperature of − 225 deg. The solidification point of carbon monoxide is − 207 deg. with a pressure of 100 m. of mercury. Oxygen stills remains liquid at a temperature considerably below − 211 deg.

The results of eleven months' use of toughened glass beakers are thus summarised by Mr. R. F. Friswell, in a paper read before the Chemical Society:—"Of twenty beakers, two burst spontaneously, = 10 per cent.; one burst on hot water being poured in, = 5 per cent.; six became useless from fissures and enfoliation, = 30 per cent.; eight are in good condition, = 40 per cent.; three have been broken by unknown means, = 15 per cent. Taking into consideration the loss of confidence caused by the high percentage of spontaneous bursting, it may be said that toughened glass is a complete failure in the laboratory."

A paper was recently read before the Physical Society "On Stream-Lines of Moving Vortex-Rings," by Professor O. J. Lodge. The communication described a method of drawing vortex stream lines, consisting in superposing uniform motion, represented by a series of parallel lines upon the lines of a stationary vortex, as given by Sir W. Thomson in his memoir on vortex motion, and joining up the corners of the quadrangles so formed. This operation is very simple, and by its application a number of the more remarkable properties of vortex rings may be obtained, the general analytical investigation of which involves mathematical methods of the highest order. Drawings were exhibited showing the nature and behaviour of a single vortex ring moving with different velocities, a vortex ring approaching a large distant obstacle, the chase of two unequal rings, and many other cases.

A battery with a circulating liquid is described by J. Carpentier (*Compt. Rend.*, 100, 849—851). The essential part of this battery is a syphon with unequal limbs, both of which are plunged in the same vessel containing the exciting solution. In the longer limb are placed the electrodes, consisting respectively of zinc and carbon, and the syphon is filled in any convenient way. So long as the circuit remains open the liquid in the syphon remains homogeneous, and equilibrium is maintained, but as soon as the circuit is closed the zinc dissolves and increases the density of the liquid in which it is immersed. Hydrostatic equilibrium is thus disturbed, and a circulation of the liquid is established proportional to the intensity of the current. The heavy liquid containing the zinc falls to the bottom of the vessel and remains distinctly separated from the fresh solution, whilst the latter continually ascends the short limb of the syphon and is brought in contact with the electrodes.

Some experiments of L. Forquignon upon malleable iron led him to suppose that cast iron, at a temperature somewhat inferior to its melting point, is decomposed into free graphite and a purer carburet of iron. He accordingly heated cast iron in a vacuum, to a temperature of from 900 deg. to 1000 deg. C., for several days, without melting or softening. The metal became malleable, and its surface was covered with a dull grayish efflorescence, which produced a mark upon paper or on rough porcelain. The fracture was sometimes of a uniform black, like that of a lead pencil, and sometimes it was dotted with black grains of amorphous graphite, regularly disseminated throughout the mass. It seems probable that this partial decomposition depends upon a tendency to equilibrium between the carbon, the iron, and the carburet of iron, the relative proportion of each of these bodies being a function of the temperature. The decomposition of a homogeneous solid into two other solid bodies is a very rare, if not a unique phenomenon.

An abstract of a paper on the examination of potable water, by J. W. Gunning, is given in the "Journal" of the Chemical Society. The method recommended by the author for the chemical examination of water consists in adding to a litre of the water, enough ferric chloride to correspond with about 5 mgrms. of iron. The ferric chloride should be as nearly neutral as possible. Under these conditions, ammonia, nitrites and nitrates are left in solution, whilst other nitrogeneous substances are carried down with the precipitate of ferric hydroxide. By heating this with soda-lime the nitrogen of these compounds is obtained as ammonia. By this treatment cloudy water is completely clarified and yellow moor-water decolorised. The process has been applied with success on the large scale in Holland for the purification of drinking water, especially during diarrhœa and cholera epidemics. In the bacterological examination of water, the author prefers to develope a pure culture in a liquid medium rather than in the solid medium recommended by Koch. The water to be tested is mixed with a clear sterilised yeast decoction. By sterilising this again, certain bacteria are either killed or rendered inactive, while the others from their superior vitality survive and develope. By a process of progressive sterilisation, beginning at low temperatures and gradually ascending, pure cultures are obtained.

The behaviour of the different modifications of carbon towards iron at an elevated temperature has been made the subject of experiments by Mr. W. Hempel (*Ber.*, 18, 998—1001), and these have been described in the "Journal" of the Chemical Society. In the experiments, the author employed commercial malleable iron-foil containing 0·021 per cent. carbon, 0·04 per cent. silicon, and 0·336 per cent. manganese; the diamonds were perfectly colourless, and were previously heated to redness in an atmosphere of nitrogen; the amorphous carbon was obtained by gradually heating chemically pure sugar to a white heat. A comparative experiment is described in which a piece of foil was covered at one end with amorphous carbon, in the middle with diamond-dust, and at the other end with graphite (crystallised from cast iron); the whole was heated for about two hours in a current of nitrogen to the highest temperature of a combustion furnace, after which treatment the iron was found to be unaltered. At the somewhat higher temperature of a blow-pipe, the iron was converted into white iron where it was in contact with the diamond, while those portions covered with amorphous carbon and graphite appeared to be unaltered. The lowest temperature at which carburation takes place with the diamond, is estimated (by Prinsep's method) at 1160 deg. The carburation by means of amorphous carbon was effected in a Schlosing's furnace, and the lowest temperature at which grey iron is formed estimated at 1385 deg. to 1420 deg. On exposing iron placed between carbon poles (in an atmosphere of nitrogen) to the temperature of the electric arc, white iron is produced. The different behaviour of the diamond and of amorphous carbon towards iron is compared to that of white and amorphous phosphorus to solvents.

MISCELLANEA.

The prospectus has been issued of a company proposed to be incorporated to construct waterworks under concession from and for the free town of Szegedin, in Hungary, Messrs. Owen and Elwes, Westminster, being the engineers.

At the anniversary meeting of the Sanitary Institute on the 9th, Sir John Lubbock presented the medals and the certificates to the successful exhibitors at the Exhibition held in Dublin. Prof. W. H. Corfield gave an address on "The Water Supply of Ancient Roman Cities."

Mr. J. S. Dixon, president of the Mining Institute of Scotland, stated at a meeting of that body held at Hamilton a few days ago, that the arrangements for the forthcoming exhibition of mining machinery were making satisfactory progress, and that a considerable number of applications for stands had already been received. The exhibition is to be held in Glasgow at the same time as the autumn meetings of the Iron and Steel Institute.

The Paris *Petit Journal* lately published an article, presumably intended to be serious, on bottled energy—"La Force en Bouteille." After passing in review the various methods—mechanical and electrical—for storing up energy, the writer gravely proposes to utilise the momentum of trains in motion, not merely when they are being pulled up, by attaching to their sides by rods and pulleys pumps for compressing air and bottling it, to be turned to account when and where required.

The engineer to the Local Board of Petersfield, Hants, Mr. Henry Robinson, C.E., of London, has been sinking a shaft in the neighbourhood of the town for supplying it with water. The site was chosen so as to get a supply from the Hythe beds and avoid the ferruginous water which is found in the overlying Sandgate beds. This has been successfully accomplished, inasmuch as at a depth of between 70ft. and 80ft. an abundant supply of very pure soft water has been reached.

A new appliance for drying and superheating steam has been devised for multitubular boilers by Max Gehre, of Hanover. As superheaters in the fire-box act unequally, and are liable to great strain, the Gehre apparatus is placed in the smoke-box, being composed of a chest traversed by tubes forming a continuation of those in the boiler, but of rather larger diameter. The steam is thus superheated by contact with the outsides of the tubes and the inside of the chest, both heated by the products of combustion.

The centenary of the establishment of the Dartford Ironworks, known as J. and E. Hall's, but now carried on by Messrs. Everard Hesketh and Bernard Godfrey, was commemorated by athletic sports, tea, concert, dancing, and fireworks last Saturday, and was a memorable success, every detail of the diverse arrangements being carried out with the utmost efficiency under a large committee. In the course of the evening Mr. Hesketh gave a lengthy description of the rise and progress of the works, and of the life and labours of John Hall and his sons John and Edward. The *Dartford Times* of the 8th inst. gives a full account of this history and of the proceedings of the day.

It appears that there are upwards of 600 local electric lighting companies in the United States and Canada. If to the arc and incandescent lamps run by these companies could be added the lamps belonging to isolated plants and private persons and institutions, some adequate notion might be formed of the rapid advance of electric lighting and of its solid basis. All Europe cannot show figures to match those of the United States in the department of public lighting. One field in which greater development has been made in Europe is that of ship lighting, for the reason that Europe has more ships than America of the sea-going class. Another field is that of installations in miniature for city dwelling houses and country residences.

At a depth of about 1100ft. Messrs. Allhusen have been successful in finding salt in two further bore holes at their Cowpen Marsh Works, Port Clarence, Middlesbrough. Their evaporating plant and that of the Haverton Hill Salt Company, are both being pushed forward vigorously, and it is probable that by September next both these companies will be in the market as salt vendors. We also understand that at Eston the bore hole which is being sunk by Messrs. Bolckow, Vaughan, and Co. is now within a distance estimated at less than 200ft. of salt. In the course of a year or two Teesside and the Middlesbrough district will probably be as widely known for chemical works as hitherto for the production of iron and steel.

On Tuesday, at a meeting of the City Commission of Sewers, it was moved that, having regard to the repeated failures of private companies to supply electricity, it was desirable that the Commission should undertake street lighting by eletricity, and that it be referred to the Streets Committee to select a small area and obtain estimates of cost of installation. The Commission, he said, were the lighting authority, under the Act, for the City, and they had ample power and means to undertake the duty. He suggested an experimental lighting of a small area, the cost of which should not exceed £1500. After some discussion, it was decided that the whole subject generally should be referred to the Streets Committee to consider and report.

Messrs. James Taylor and Co., of Birkenhead, have just completed a large 60-ton steam-fixed crane for the Japanese Government. The machine is to be immediately sent to Yokosuka, near Yokohama. The crane, when fixed, will be close upon 50ft. high, and will stand upon a foundation of concrete and masonry. It has a sweep of 46ft. radius, and has a "live" ring with a series of rollers working on a path 27ft. in diameter. The jib is of steel in the shape of two cylindrical masts united at the top and terminating with rope pulleys all in one structure. The back stays are also made of steel. The rope to be used is of steel wire. The crane is provided with four different speeds so as to lift quickly lighter loads down to five tons. The machinery is so arranged that it can be worked by one man. The motive power is supplied by a pair of engines of about 15-horse power.

Messrs. Alex. Stephen and Sons, shipbuilders, of Linthouse, Glasgow, have during the past week added to their plant a 60-ton Denison's patent suspended weighing machine. This machine is very easy and handy to manipulate, and has no loose weights; it is also extremely sensitive for so large a power, and indicates a weight of 7 lb. with its full load on. The machine is made entirely of forged iron and steel, and weighs only 19 cwt. 1 qr. 4 lb. The makers of this tool are Messrs. S. Denison and Son, of Leeds, who are the originators of the system of weighing large weights in suspension by means of compound leverage, and who claim for all these appliances that, when sent out of their works they are accurate to ·001 per cent. of their capacity. Messrs. Stephen will now be able to ascertain with certainty and the smallest amount of trouble the exact weight of their marine boilers, tanks, engines, &c., as they are being lifted into the ships, thus saving a great amount of work.

The members of the Société des Ingénieurs Civils, of Paris, have been invited by the Association des Ingénieurs sortis de l'Ecole de Liège to visit the Antwerp Exhibition and other points of interest. A deputation of the Liège society will go to Paris in a special train of sleeping cars to fetch their French *confrères*, who are timed to arrive at Antwerp at 3 p.m., 9th August, when there will be the inevitable *vin d'honneur* and speeches by the municipal authorities. On the 10th, a visit to the Exhibition will be followed by a banquet. On the 11th, the Antwerp Harbour works will be visited, under the guidance of the engineers of the Ecole de Gand. The 12th will be spent at Brussels, where a banquet will be given by the engineers of the Ecole de Gand, the Ecole de Louvain, and the special engineering school annexed to the Brussels University. On the following days there will be alternative excursions to Ghent and Louvain or to Liège and Spa, including the Cockerill Works. It is this invitation to the French engineers which has this year prevented the Liège engineers from paying their return visit to the members of the Institution of Mechanical Engineers.

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*** *This week a Double Number of* THE ENGINEER *is published containing the Index to the Fifty-ninth Volume, a large quantity of extra matter, and a Supplement consisting of a double-page engraving of a Four-coupled Passenger Engine, Great Southern and Western Railway of Ireland. Price of the Double Number,* 1s.

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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.*

DEATH.

On the 13th July, at his residence, 26, Endsleigh-gardens, GEORGE GORDON PAGE, M. Inst. C.E., in his 49th year. Australian papers, please copy.

THE ENGINEER.

JULY 17, 1885.

THE DISTRIBUTION OF ARMOUR IN SHIPS OF WAR.

AN official publication has recently made its appearance, being the substance of two lectures delivered at the Royal Naval College, Greenwich, by Mr. W. E. Smith, Instructor in Naval Architecture at that establishment, and Assistant-Constructor at the Admiralty. The subject treated upon is identified with the controversy as to the value of the continuous belt in armour-clad ships, and the merits of the citadel system. An introductory note by Sir Nathaniel Barnaby, the Director of Naval Construction, gives peculiar importance to the succeeding pages, testimony being given to the qualifications of the lecturer and the accuracy of his facts. It is evident that the dissertation contained in the book is intended as an official defence, and embodies a reply from the Admiralty experts to those critics who have assailed the character of the armour-clads which have been constructed since Sir Edward Reed left Whitehall. The lectures, in the form which they now present, are therefore authoritative, and in that respect possess more than ordinary significance. Happily the various points at issue are discussed in a calm and logical spirit, the relative advantages and disadvantages of the two systems being brought forward in a manner not only practical, but we might say also philosophical. The fiery declamations and onslaughts of Sir Edward Reed are here met by hard facts and cool arguments, care being taken to elucidate the true conditions of the problem. Indeed, it is on this point that everything turns. The naval architect is limited by certain conditions, beyond which he cannot escape, and his skill has to be shown in the exercise of the principle of selection, taking care that he does not lose more in one direction than he gains in another. Imperfection must be accepted as inevitable; but in no respect is a ship to be so imperfect as to admit of her speedy destruction by any possible mode of attack to which she is liable to be subjected. If an agreement could be arrived at as to the relative values of the various risks to be encountered by any one ship, little room would be left for difference of opinion as to the best balancing of imperfections. Excess of size is itself a defect in a ship, and this fault would be the necessary outcome of a demand for thick and extensive armour, enormous guns, great engine-power, large coal-carrying capacity, and the like. Cost also has to be considered, and although it is said that the nation is ready to vote all the money necessary for creating and maintaining a powerful navy, an expensive ship is not generally approved.

Newspaper authorities and parliamentary orators dealing with naval questions will do well to study the points to which attention is drawn in Mr. Smith's lectures. Perhaps, as suggested, some of these gentlemen would like to see a ship with a continuous belt of armour ranging in thickness from 24in. down to a minimum of 18in. As to guns, possibly four of 150 tons each would be thought desirable, supplemented by a dozen 6in. guns. As a defence against torpedoes there might be an inner bottom of 4in. armour at a distance of 10ft. from the outer bottom. Speed must doubtless be 20 knots. All this can be had if we submit to a displacement of something like 25,000 tons, and a cost not far short of £2,000,000. The ship must be more than 500ft. in length, her beam about 75ft., the mean draught 28ft., and the indicated horse-power about 30,000. But her armour would not be absolutely gun-proof, and there would be no actual protection against ground mines. Whether any mortal man could efficiently command such a huge machine is a matter of doubt. Notwithstanding the great power of her engines, such a ship would be difficult to handle, and might be out-manœuvred by a shorter vessel, capable of turning more rapidly. Passing away from this ideal monster to ships of practical size, we may see how the increase of any one element of efficiency has to be balanced by a decrease in another direction. We may compare a ship having an armour belt from end to end with another having only a short belt. The latter will have a displacement of 10,000 tons, a speed of 16 knots, and four 63-ton guns. The ship with a completely protected water-line will have a displacement of 10,900 tons, her speed will be reduced to 15 knots, and her four guns will only be of 48 tons each. At some points the bigger ship will have thicker armour than the other, but at other points the short-belted ship will have the best protection. On the whole, the fully belted ship will have most armour, yet the other will have the best defence for the loading gear of the big guns. If we go to a larger size, and have a fully belted ship of 11,200 tons, the speed is still 1 knot less than that of the short belted, and the coal capacity will also be deficient. The guns will be three of 75 tons, and the loading gear will be imperfectly protected. A useful comparison can be made between the Camperdown and the Dreadnought. In the former the maximum thickness of side armour is 18in., there are four 63-ton guns, the speed is 16 knots, and the displacement is 10,000 tons. In the Dreadnought the maximum thickness of armour is only 14in., the four guns are of 38 tons each, the speed is 14 knots, and the displacement is 10,800 tons. For the latter it may pleaded that the hull is completely protected along the water-line; but it would appear that this advantage has been purchased at the sacrifice of other valuable qualities. The latest types of English battle ships are spoken of as being all central citadel ships, the turret ships having a comparatively high and short central citadel, and the barbette ships a shallower but longer belt. As an example of the turret central citadel ship we have the Agamemnon. The armour composing the citadel extends for a length of 104ft., and reaches from 6ft. under water to the upper deck. At the ends of the vessel there is no side armour at all; but a 3in. under-water deck runs from the end of the central citadel forward to the stem, where it gives thorough support to the ram, and aft to the stern of the ship, where it protects the compartments below it. It is very difficult for a projectile to get either through or below this deck, on account of its being so far under water. Projectiles striking the hull near the water-line will simply go through the ship above the deck, and the inflow of water cannot extend below. On the other hand, it is argued that a heavy projectile striking a fully belted ship in the region of the water-line where the belt is thin, would get through the side armour, and under the protective deck, which is on the top of the belt. Hence the projectile would reach the vitals of the ship, and might blow her up by firing the magazine. It is claimed for the under-water deck of the central citadel ship, that it prevents all risk of such a catastrophe. Supposing the magazine of the belted ship not to be touched, a very large and perhaps fatal quantity of water would find its way into the compartments below the protective deck, this deck being above the water-line. In the citadel ship the top of the protective deck is not only below the water-line, but is covered by coals and other stores, which serve to exclude water when the thin ends are damaged. When the stores are consumed, or partially so, and the thin ends are riddled by shot and shell, so as to admit water on to the protective deck, the vessel does not sink so far beyond her load draught as when the ends are riddled and all the stores are in place. Thus the Inflexible with all the stores and coals on the under-water deck in their place, and her ends riddled, would sink 23in. below the load-draught; but with half the coals and stores on the under-water deck, and the ends riddled, the sinkage is only 19in.; and with all the coal and stores gone, the sinkage below the load-draught is as little as 15in. Moreover the stores on the protective deck are separated into several water-tight compartments, all of which must be destroyed before these sinkages can be brought to pass.

An objection to the citadel ship lies in the fact that the ends being formed of only thin plate are readily penetrable, rendering a diminution of speed and stability both possible and probable. But if the belt were carried to the ends of the vessel, and all her existing qualities were retained unimpaired, there must necessarily be an addition of more than 1000 tons to the displacement, and there would be less security against certain risks than there was previously. Thus the steering gear would be more exposed, the magazines and shell rooms could be more easily reached, and it would be more likely that the damage caused by monster projectiles would completely flood one or both ends of the ship than when the strong deck was well under water. The effect of the change is thus described: In attempting to obviate the risk of having a *moderate* quantity of water almost certainly admitted to the ends, we have largely increased the risk of having *fatal* quantities of water admitted, besides which we have increased the probability of the ship being blown up, or rendered unmanageable by damage to her steering gear. At the same time the size of the ship has been greatly augmented. A very striking description is given by Mr. Smith as to the manner in which a belted ship may be capsized by water entering through shot-holes just above the belt. The wave raised by steaming is sufficient to send water in above the belt, when a shot has entered at that spot. If there be any sea-way, and the vessel rolls, the process is much more rapid. If the vessel be rolling, the water runs from the side that rises to the one that descends. Going to the lower side, the water is there imprisoned by the superior level of the water outside; hence the water comes in faster than it goes out, and the vessel ultimately capsizes. The catastrophe can only be prevented by stopping the holes, or by the effect of water-tight subdivisions remaining intact despite the enemy's fire. Models have been constructed to demonstrate this fact, and the belted model has capsized as readily as the other. But the result depends on having the water agitated. If the surface remained at a dead level the belted ship would not receive water through holes above her armour. This condition, however, is not likely to be fulfilled, the mere passing through the water when steaming at high speed being sufficient to create a considerable wave. So far as mere sinkage is concerned, it appears that the Inflexible goes down 4in. more when she takes in her coals than she would if her unarmoured ends were completely riddled and the numerous water-tight subdivisions which they contain were destroyed. In the Warrior the sinkage due to riddling would be 16in. more than that caused by coaling; in the Resistance, 26in.; and in the Agamemnon, 2in. In the Inflexible the effect is reversed, and we see the same in the Colossus, the Collingwood, and the Camperdown. The last named sinks 8in. more in coaling than she would by riddling. Accordingly, we are told that the amount of sinkage due to riddling is not great in itself, and, unless it involves the loss of seagoing and fighting qualities in the ship, cannot itself be objected to. If only one end be riddled, the ship will change trim unless water be voluntarily admitted to the other end, and for this provision has been made. We are told that the change of trim is in no case sufficient to cause much inconvenience to those on board, and does not imperil the ship in the slightest degree. In summing up his arguments, the lecturer says he does not want to leave an impression that the belted ship is less safe against the machine-gun and small gun than is the central citadel ship, or that the belted ship could be easily capsized by the complete destruction of her upper works. But he contends it is altogether wrong to suppose, as some do, that the possession of a completely armoured water-line takes away all serious risk with regard to the fire of light guns. He says it is perfectly true that the "Admiral" type of ship is destructible by light guns "if they have time enough." But, he adds, it is also "perfectly true" that the belted ship is destructible by the same weapons, and is more likely than the citadel ship to be destroyed by the big gun.

In discussing the behaviour of ships in a sea-way, Mr. Smith says that both resistance to rolling, and stability are necessary to safeguard a ship against capsizing. It is a singular, and, we may say, a happy circumstance, that the resistance to rolling is increased when the ends of the citadel ship are perforated and water is admitted. This principle is turned to account in what is called the "water chamber," which enters into the design of the more recent of our battle ships, and has been tried on a large scale in the Inflexible. Into all the details of the official defence we cannot at present enter; but what we have said may suffice to show its general character. The subject has been most carefully worked out by Mr. Smith, and the principles laid down are of extreme interest. Perhaps the lecturer has done more to show an equality of risk than a superior degree of safety as between a citadel and a belted ship. But this view of the case is simply another expression for the fact that fighting means mischief, exemplifying the proverb that we cannot make omelettes without breaking eggs. Certainly, the completely belted ship is made to appear as possessing none of the superiority which has been claimed for it by some eminent advocates.

TORPEDO BOATS.

THE experience acquired during the cruise of The Evolutionary Squadron on the coast of Ireland has not added much to the previously existing stock of information concerning the performing powers of torpedo boats. It did not require any special foresight to perceive that a boat built of steel plates one-eighth to one-sixteenth of an inch thick was not well calculated to bear the shock of a collision or to jump a heavy boom. It was also obvious, though not quite so obvious, that a craft of this kind, if made watertight above the level of the sea as well as below it, would be as unsinkable as a corked bottle. The torpedo boats stood rough weather very well in a sense, that is to say, they did not sink, although two of them leaked, and they could steam at a fair speed. Indeed, German experience goes to show that in rough weather these boats must be kept steaming at such a pace that they will go through rather than over the waves. It does not appear, however, that a torpedo boat could effect anything in the way of attack during a moderate gale. Her excessive liveliness would render it impossible to despatch a fish torpedo with any accuracy of aim; and the performance of the fish in a rough sea is well known to be extremely unsatisfactory. One thing, however, is certain, and that is, that in the smaller torpedo boats, at all events, the motion in a rough chopping sea is so violent and incessant that no crew can stand it for many hours. Cooking becomes impossible; the accommodation on board is miserable, and must of necessity be so; and it is extremely difficult for even the most hardened sailor to get sleep. All which goes to prove that the smaller type of torpedo boats is only suitable for operations in smooth water, such as harbours, and rivers, and bays. This does not mean that they are useless, but only that their utility is limited;' and any ironclad having a good offing would be quite safe as far as torpedo attacks go, so long as it blew pretty hard with a rough sea.

Of late the principle involved in the torpedo boat has been extended, and craft of the kind of considerable dimensions, comparatively speaking, have been made. There is still, however, we think, too wide a gap between even the largest torpedo boat and such a ship as the Scout. No navy in the world at present possesses a boat of 250 tons displacement or thereabouts capable of steaming at a very high speed, and yet it seems certain that vessels of the kind could be made extremely useful. A boat of this kind built of steel, as light as it is possible to make her, and of good form, ought to attain a speed of 20 knots with about 2000-horse power—possibly less would do. For various reasons this, however, would best be divided between two screws, say 1000-horse power to each. A speed of 20 knots an hour is 2082ft. per minute. If the engines make 300 revolutions per minute, a pitch of 6·9ft. would suffice to give this speed, provided there was no slip. Allowing 20 per cent. for slip, then a pitch of 8ft. 3in. would do very well. The engines would be of moderate size. With a stroke of 2ft. the piston speed would be 600ft. per minute. Now 1000-horse power = 33,000,000 foot-pounds per minute, and $\frac{33,000,000}{600} = 55,000$lb. as the average gross effective pressure on the pistons. Referring the power all to one cylinder, and taking the average effective pressure as 50 lb. on the square inch—corresponding to an absolute boiler pressure of, let us say, 175 lb. on the square inch—we have $\frac{55,000}{50} = 1100$ as the number of square inches required in the piston. This is the area of a piston 31½in. in diameter. We have here the elements of our compound engine. The low-pressure piston will be 31½in. in diameter; the high-pressure cylinder about 17½in. in diameter; the stroke 2ft.; propeller about 8ft. in diameter, by 8ft. 4in. pitch. All these are perfectly manageable dimensions. The power contemplated is, of course, much less in proportion than that provided in an ordinary torpedo boat, being only 4-horse power to one ton of displacement; whereas in torpedo boats it sometimes rises to as much as 25-horse power to the ton. But it must be remembered that as the displacement increases the propelling power required for given speeds rapidly decreases in proportion. Thus, for example, the Oregon can run 20 knots an hour with very little more than 1-horse power per ton of displacement. There would be no difficulty in supplying steam by the aid of boilers working with a forced draught.

Such a craft as we describe could be made to play an important part in channel warfare. As the upper works could be very small at all events when she was in fighting trim she would be very difficult to hit at any distance with a gun of some size; and it would be quite possible to make her turtle-back deck proof against the fire of machine guns, save at very short ranges, over at least all those portions which needed protection, such as the engine and boiler rooms and the torpedo chamber and magazine. Men could live on board such a craft in some comfort; and she would in time of peace make an admirable despatch boat, running at 15 or 16 knots with a very small consumption of fuel. As to her armament, that would be matter for consideration. She would be provided above and beyond all else with torpedoes; and it would appear that she might with advantage be fitted not only with the ordinary fish torpedoes but with torpedoes to be towed. These would prove very useful in case she was attacked by torpedo boats herself, as with a little manœuvring she could perhaps get them foul of the towing line, when their disablement would be tolerably certain. Possibly more may yet be heard of towed torpedoes coming along in the wake of a boat instead of being launched before her, and towed broad off either beam at pleasure by devices well known to sailors. In addition, our imaginary craft ought to mount a couple of rapid-fire six-pounders, one in the prow the other in thestern, for she is supposed to fight as well running away as at any other time.

It is of course out of the question to do more than roughly sketch here the salient features of a type of vessel which might, we think, be added to our navy with advantage. It is not to be supposed that 250 tons displacement possesses any charm, or that it may not be departed from either way. As soon, however, as we go much above it, we get a vessel too big and costly for its purpose; while if we go much below it the hull will be too small to carry all that is necessary. It will be found, we think, that on a displacement of 250 tons, a very satisfactory craft can be produced, which would be much more generally useful than any torpedo boat now afloat. There is no doubt but that such boats will be built ere long. The drift of opinion among qualified authorities is in favour of big torpedo boats. In all probability, however, the English navy will be the very last navy in the world to have them.

CELYON RAILWAYS.

ON the 20th May last the first through train from Colombo ran to the Nanuoya terminus of the extension which has just been added to the railway system in Ceylon. The total distance to which this main line has now been opened is but 130 miles; a length which may appear to be insignificant, but which ceases to present that appearance when the character of the works upon it is taken into account. These are among the heaviest which have ever been undertaken, and the fact that this comparatively short length of line reaches an altitude of 5291ft. must suffice to afford evidence that the obstacles to be overcome have been of a decidedly serious nature. We purpose to indicate the chief of these, and to quote figures illustrative of the heavier works of construction involved in the attainment of the present terminus. For the first fifty miles from Colombo, the rails—as a single line—are laid, comparatively speaking, almost through a level country, but when that distance is reached the ascent is commenced by the great Kadugannawa incline, the successful engineering of which did such great credit to the skill of its designer, Mr. G. L. Molesworth, M. Inst. C.E., the present Director-General of Indian State Railways. This incline carries the traffic up to Peradenia, about seventy-one miles from the starting point, and to an elevation of 2000ft. above sea level. At this place there is a junction, whence a branch carries the traffic into the mountain capital, Kandy, and thence on to a northern extension of seventeen miles to Matale.

The great Kadugannawa incline alluded to has a length of 11¾ miles, and constitutes the first attack upon the formidable barrier of mountain ranges which occupy the southern central portion of the island. The total rise is 1388ft., to attain which a continuous gradient of 1 in 45 had to be adopted, while the sinuosities of the mountain spurs enforced curves as low as of 660ft. radius. There is, perhaps, no finer sight imaginable than from the low country to watch at night the descent of a heavily loaded train down this incline. With steam shut off and full brake power on, its whole course appears a streak of flame in the darkness, from the commencement to the termination of its descent. Severe as are the conditions under which this incline had to be constructed and worked, they are surpassed by those which have had to be contended with in the extension, the completion of which we now chronicle. The more the heart of the hill country is reached the sharper becomes its features as they trend upwards to the extreme ranges. On the first incline above described it was thought that the limit of gradients and curves had been reached, so as to insure a possibility to safe and economic working of very heavy traffic, and for a long time fears were expressed that it would be necessary to rest and be thankful at a point, Nawalapitya, some seventeen miles beyond Peradenia. On the section between these two places, the works required, though exceedingly heavy, presented no very grave obstacle. Beyond Nawalapitya, however, the course of the line just completed had to be laid through a country presenting natural difficulties even far exceeding those met with on the Kadugannawa incline, and the boldness of the engineers has been taxed to the utmost in the provision of means to overcome them.

It must be remembered that it was a *sine quâ non* for this last extension that it should in every respect be suited to the necessities of first-class traffic. No reversing stations were permitted, still less any break of gauge, while the passage of the rolling stock from the low country was to be continuous. We find, therefore, that to meet these requirements curves of as low a radius as 300ft. had to be adopted, and these upon inclines of 1 in 44. The curvature was of almost continued reversal to enable the line to wind in and out of the mountain spurs. We shall, perhaps, best convey an idea of the character of the works now terminated by placing before our readers in a tabulated form the particulars of the several great inclines of the world in comparison with those on the Ceylon Railway.

Name of incline.	Length of incline. Miles	Total rise in feet.	Average gradient	Steepest gradient.	Sharpest curve in feet.	Length of tunnels. Miles.
Giovi	6	884	1 in 36	1 in 29	1320	2·25
Semmering	13¼	1325	1 in 47	1 in 40	660	2·66
Bhore Ghaut..	15⅞	1831	1 in 48	1 in 37	1000	2·26
Alleghany	15	1690	1 in 47	—	600	
Tabor (Chili)	12	1360	1 in 46½	1 in 44½	604	
Kadugannawa (Ceylon)	11¾	1388	1 in 45	1 in 45	660	·88
Ambagamuwa do.	19	2227	1 in 45	1 in 44	300	.30

The last in the foregoing list is included within the extension now just completed. Its extreme curves and gradients, when associated, show a severity not met with on any other of the works contained in the list, and we may feel proud of the advance of engineering science which has rendered their adoption possible and successful. The colonists of Ceylon hope soon to see undertaken a yet further extension to the summit of the Haputale Pass. The design for this has been prepared, and its execution will also involve a further incline of 12 miles rising 1359 feet, on which an average gradient of 1 in 46½ with a maximum of 1 in 44 will be compulsory, as it will also the adoption of curves as sharp as 300ft.

We have thus briefly sketched the leading features of one of the heaviest works of railway construction as yet attempted. Of the magnificent scenery met with throughout the entire length of the line it is scarcely within our province to speak; but it is known to be of such a character as to offer an inducement to passengers proceeding by the mail steamers to and from the East to avail themselves of the opportunity afforded by the necessary delay for coaling at Colombo to go as far at least as Kandy and back.

In connection with the subject of further railway extension in Ceylon, named above, we may refer to a rumour that the Governor, Sir Arthur Gordon, purposes an immediate visit to this country with the object of urging in person on the Secretary of State for the Colonies the immediate necessity of raising a loan for the purpose of carrying on the line another seventeen miles or so to the Haputale Pass. At this point it would appear that the colonists are willing that for the present railway extension in this direction should stop, and attention may then be given to further additions to the coast railways. There has been much discussion over the estimates for this proposed work, and we see it stated that a revision of them has shown the possibility of their reduction by sums variously stated between £50,000 and £80,000. Sir Arthur Gordon appears to have at last recognised the fact—so persistently asserted—that this extension will very largely increase the returns to be expected from that addition to the railway system of the island which has just been completed. That system has hitherto proved a most remunerative investment for the colony, and it can hardly be doubted, in view of the figures published, that its present and further extensions into the planting districts will afford equally satisfactory results, while the boon they must prove to the planting interest can hardly be over-estimated.

PROSPECTS OF SHIPBUILDING.

ALTHOUGH it cannot be said yet that there are many signs of improvement in the shipping trade, there is one indication of the future which must be kept in mind, and which will ultimately affect both the shipping and the shipbuilding trades. It is the decrease in the stocks of imported goods—especially of colonial produce. This has been in progress for some time, and it is to be believed that we shall soon witness a more extensive importation, and fuller employment for shipping, and it is on the latter that the hopes of the shipbuilding trade depend. We do not forget that there is a demand just now which is due to cheapness; there are some companies and firms who find that they can buy vessels cheaper than for many years, and who now take advantage of the circumstances, and have given out orders for vessels for special trades and uses, and some of our shipbuilders are employed in the construction of vessels for warlike purposes, which enables them to tide over the time of dulness in the trade. There is a benefit to both the buyer and the builder in these orders—the one in obtaining very cheap vessels and the other in keeping together connection and workmen. We believe that the tonnage is the gauge of working power, and the merchant shipping of the kingdom is now beginning to decrease—the amount launched being less than that lost—and as that decrease makes itself felt in the freight market there will be the change which has so long been desired. It is the wider employment for ships that must set in when there is any increase in prices of commodities and in freights which will stimulate the shipbuilding trades. Our merchant navy must be kept in the van of the navies of the commerce of the world; and whilst it is the primary need that the ships should be more remunerative than they have been of late, yet that will arise from their fuller employment, and from the fact that the carrying capacity for cargoes is decreasing. We are still building considerable amounts in tonnage, it is true; but it is tonnage for special purposes, and it includes a very large proportion of sailing vessels, whilst the loss is proportionately heavier in the cargo-carrying steamers which do so much of the world's oversea work. Very slowly the market is adjusting itself to the changed condition of trade, and it is pleasant to find that that change gives indications of more work for our shipbuilders in the early future.

CENTRIFUGAL PUMP PATENTS.

THE trial of the case of Gwynne *v.* Drysdale, which bears on centrifugal pumps, was opened in the Court of Session, Edinburgh, on the 14th inst., before Lord Ordinary McLaren. It involves determination of a point in which patentees and manufacturers as well as users of patented machines are deeply concerned, and is, therefore, followed by parties of these classes and others with considerable interest. The productions in the case include such a great variety of models that for their accommodation, as also the accommodation of the large number of witnesses, it was necessary to shift the trial from Lord McLaren's small court room to the large Justiciary Court Hall. The pursuers are Messrs. John and Henry Gwynne, of Hammersmith, and the defendants Messrs. Drysdale and Co., of Glasgow. Pursuer's patent is No. 2922, of 1878, which consists in fixing together the two main parts of a steam centrifugal pump, viz., the steam engine and the pump proper, so that the suction and discharge pipes may be set to any angle by swivelling the pump case without interfering with the driving engine, and the main point is whether or not the device is invaded by the defendants, who manufacture a steam pump with the two main parts arranged in the same way as pursuer's, but whose suction and discharge pipes cannot be swivelled without forming or boring fresh holes for reception of the bolts securing the parts together. Defendants plead that the patent founded on is null and void in respect (1) that the invention described was publicly known and used prior to the date of the letters-patent; (2) that the invention is of no practical utility. The leading skilled witnesses for pursuer are Messrs. Hunt, of Glasgow, Stevenson, of Airdrie, and Allan, of London; and for defendants, Messrs. Cruikshank and Fairweather, of Glasgow. We shall publish the judgment of the Court when it is issued, and possibly give further particulars as to the points of the case, as well as to their disposal.

THE COMMISSION ON TRADE DEPRESSION.

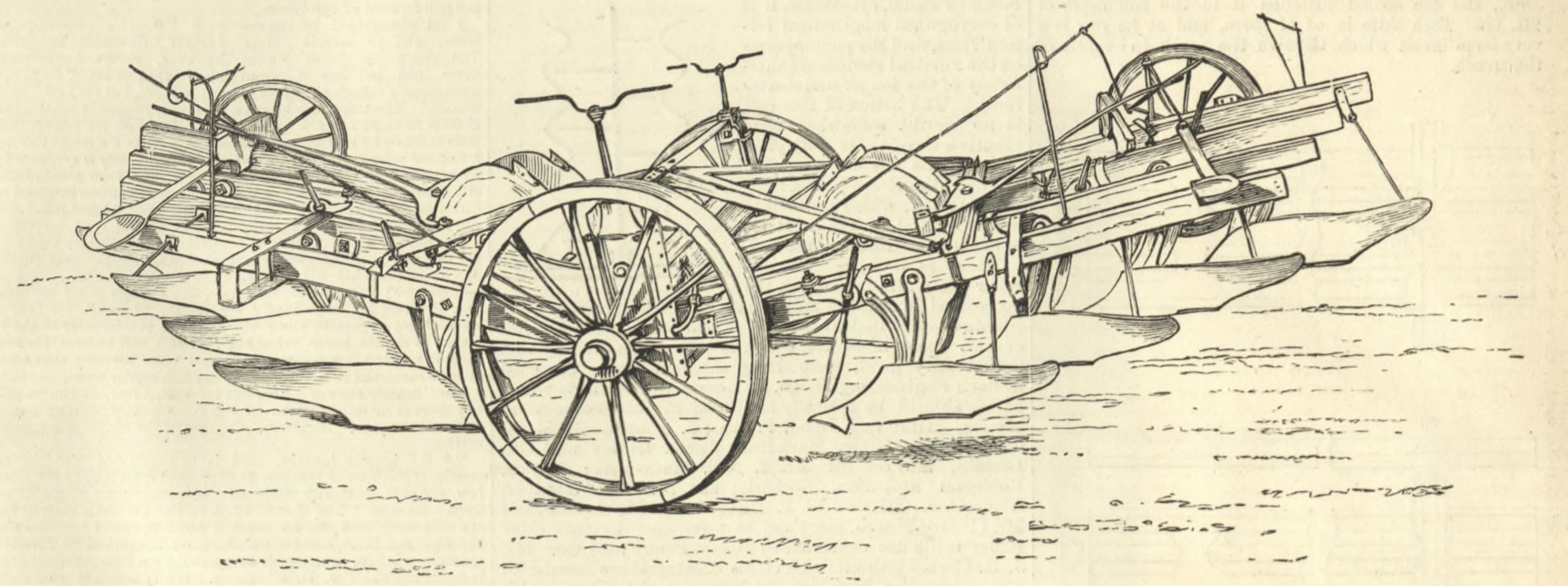
THE ironmasters and the iron manufacturers of the Cleveland district have united in drawing up a petition to Lord Iddesley, who is understood to be the presiding genius of the new Royal Commission of enquiry into the causes of the present depression in trade. The prayer of the petitioners is that Mr. David Dale, of Darlington, may be made one of the Commissioners. It is understood that the president and secretary of the Ironworkers' Association are likely to send up a similar petition on their own account. Mr. Dale seems, by his position and experience, singularly fitted for such a post. From a youth he has spent his life among the iron, coal, and railway interests of the North. He is a partner in the great firm of Joseph Pease and Co., a director of the North-Eastern Railway, chairman of the Consett Iron Company, director of the Barrow Steel and Iron Company, a Justice of the Peace, the referee of the Board of Arbitration, and he holds many other positions of importance and responsibility. There is no one who is more likely to throw light upon the enigma in question than Mr. Dale, and the selection of him as a Commissioner would be most acceptable to all classes in the North of England.

THE PRESTON DOCK AND RIBBLE IMPROVEMENT.

THE Prince of Wales is to-day to lay the foundation-stone of the new Preston Dock work, which is now making rapid progress in the hands of the contractor, Mr. T. A. Walker. The project includes the dock of about 40 acres, River Ribble diversion at Preston, graving docks, and extensive river works, chiefly consisting of several miles of training walls, and dredging. We gave an account of the project in our impression for the 20th June, 1884, and in another impression shall give some further details. About 800 men are at present engaged on the work of constructing the dock and on the river diversion. The sea wall require nearly 600,000 yards of dumped stone, most of which will come from the dock excavation. About 1,700,000 cubic yards of dredging, chiefly in marl, will have to be done, and the largest dredger ever built is about to be constructed for the purpose. Mr. E. Garlick, C.E., is the engineer for the work.

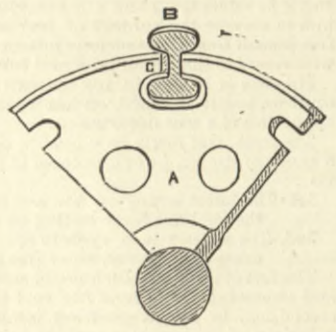
MISCELLANEOUS MACHINERY AT THE ROYAL AGRICULTURAL SHOW, PRESTON.

THE gratitude that is called forth by small things will be found a necessary quality by the seeker after novelties who goes to the Preston Show and does not leave disappointed. Originality is nearly dead. There are no new loaves, we must pick up the crumbs.

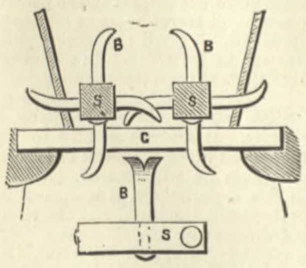


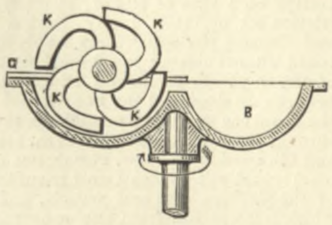
EARLY FOUR-FURROW BALANCE STEAM PLOUGH.

On the stand of Messrs. Allchin Linnel is a new thrashing machine drum, made under Caswell's patent. It is made with cast steel heads A and beaters B of double-headed railway rail section, as shown by the annexed sketch. The beaters are heavy, but they need no wood backing and plate covering or bolts. They are fixed in the heads with flat wedge keys C driven in between the web and the side of the slot in the head. The arrangement probably makes a very good drum, but it does not afford any facilities for balancing, holes being drilled in some of the beaters to lighten them for this purpose. This is necessarily a rather slow method, and one which would not recommend itself to thrashing machine users who may want to put in a new beater in the field, and whose only alternative would be to put lead rivets or bolts and nuts into the holes in the other beaters. The form of the beater is very good, but we do not know whether the drum has been practically tested.

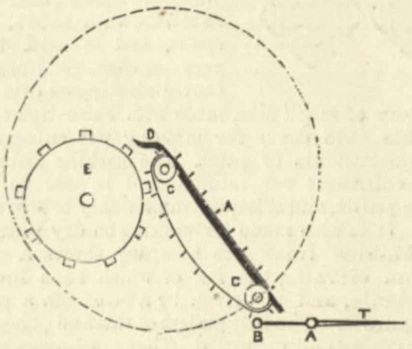


We have several times lately been asked for peat breaking machines. At Stand No. 180 Bracher's machine for this purpose is exhibited. The essential parts of the machine are two parallel square spindles immediately over a wrought iron grid, the spindles being fitted with a number of claw teeth, as shown in the sketch. The machines are thus of the simplest character. The old chopping sausage machine, which used to make its yearly appearance at the show, has now been replaced by one having a revolving cutter, working in a turned and slowly-revolving cast-iron basin, B, of the section shown in the annexed sketch. The cutter consists of a number of thin blades, K, of scimitar form, and about half an inch apart, each blade working through the openings in a grating, G, the meat being prevented from running away from the knives by a guard descending from the grating, G, at the farther side, to within about two inches from the bottom of the basin. Machines of this kind are shown by two makers, one of them being Messrs. T. Green and Son, Leeds, and Messrs. J. Gardner and Son, Birmingham. Our sketch is not accurate, but it serves to show the idea; the separate blades, K, are removable for sharpening. The old noisy machines, with knives chopping on a block, were a great nuisance in many places, and, no doubt, will be replaced by the new silent machines.





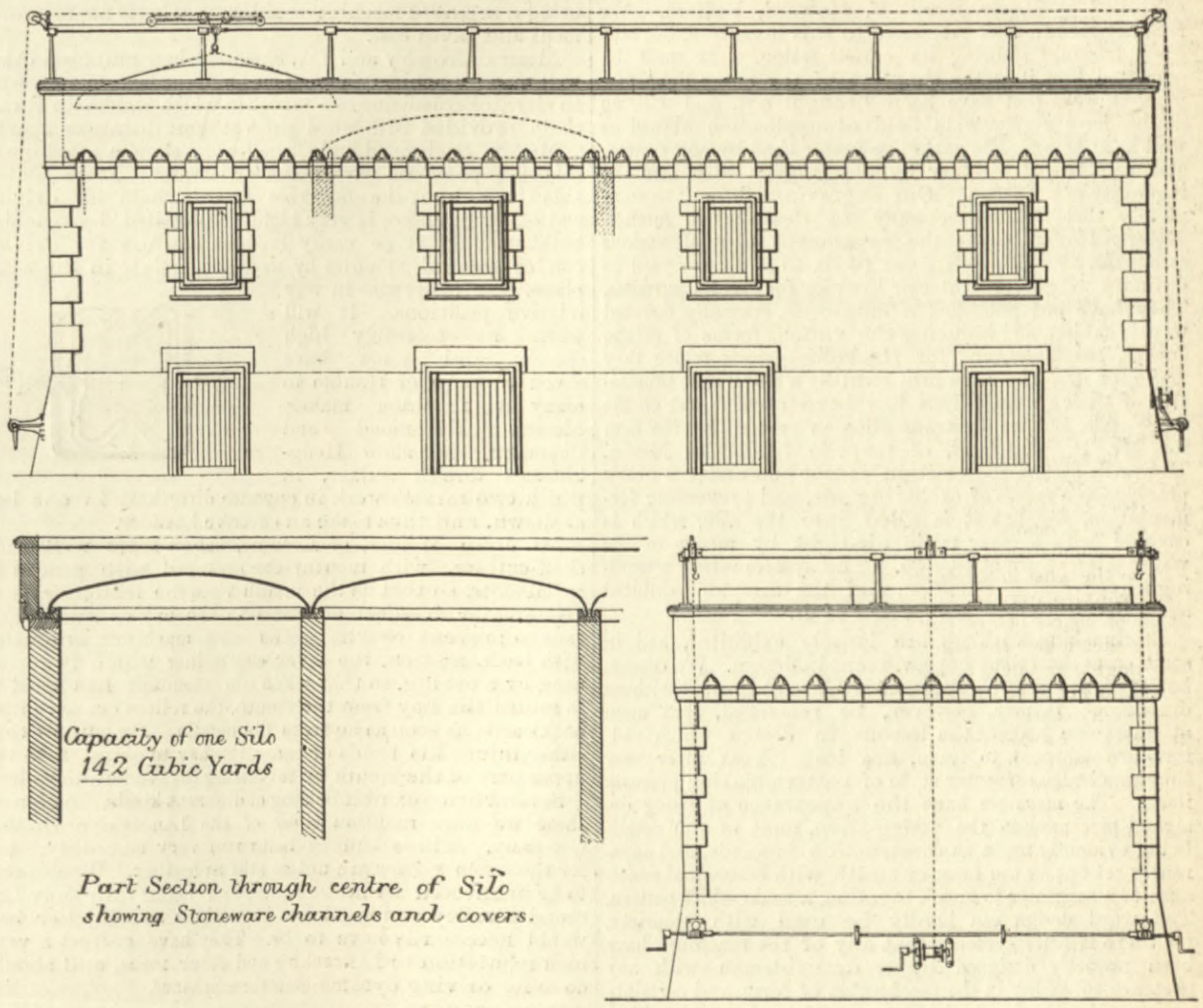
Mr. T. H. Ramsden, Leeds, exhibits an implement of no very prepossessing appearance æsthetically, mechanically, or agriculturally, though it may, perhaps, even in view of an unlikely illustration, be sometimes admitted that appearances are occasionally deceiving. The combined horse-rake and haymaker by Mr. Ramsden may be of this sort, and he was certainly determined that no favourable notice should be obtained by superficial attractiveness. Of this machine we have no drawings, but the accompanying diagram will enable us to give its mechanical features. The ordinary horse-rake teeth are replaced by a horizontal set of teeth T pivotted at A, and controlled by levers connected at B. These teeth are carried a small height above the ground. Above the rear part of the teeth is the lower part of an iron apron A, up which the crop collected at T is persuaded to go by the teeth carried on the endless chain arrangement running over rollers C C. By these means the crop is delivered at D to a revolving drum E, the duty of which is to distribute the crop haymaker fashion. The machine is carried on wheels approximately as shown by the dotted circle. The price of the machine is £17, which we mention, because for £3 15s. more a really efficient haymaker and a horse-rake could be obtained from well-known makers. We welcome a new thing with much pleasure, but can seldom say much for combination tools of this class.



Messrs. Jenkinson and Giblet, of Grantham, have done a neat thing in making a sheaf-binding reaping machine. We have not seen it at work, but do not see why it should not, and be light in draught. They have simply taken a Hornsby's "Progress" sheaf delivery reaper, and along the delivery tail of the platform of this machine they have attached the upper works of a sheaf binder with the Appleby binder. The price of this attachment, which can be fitted to any self-delivery machine, is £26, and this added to the £28 or £30 for the reaper, makes the total cost rather more than that of a sheaf binder of the usual type. This, however, would not influence many farmers who possess self-delivery machines in good order, which for £26 they can convert into a sheaf binder. For making new machines, however, the reaper part may be much simpler than the ordinary machine, such as the sheaf-delivery machines with the arrangements for making sheaves of different sizes or of the same size in a varying crop. A cheap and, we should be inclined to think, efficient sheaf-binder reaper could be made this way. The machine exhibited shows signs of being one of the first, but the arrangement is promising. It delivers within about a foot of the ground, and will deal with any length of straw.

Several makers now show haymakers with screens made as an integral part of the machine, and not as a makeshift suggested by afterthought. Amongst others who make a solid screen are Messrs. Bamford and Son, who have made a neat and rigid application of corrugated iron. The screen is not heavy, and saves much trouble and some rudimentary profanity on a very windy day.

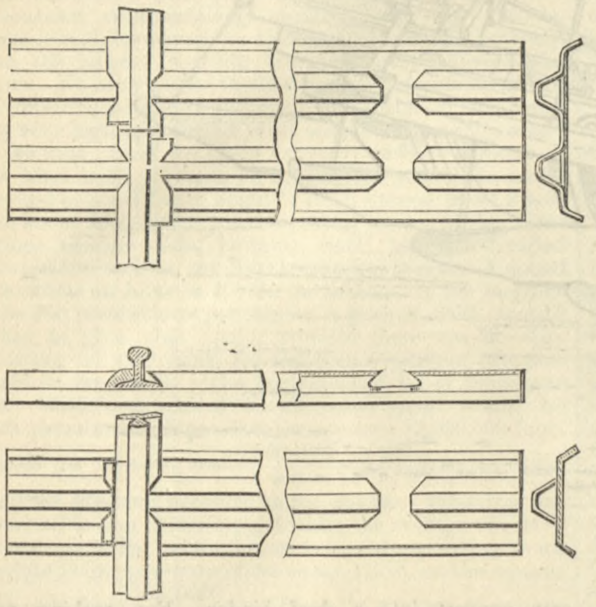
Steam ploughing machinery seems to have got into a groove, like almost every other kind of agricultural implement. The balance plough shows no desire on the part of the makers to offend by innovation. In general design it is as it has been for years, and the chief features may be traced without any effort in the engraving which we now publish of the first, or one of the first, two or three ploughs made at the Orwell Works, by Worby, when the late John Fowler and he were scheming out the single engine ploughing set, and before Worby made the self-moving anchor. The plough, as shown, had the beams of 7in.



SILOS ON HOWARD'S SYSTEM.

deals; it contained the slack gear, and all the essential features of the modern more finished implement.

A new implement is, however, shown by Messrs. Fowler and Co., namely, a big balance ditching machine or plough. This is shown this year for the first time, and is designed to make a ditch in two operations, 2ft. 6in. deep, 1ft. wide at the bottom, and 2ft. wide at the top. It will, we are informed, make a ditch of this size at the rate of a mile per hour. One of the two skifes cuts the soil to a depth of 15in., and the second finishes it to the full depth of 2ft. 6in. Each skife is of ⊔ form, and at its rear is a very large breast which throws the earth to one side of the trench.



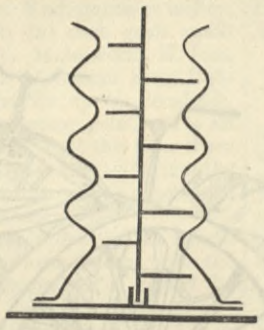
HOWARD'S LIGHT PERMANENT WAY.

A new implement for finishing and twitch eradicating is also exhibited for the first time. It is designed with the object of finishing the cultivation of the land at one operation, and is more especially suitable for the spring and after harvest work, when the land is in a dry state. It first cultivates the land, then rolls it with a very heavy roller, which is a consolidator rather than a roller, and then cultivates it again, but in the after cultivation the tines are placed so close together that the land is left as a harrow would leave it. The implement being carried on rollers at ends and centre does not sink in soft land. A uniform depth of cultivation is thus obtained. The effect of using the roller or consolidator in the centre is to overcome a danger from steam cultivation in dry seasons, namely, leaving the land too loose for the favourable running of the roots of the plants. This implement promises to give the farmer a means of accomplishing a certain kind of work at low cost.

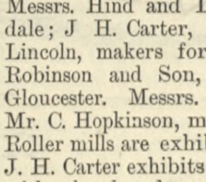
A novelty in light railways for farm and other use is exhibited by Messrs. J. and F. Howard, Bedford. We recently made a brief reference to this invention, but now give drawings showing its construction. It must be admitted that it is the simplest of the many light permanent ways that have been brought out, and will, no doubt, have a very wide field of application abroad as well as at home. The parts are fewer than by any system, and can be put together by any nigger with half the ingenuity of a monkey. Our engravings show it so completely that it is unnecessary to describe it further. Messrs. Howard make the permanent way of various strengths, and with rails from 10 lb. to 20 lb. per yard as ordinary weights, or lighter or heavier for special purposes. They have just published a catalogue, specially devoted to this subject, and including the various forms of points, curves, turntables, and for the rolling-stock which they make for it. The same firm exhibit a small silo, illustrative of their system. This has been carried out on the large scale, and we illustrate silos as erected by the firm for Mr. R. Whitehead, of torpedo fame. In Messrs. Howard's system the ensilage is not put under a heavy pressure as a means of excluding air, and preventing fermentation, &c., but it is filled into the silo, which is covered with a cover made air-tight by means of the water joint, shown at page 55. The system is now attracting a good deal of attention, and the samples exhibited show that much may be expected of it.

Brickmaking machines are largely exhibited, and in some cases show some improvement in design. We cannot, however, now describe them, as we are at present without drawings. It may, however, be remarked, that upon at least one maker, the lessons in design which visitors are supposed to learn, are lost. Year after year the same hedge carpenter style of pattern-making presents itself. The machines have the appearance of being designed piecemeal in the fitting-shop, most of the details being evidently made as construction proceeds, and apparently set out by the fitter or smith with occasional assistance of a carpenter to knock together a make-shift pattern. The word design can hardly be used with propriety, for there is little evidence that any of the machines have been properly designed by a draughtsman with any pretence to ability in the mechanics of form, and certainly no appreciation of æsthetic fitness. There is one machine, the side frames of which appear to have been made when half-inch board was the only material in the pattern shop. They are of the ribbed type, some of the ribs being thickened where holes are made for a strengthening bolt, and some not thickened. The strengthening bolt is passed through the neutral axis of the casting, and is so employed as to be of very much less use than a little more than its own weight of properly disposed cast iron. There is no reason why brick and tile machines should be the embodiment of poverty in design, and of the neglect of all that commends itself in the modern style of high class machine construction.

Well designed machines are exhibited by Messrs. Bradley and Craven, and Mr. T. C. Fawcett; Messrs. J. Whitehead and Co., Messrs. E. Page and Co., and Mr. W. Johnson are exhibitors in this class, the machines of the last mentioned having been recently illustrated in our columns. A pug mill of new form is shown in section by Messrs. Whitehead and Co. Instead of the casing of the mill being as usual, cylindrical, it is of corrugated longitudinal section thus, and the pugging arms on the vertical spindle are alternately of the longer and shorter radii. The action of this mill is no doubt somewhat more effective than those with plain cylinder, as the clay from the smaller diameters gets a turnover motion, which causes it to be presented to the next set of arms in a different position.



There is a large show of roller flour mill machinery, the horizontal burr stone mills having almost disappeared. It is noteworthy that in these roller flour mills, with but one or two exceptions, the design is both mechanically and æsthetically good, some being excellent types of good modern engineering design. Amongst the makers whose names should be specially mentioned in this respect are Messrs. Hind and Lund, Preston; J. Tomlinson, Rochdale; J. H. Carter, Mark-lane; Messrs. Robey and Co., Lincoln, makers for Mr. F. Nell, Mark-lane; Messrs. Robinson and Son, Rochdale; and Mr. W. Gardner, Gloucester. Messrs. W. R. Dell and Son, Mark-lane, and Mr. C. Hopkinson, must also be mentioned in this class. Roller mills are exhibited by Messrs. Penny and Co. Mr. J. H. Carter exhibits one of his disintegrators combined with a breaker, by which the hard material upon which the disintegrator is to work is reduced to a size which will agree with its inside. The breaker consists chiefly of two steel spindles, the centre parts of which are square, and are fitted, as shown, with short, hard steel spuds, and is said to make a very satisfactory breaker. Mr. Carter also shows one of his disintegrators of small size, made with water-tight and easily removable side cover for grinding wet substances, such as the constituents of paint. The machine runs at about 5000 revolutions per minute, and is said to produce a very fine paint, and it is quite unnecessary to say thoroughly mixed. It is also made for working on dry paints.

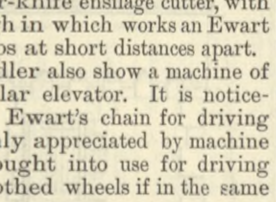


The Malden Ironworks Company shows a chaff-cutter with a fan elevator, the fan of which runs loose on the main spindle, and is driven by a belt from a pulley on a second spindle. The belt pulleys of this and other machines by this firm are all unturned. They are, however, moulded from good patterns and run quite truly, and are for many purposes better than turned pulleys.

Mr. W. B. Stubbs, Hawksworth, shows a winnowing machine with a combined elevator in one frame, instead of being a separate machine as hitherto. This is an improvement and saves cost.

Messrs. Crowley and Co., Sheffield, show amongst other well-made machinery a fine four-knife ensilage cutter, with an elevator consisting of a trough in which works an Ewart chain provided with wood strips at short distances apart.

Messrs. Richmond and Chandler also show a machine of this class provided with a similar elevator. It is noticeable throughout the show that Ewart's chain for driving and other purposes is very highly appreciated by machine builders. It is so easily brought into use for driving one or several spindles by toothed wheels if in the same plane, but otherwise in any relative positions. It will work at tolerably high speeds, and must have saved a heap of trouble to many a machine maker. Messrs. Richmond and Chandler also show Hodgkinson's dough mixer, in which two mixers work in opposite directions in one box as shown, and thus make an effective kneader.



Mr. John Wilder, of Reading, shows some well-made chaff-cutters, with mouthpiece arranged with guides in radial slots, so that as the mouth rises the tendency is to give greater freedom of egress to the hay or straw, and thus to prevent choking. The same machines are fitted with back motion, the lever controlling which is forced back by a spring, so that when the attendant has used it to return the hay from the mouth, the rollers cease to turn backwards as soon as he frees the handle. He cannot thus either injure his hands or cause the hay to wind into the upper part of the mouth by forgetting to reverse the rollers.

Several firms exhibit belting of different kinds. Amongst these we may mention those of the Lancashire Belting Company. These endless belts run very smoothly, and for the same power are not so stiff as leather. They seem to be unaffected by heat or wet, and being thin they lick round a pulley and need not be so tight as a thicker belt would necessarily have to be. They have gained a very high reputation in Lancashire and other mills, and should do so for driving dynamo-electric machines.

THE CHAIR OF ENGINEERING, UNIVERSITY COLLEGE, BRISTOL.—We have pleasure in announcing that Professor H. S. Hele Shaw has been appointed to the new Chair of Engineering in University College, Liverpool. Professor Hele Shaw's acquirements and training and experience eminently suit him for the duties of this chair. His ability and acquirements are not only of a high order, but he has made excellent use of both, as is shown by the long list of his work since 1876, which, as we know, does not include much that he has done in work of great merit. The authorities of University College, Bristol, will severely feel his transfer to Liverpool.

LETTERS TO THE EDITOR.

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

LAWS OF MOTION.

SIR,—The "other force" for which "A Student" asks, is the reaction of the stone against the gravitation medium, and is the product of the stone's mass and acceleration. I never said it was incorrect to speak of the drawback of a cart: it is simply equal to the pull forward of the horse.

I am constrained to agree with "Φ. Π.'s" opening sentence, and to admit that further discussion is useless. The points at issue have, however, narrowed themselves down, and it has become clear that what "Φ. Π." is most directly running foul of is not the third, but the *first* "law of motion." The third law has, in his mind, become so swollen, that there is no room for the other two. The first law asserts that a body acted on by no force continues to move in a straight line with a uniform velocity. "Φ. Π." asserts that no body is ever acted on by any force of resultant magnitude greater than zero. Hence, either he must maintain that all motion is uniform in speed and direction, or he must deny the validity of "the first law." I do not know which horn of the dilemma he prefers.

Not content with the actual assertion of the third law that forces are balanced so as to constitute stresses, "Φ. Π." goes further, and maintains that all the stresses in a connected system are balanced too; so that, for instance, the stresses in all the draw-bars of a train are necessarily equal—the stress in that near the engine being no greater than the stress in the draw-bar of the last truck! I do not know whether "Φ. Π." will endorse this statement or not, but it is no more absurd than his view that all the stresses concerned in a tug-of-war are necessarily equal.

The "definite answer" he asks for will, I fear, do him no good, but there is no difficulty in giving it. *Question:* "Why are the stresses not equal?" *Answer:* Because of the inertia of accelerated matter.

"Φ. Π." ignores inertia, and is unacquainted with the real essence of the laws of motion as expressed most fully by the second law, and so he naturally fails to understand some simple kinetic facts. He says, "The thrust of A on the ground is derived from the rope stress, and can be neither more nor less; for, take away the rope, and there can be no stress on the ground." This is an example of a false conclusion supported by a false premise; but it is consistent with "Φ. Π.'s" views. He is bound by consistency to uphold the ludicrous doctrine that unless a man is pulling at a rope there can be no stress between him and the ground. Surely a most obvious *reductio ad absurdum*.

I do not expect "Φ. Π." to recant or admit his error here and now; it has become engraven, and is not so easily removed. But if he values truth and clearness, as I am sure he does, I adjure him to consider the subject of inertia carefully, and to gradually free himself from those serious misconceptions which he has formed with regard to this important and fundamental matter.

His error is unique in my experience of fundamental misconceptions, and it is based on an exaggerated or too broadcast an application of a true doctrine.

The truth, *that forces in a system are balanced so as to constitute a system of stresses*, he overpresses in two perfectly erroneous ways, viz.:—

1st. The forces acting on an accelerated body are balanced, or the resultant force acting on a body is always zero.

2nd. The stresses in a system are balanced, or whatever stress exists at one point the same exists at every other point.

The first of these two erroneous statements is his old-established and serious belief, and is at the root of most of his difficulty. The second may be only a position temporarily taken up under the exigencies of controversy, and if so I certainly have no wish to press him to continue to occupy so pregnable a fortress, from which a couple of spring balances could at any time dislodge him.

The above first statement, however, appears to be his serious and long-held belief. I pray him to notice that it is a direct contradiction of Newton's first and second laws of motion, to consider it again in this light, and to choose between the mutually incompatible statements.

I have now, I hope, clearly and fairly pointed out to him his vulnerable points, and having done so, I trust he will permit me to shake hands and step out of the arena. OLIVER LODGE.

SIR,—Mr. Benson's letter supplies an admirable instance of "how not to do it." His is an entirely different experiment from mine, and the result he obtained is just what I would anticipate. By cutting or burning what I shall term the trigger thread across, he at once did away with the balance of forces so far as his board resting on the pencils was concerned. I shall not take up your time in showing what I have no doubt he will see in a minute, viz., that the conditions are quite different from those of my experiment.

As he does not seem to have quite caught the point at issue, I may put the thing in another light. It matters nothing to my argument whether the motion produced along the plank be fast or slow, so long as there is motion. This he will concede. Now if the motion be violent, as it is in his experiments, it is impossible to maintain that steady contact between the board and the thing pulled which is essential to the fulfiment of the conditions. If, for example, in the tug of war, one boy jumps on the board, the board will immediately fly from under his feet, and the other boy standing on it will fall on his back. In Mr. Benson's experiment the load jumps along the board when the string is cut. If your correspondent will suppose that a crab winch is put at one end of the board and the rope is carried down to a fair lead, so that the rope may lie half an inch or so above the board when stretched horizontally, and if this end of the rope be then hooked to a heavy weight resting on a kind of sleigh, so that there will be considerable friction set up, then I say that a man standing on the board and turning the winch can haul the weight to him along the board without moving the board in any way. For the resistance of the weight to be moved is due almost wholly to the friction between the sleigh and the board, and this friction will tend to drag the board one way just as much as the pull on the rope, connected through the winch to the platform, tends to move it the other way; and the speed being slow, resistance offered by the inertia of the mass moved will be small and insufficient to overcome the inertia of the platform, man and winch, and the small roller resistance which is inseparable from the construction.

If your correspondent will modify his experiment by putting a little pulley at the end of the board, placing a flat weight on the board, letting a string attached to the weight hang over the pulley and the edge of the table, and hanging a weight on the string just sufficient to make the weight on the board slide slowly along it as the weight falls, he will find that the board will not move on the pencils while the weight is falling. As the friction of repose is greater than that of motion, it will probably be necessary to start the sliding weight or load with the finger. All experiments, however, conducted on so small a scale must be unsatisfactory, because elements of inaccuracy are introduced which become of no importance when we operate on a large scale. If Mr. Benson will support a plank on some rollers and will lie down on his face upon it, stretch out his arms and grasp the edge of the plank above his head, he will find that he can draw himself along the plank without moving it. If Dr. Lodge's argument were sound, he would simply shoot the plank from under himself.

I do not quite understand what Mr. Muir's long letter is intended for. I may, however, ask Mr. Muir if when his two engines were pulling against each other with a balanced pull, what would happen if an external force were applied which would start them off at, say, five miles an hour, under the conditions laid down by Mr. Muir—that is to say, neglecting rolling friction and the friction of the axle boxes? The engines would go on for a mile or so, What would happen to the roller-supported rails? I think Mr. Muir will grant that they would stand still.

If Mr. Muir will let me have his views on this point, so that I may be quite sure that we have a common ground of discussion, which we certainly have not now, save of minute dimensions, I may have something more to say to him. Φ. Π.

London, July 14th.

STEAM HAMMERS.

SIR,—Messrs. Glen and Ross having been largely concerned in manufacture and sale of patented machinery a full half century, and having had the patent rights of the Rigby hammer assigned to them as far back as 1856, should not be ignorant of the fact that the rights and privileges of patentees are imperilled by asking—or at all events by answering—such queries as "wherein lies the patent?" till after a patent has been sealed. Previous to this stage, if more is done than give public intimation of the fact and title of the patent, thanks and not blame is surely due to him. If my assailants in the present instance, and self-confessed assailants of myself and others in other instances, see in such queries as they have put "a beauty born of grace," they must pardon my inability to see aught but the reverse.

In their letters to you under this heading three issues are raised which I will touch on, passing over many others. (1) In point of fact, did the patent rights of the Rigby hammer pass into the possession of Messrs. Glen and Ross in the year 1856, as claimed by them? (2) Have I or have I not drawn on public credulity by asking them to accept my hammer as patent without having at all applied for the necessary rights? And (3) is their reiterated queries of "wherein lies the patent" ill-timed and not *bonâ fide*?

As regards the last, all I have to say for the present is contained in the above lines, and as regards that immediately preceding, reference to the "Patent Journals" will certify. There is, however, a little more to be said of the first issue, and shortly it may for present purposes be thus said. Messrs. Glen and Ross claim to have fallen into possession of the patent rights of the Rigby hammer in 1856, and, as is well known, they for many years subsequent to that date proclaimed themselves broad and wide "Sole Makers of Rigby's Patent Hammers." Now, keeping in view that the patent rights of the Rigby hammer fell into the hands of the British public on 26th January, 1857, a few weeks or a few months at most after they are claimed to have fallen into the hands of Messrs. Glen and Ross, it is difficult to conceive of any intrinsic value the possession of patent rights a few weeks or months could possibly be to Messrs. Glen and Ross or any other; and returning to poetry for a moment, it is still more difficult to see "a beauty born of grace" in the world-wide proclamation of their claim to the sole makership of the patent Rigby steam hammer throughout many long years subsequent to the one on which the patent lapsed into public possession. But a greater difficulty than all consists in seeing the "beauty born of grace" of calling in question "the action of various parties, Mr. Stevenson himself among the number," when these various parties and Mr. Stevenson were doing nothing more than they were honourably justified in doing in furtherance of right and suppression of wrong, consisting, amongst other things, of self-constituted and catch-penny arrogance. G. STEVENSON.

Airdrie Engine Works, Airdrie,
July 8th.

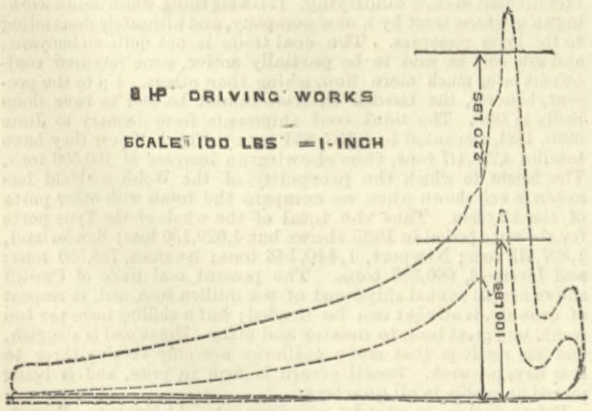
[This correspondence must end here.—ED. E.]

GAS ENGINES.

SIR,—In justice to our company, may I ask you to correct a slight mis-statement that appeared in your last issue, in the review of Macgregor's book on gas engines, which, if allowed to pass uncorrected and endorsed by your authoritative paper, is calculated to do us serious injury.

In this review it is mentioned that "Atkinson's latest engines are governed by regulating the supply of gas;" also rightly stating that such a mode of governing is not the most economical.

I have given up using in our compression engines a governor that in any way varies the strength of the charge (excepting to a modified degree in special instances, such as electric lighting), and for some time our horizontal compression engines have been fitted with an automatic governor that regulates the amount of the charge compressed, but not its proportions of gas and air, with the result of giving stronger or weaker working strokes, as shown in the accompanying diagrams taken this morning from our shop engine, which is of 8 nominal horse-power.



The larger diagram shows the ignition of a full charge, giving an initial pressure of 220 lb. The smaller diagram is from a much smaller charge, giving an initial pressure of only 100 lb. This mode of governing has two very great advantages—in the first place, the gas is more economically burned in the smaller diagram, because the expansion is continued down to atmospheric pressure; in the second place, the engine never misses an ignition for every revolution, thus keeping up a very steady speed, and working with greater economy when only doing, say, one-third to one-half of the maximum work, as is proved by the fact that our consumption of gas per hour when driving all our machinery is sometimes as low as 125 cubic feet of London gas with an 8-horse power engine.

The "Differential" engine is controlled by a governor that cuts off the gas entirely when its speed exceeds that to which it is adjusted. I hope shortly to apply the automatic governor to this engine also. JAMES ATKINSON, Managing Director.

The British Gas Engine and Engineering Co., Limited,
Albion Works, Gospel Oak, London. N.W., July 13th.

THE BLOCK SYSTEM.

SIR,—In reply to your correspondent, "A. B. R.," respecting the empty, or block, section of signalling on railways, known as the block system, I tried to get the system introduced on the Great Western Railway twenty years ago, but without success. I then published the system. I was informed by a firm of signal manufacturers that Funnell, of Brighton, had anticipated me; and no doubt Mr. Funnell, or some one connected with him at that time, can give your correspondent the information required. C. J. L.

July 14th.

SOLID BEAMS.

SIR,—I was not surprised to find in your last issue that my review of Mr. Donaldson's small book on girders had met with his disapproval. I only wish I could have conscientiously made it more according to his taste. He is, however, quite mistaken in supposing that my brain had been "bemuddled" by a previous dose of Rankine's "Applied Mechanics"—a book for which I have much respect, but which I did not consult before writing the review. Indeed, my criticism stands perfectly independent of books. If, therefore, Mr. Donaldson has found any points of agreement between Rankine and myself, I can only feel gratified at the coincidence. I cannot comprehend that Mr. Donaldson should need to be told what is meant by "a moment of inertia of a surface." Regarding the other questions, I regret my inability to agree with Mr. Donaldson's views.

July 11th. THE AUTHOR OF THE REVIEW.

AMERICAN NOTES.

(*From our own Correspondent.*)

NEW YORK, July 3rd.

THE most important work now in hand is the laying of pipe lines, the building of bridges, and the completion of railway terminal facilities in this city, Philadelphia, and in some Western cities. The New York Central has been obliged to greatly increase its depôt room and car track. The Pennsylvania terminal arrangements in Jersey City are barely sufficient, and, in short, the railroad accommodations in general are growing more and more contracted when measured by increasing necessities. Within a day or two the announcement has been made of the proposed construction of some two thousand or more miles of road, which have been under consideration for several months. The investors are anxious to find channels for investment, and the recently submitted reports of experts who have been carefully investigating into the prospective carrying power of projected roads in the Far West and South are favourable to the immediate prosecution of these enterprises. Some of the Pennsylvania rail mills have already secured important rail contracts, and expect more during July and August.

Very much has been said in and out of print in regard to the place in metallurgy which will be filled by the Clapp-Griffith process. As yet steel makers do not feel altogether assured that it is all its friends assert it is; but three plants, at least, will soon be in operation.

Bridge builders are submitting specifications for large lots of bridge iron. The autumn months will be active in bridge construction. Some 2500 miles of broad-gauge railroads will be changed to the standard gauge in the Southern States as rapidly as possible. The narrow-gauge system meets with less and less encouragement. Most of the railroad construction during the autumn will be directed to the development of lumber, mineral, and agricultural regions, where large purchases have been already made by capitalists for the purpose of holding until the properties appreciate in value, as they certainly will do. The Baltimore and Ohio Company begins the work of constructing its terminal facilities in Philadelphia next week, and by mid-winter will have a New York outlet. The Pennsylvania Company has fought the new comer valiantly, but it has gained a footing in the den of its adversary.

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

(*From our own Correspondent.*)

ON 'Change in Wolverhampton yesterday, and in Birmingham to-day, Thursday, there was a slightly better feeling than a week ago. The improvement was not conspicuous, still it existed. The reports did not lead to the impression that the ironmasters' order-books had been materially swelled by the business placed since the quarterly meetings. But contract negotiations between buyers and sellers which were opened at those gatherings were yesterday and to-day brought to a satisfactory conclusion in a number of instances, and in the course of the ensuing week additional orders will be received.

Marked bar makers did not report much increase of trade upon the week, and Round Oak bars remained at £8 2s. 6d.

W. Millington and Co. quoted cable iron, plating bars, and small rounds and squares, ⅝in., £8; best chain iron, best plating bars, and rounds and squares, ¼in., £9; rivet iron, £8 10s., £8 15s., and £10 5s., according to quality; angles, 1½in. to 3in., £8 10s., £9, and £10, according to quality; tang iron, ½in. and $\frac{7}{16}$in., £7 10s. for ordinary, £8 10s. for best, and £9 10s. for double best; horseshoe and shutter bar iron, 1½in. to 2in., £7 10s.; rounds and squares, $\frac{5}{16}$in., £8 10s.; ditto, No. 5, £9 10s.; ditto, $\frac{3}{16}$in., and No. 6, £10; No. 7, £11; No. 8, £12; No. 9, £13 10s.; No. 10, £15 10s.; and No. 11, £17 10s. Treble best bars they quote £11 10s.

Plates Messrs. Millington quoted at £9 for ordinary, £9 10s. for best boiler, £10 10s. for double best, £12 10s. for treble best for flanging inwardly. Sheets not larger than 10ft. by 3ft. by ⅛in. they quote £9 10s., and best qualities 20s. per ton additional.

The orders offered to the sheet makers by merchants, by the galvanisers, and the hardware manufacturers, were not to-day of large individual extent, yet the aggregate was encouraging. If only better prices could be obtained there would not be much to grumble at. At present there is no revival in rates, and one or two firms have decided to stop making until a revival does occur.

Messrs. John Lysaght and Co.'s Swan Garden Ironworks at Wolverhampton continue a conspicuous exception. At this extensive establishment all the mills are running night and day in supplying sheets for galvanising at Bristol, mainly in satisfaction of the needs of the Australian markets. Yet the supply of black sheets of the firm's own manufacture is inadequate to their needs, and they would be glad to set another works going if one could be had to their mind.

Sheets of 20 gauge for galvanising were quoted to-day £6 10s.; 24 gauge, £6 15s. to £6 17s. 6d. and on to £7; 27 gauge, £7 10s. to £7 15s. Merchants' singles were to be had at £6 5s. and upwards all at works.

Shropshire makers are getting better prices than the Staffordshire firms. The quoted working up sheets, superior quality, 20 gauge, £7 5s., Liverpool; 24 gauge, £8 2s. 6d., Liverpool; and 27 gauge, £9 2s. 6d. Galvanising qualities they quote at £7 15s., Liverpool, for 24 gauge; and £8 12s. 6d., Liverpool, for 26 gauge. They reported themselves in the receipt of good Indian inquiries.

The best—thin—sheet makers of East Worcestershire are doing more than many other firms, and are obtaining more profit. Most of these makers keep quite busy. One or two report more orders ahead than for a couple of years past. Tin-plates also are in larger demand. The most important markets at date are the Australias, the United States, Canada, Germany, and other parts of Europe. E. P. and W. Baldwin quote their "Shield" quality of singles for working-up purposes £9; Severn, £10; B., £11; and B.B., £12. Doubles are quoted 30s. extra, and lattens a further 20s. Steel stamping sheets of 24 gauge are £13, and 26 and 27 gauge, £14 10s.

The United States demand for baling hoops is only slow, but Messrs. Dawes, of Oldbury, are working on an order for 1000 tons. Common hoops are quoted £5 10s., while narrow strips for gas tube making are £5 5s. and upwards. Common bars are £6 down to £5 5s. per ton. Good second-class bars are abundant at £6 10s.

In steel, competition from other districts with local makers is keen. The Staffordshire Steel and Ingot Iron Company quoted this afternoon for basic steel for boiler and bridge plates an average of £7 10s.; tin-plate bars, £4 5s.; and blooms and billets, £4 17s. 6d.

The Herbert's Park Ironworks, Darlaston, has been re-started by the Herbert's Park Iron Company for the manufacture of iron and steel sheets. The works, which formerly belonged to Messrs. David Jones and Sons, were closed about six years ago, and the new company have made considerable improvements. The Pleck Works, Walsall, of Mr. J. Southern, are to be closed until sheet prices improve.

Orders in the galvanised sheet trade are more numerous, mainly on account of the Australias and South America. This week the Gospel Oak Company's works at Wolverhampton started on Monday night, an occurrence which has not taken place for a year or more. Some seventy workpeople were put on.

The business that was done in pig iron a week or two before the quarterly meetings has mostly satisfied buyers' present necessities. Agents will not generally book at current rates more than three months ahead. Sales of the Lonsdale foundry pig—No. 3—have this week been effected at 57s. 6d., and of No. 4 selected forge pig at 45s. Thorncliffe pigs are firm at 50s.

Lincolnshire gray forge pigs are quoted at 41s. 6d. Wingerworth and Westbury forge pigs are 39s. 6d., and other Derbyshire sorts 40s. easy. Westbury No. 3 is quoted 41s., and No. 2, 42s. 6d. Northamptons range from 37s. 6d. upwards. Native all-mine pigs are selling at 55s. to 57s. 6d., and are quoted up to 60s. Capponfield mine pigs are 47s. 6d.; Darlaston Northampton forge, 38s.; and Capponfield common, 33s. 6d.

Constructive engineers note with interest that among the contracts for which tenders are at present invited are several from Ireland, including the construction of a pier, 350ft. in length, at Clogher Head, Oriel Harbour, and a wrought iron bridge, of 100ft. span and three 35ft. spans, for a single line of railway over the river Lee, near Macroom, which is some twenty miles from Cork.

The important market which exists for iron and steel masters, engineers, and other manufacturers in the needs of the great railway interest in India, receives every week fresh illustrations. The Secretary of State for India is enquiring for steel rails, steel fish plates, switches and crossings, and the South Indian Railway Company needs Lowmoor fire-box plates, brass boiler tubes, crucible cast iron tires, wrought iron tubes, and spiral springs. The Scinde, Punjaub, and Delhi Railway Company wants a supply of crossings, switches, switch-boxes, screw jacks, screw couplings, springs for rolling stock, fish plates, and the like.

The Union Rolling Stock Company, Birmingham, has paid dividends of 6 per cent. upon preference shares, and 10 per cent., together with a bonus of 2 per cent., upon ordinary shares, for the half-year ended 30th June.

The Birmingham Tramways and Omnibus Company will pay an interim dividend of 10 per cent.

A somewhat serious difficulty has arisen as to the receipt by the Birmingham, Tame, and Rea District Drainage Board of the sewage from Sutton Coldfield. Under the provisions of the Act of 1881 it was provided that it should not be obligatory on the joint board to receive sewage from Sutton Coldfield at the outfall works to any extent exceeding 40 gallons per head per day. The Works Committee are of opinion that the amount of sewage now actually conveyed from Sutton Coldfield is very largely in excess of this quantity, and the question is to be submitted for decision to the Local Government Board.

The internal drainage of Stourbridge is occupying the attention of the commissioners of the town. Tenders have been advertised for carrying out the proposed new works, and a dozen contractors have replied. The amounts of the tenders range from £6217, which is the tender of Mr. T. Dawson, Bury, down to £4561, the tender of Mr. T. Vale, Kidderminster. The three lowest tenders have been referred to the surveyor for examination and report.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester.—"No improvement," "no trade doing," "ruinous prices," are becoming not only very general, but painfully monotonous phrases week after week in the iron market here, and there is nothing in the trade outlook of this district to give hope of anything better in the immediate future. The quarterly meetings have certainly not left behind them any stronger feeling, but seem rather to have emphasised the prevailing depression by the discouraging reports brought back by those who had attended the meetings. Generally no material revival is now looked forward to as at all probable this year, and a continuance of the present low prices during the ensuing six months is regarded as practically certain. This, of course, tends to check business; makers are open to sell over the year at current rates; but buyers, except they have actual requirements to cover over that period, are content to buy simply from hand-to-mouth, as their experience so far has been that a policy of waiting has been the most profitable to the buyers. Even where sellers have recently induced buyers to give out fairly large orders, they are in many instances in not much better position, as they are finding it almost as difficult to get some customers to take the deliveries of the iron they have bought as to induce others who have not bought to give out orders.

The Manchester iron market on Tuesday was only very thinly attended, and the business reported extremely small. For pig iron there were scarcely any inquiries; the current market rates were without material change from last week, but in most cases a firm offer would have led to something under the prices quoted being taken. Lancashire pig iron is, if anything, a trifle easier, 39s. 6d., less 2½, delivered equal to Manchester, being now only held out for in the case of very small orders, the average figure for ordinary business of any weight being 39s., less 2½, delivered. In district brands the tendency is also to shrink within the compass of the minimum market prices, and 38s. to 39s., less 2½, delivered here, now practically covers all the district brands coming into this market. Middlesbrough and Scotch irons are also being offered here at very low figures.

In the manufactured iron trade a few extra orders which were previously either being held back or in negotiation, have been given out, and this has tended towards an appearance of more business doing. The market, however, has not been appreciably affected, and no better prices are obtainable—£5 5s. for Lancashire and North Staffordshire bars, £5 15s. to £5 17s. 6d. for hoops, and £6 15s. to £7 per ton for sheets delivered into the Manchester district, with North-country plates again almost the same price as bars, remain the basis on which orders can be readily placed.

In the engineering trades generally reports from most of the branches are to the effect that there is a continued slackening off. Some exception to the general rule would, however, seem to be furnished in the tool-making branch, as I understand that although there are a number of vacant situations for tool draughtsmen in this district, not a single draughtsman is to be found out of employment. This would certainly appear to be an indication that there is a good deal of work in preparation in the drawing offices, whatever may be the condition of work in the shops.

A new cutter sharpening machine of very simple construction has just been patented by Messrs. Browett, Lindley, and Co., of Salford. The machine, which is mounted on a neat cast iron pillar with broad base, containing the countershaft and driving pulleys, consists of an emery wheel, underneath which is an abutment having the same shape as the periphery of the wheel. The cutter to be sharpened is held in the holder, which also contains a sheet steel former, placed directly underneath the cutter, and the motion of the former against the abutment is exactly reproduced by the tooth of the cutter against the emery wheel. This machine is specially adaptable where milling cutters are in use, one great question in connection with the economical use of this class of tool being that of cheaply and expeditiously sharpening the cutters without re-softening, and this requirement appears to be very effectively covered by Messrs. Browett and Lindley's new sharpening machine.

Mr. James H. Lynde, of Manchester, has designed and patented a new steel substitute for the wooden keys at present used on railways. This is a very simple arrangement, consisting of a piece of steel plate $\frac{5}{16}$in. thick, bent to the form of a U, with square slots at the two ends, through which an ordinary fish-bolt is passed. The bent plate is placed between the web of the rail and the jaw of the chair; then, by screwing up the bolt passing through the slot holes, the plate is made to take a still deeper bend, and it thus operates on the web of the rail, tending to hold it firmly in its proper position. This method of keying up the rails has only been so recently introduced that it has not yet had an opportunity of any extensive practical test, but on the face of it a very simple arrangement is presented for dispensing with some of the serious disadvantages attaching to the use of the ordinary wooden keys.

The result of the coroner's inquiry into the Clifton Hall Colliery explosion, although probably the jury could have come to no other decision upon the facts they had before them, can scarcely be regarded as a satisfactory ending of the investigation, and until Mr. Arnold Morley has presented his report to the Home-office the inquiry cannot be said to have been finally closed. The Miners' Conference, sitting in Manchester last week, took a very strong view of the matter, and passed a resolution to the effect that the verdict given was not in accordance with the evidence placed before the jury. This, however, may be taken more as the natural result of the prejudice entertained against a non-unionist colliery than as the outcome of fair criticism. But there are matters in connection with the disaster with regard to which it would have been better that something more definite could have been known. The main question which the disaster has brought to the front is the use of naked lights in mines. To the use of such naked lights the explosion was found to be due, and the question naturally arises—Should they be allowed in mines at all? The argument put forward at the inquest that a naked light, with its known danger, is preferable to the fancied security of a "safety" lamp, which when danger arises is unable to stand the test, may apply very well to mines in which the old Davy lamps are still in use, but with one or two of the best lamps brought out during the last two or three years, an almost absolute protection against explosion through the medium of the lamp has been provided. Unless not only the use of naked lights, but also the firing of shots when the workmen are in the pit, are strictly prohibited in all mines, it is to be feared we shall still have to witness the periodical recurrence of such terrible disasters as that at the Clifton Hall Colliery near Manchester.

The usual monthly meeting of the members of the Manchester Association of Employers and Foremen was held on Saturday evening, Mr. Thos. Ashbury, C.E., in the absence of the president, occupying the chair. No paper was read, and the proceedings were purely formal, the election of auditors and the nomination of new members being about the whole of the business done.

Generally the coal trade of this district continues in about a normal condition so far as the demand for house-fire consumption is concerned, the orders giving out, although very small in weight, being about equal to the usual requirements for the time of the year. In other descriptions of fuel the trade doing is, however, abnormally dull; the continued depression in all the large manufacturing branches of trade keeps down the requirements of consumers, and common coal for iron-making purposes is bad to sell, the short time prevailing throughout the cotton manufacturing districts, and the slackness of trade amongst the chemical and salt manufacturers, also tend to very largely lessen the requirements for engine fuel. There is consequently a good deal of coal and fuel of all descriptions being thrown upon the market, and except where collieries are either prepared to run about half time or put into stocks, very low figures are taken to effect sales. The leading colliery proprietors in the Manchester district are holding firmly to their present rates, and at some of the large collieries in other parts of Lancashire there is also a disposition to stock their coal rather than force it on the market at any prices that can be got. There is, however, a good deal of underselling, and for temporary sales to clear away stocks it would be difficult to say how low some sellers would be prepared to go. The average current market rates remain at about 8s. to 8s. 6d. for best coal; 6s. 6d. to 7s. seconds; 5s. to 5s. 6d. common; 4s. 3d. to 4s. 9d. burgy; 3s. 6d. up to 4s. best slack; and 2s. 6d. to 3s. common sorts.

Shipping, which generally has only been very dull for some weeks past, is reported to be showing indications of improvement, which may help to take away some of the steam coal at present a drug in the market, but prices continue very low.

For coke there is a moderately good demand; at the ovens ordinary qualities average 9s. 6d. to 10s., with the best sorts up to 12s. and 13s. per ton.

Barrow.—The hematite pig iron market is still weak, and there does not appear to be any immediate prospect of a revival even on a limited scale. The long depression is being very severely felt in the district, and the consequences of an over-production are beginning to be felt. The output of the furnaces has been for several months greatly beyond the requirements, and as stocks have increased very heavily, producers have at last been compelled to prepare for blowing out one or two furnaces, and as a consequence the number of hands is being reduced. The orders which are being given out are only sufficient to cover pressing requirements. Indeed, some of the parcels are very small, taking into account the quarter from which they come. Continental and colonial inquiries are very small, and no likelihood of being any better for some time to come. Prices are unchanged. No. 1 Bessemer, 43s. per ton; No. 2, 42s. 6d., and 42s. for No. 3. Steel makers are in an even worse position than makers of pig iron. Not only are prices very low, but inquiries are very few—so few, indeed, that the mills are only working short time. It is owing to this department being so slack that stocks of pig iron are so heavy. Iron ore is still in very slow demand at same rates as last quoted. Iron shipbuilders are not quite so fully employed, though the position at present is satisfactory.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

THE official return of coals exported from the South Yorkshire collieries to Hull during June shows a total of 102,592 tons, as compared with 105,728 in the corresponding month of 1884. For the six months January to June, 1885, the total is 532,256 tons, as compared with 611,920 tons during the same period last year. Of the imports last month, 44,944 tons came by river, and 57,648 tons by rail. The exports show a total of 60,818 tons, as against 49,172 tons in June, 1884. Manvers Main heads the list by a very long way for last June, that colliery having sent a tonnage of no less than 11,224 tons, being more than double sent the previous June. Shireoak occupies second place, with 6808 tons; and Thrybergh Hall is third, with 5544 tons. Denaby Main, from which 11,848 tons were sent in June, 1884, was again blank last month, and Fryston, which sent 5064 tons a year ago, shows a similar result. The increase in exports is mainly caused by very large demands from Russia—17,194 tons against 11,940 tons; as well as by Sweden and Norway, 20,923—13,028; East Indies, Gibraltar, Belgium, California, and United States.

The Board of Trade returns of exports again show a regrettable falling off. Hardware and cutlery alone have fallen in value from £250,932 in June, 1884, to £235,794 in June, 1885, the falling off in the half-year being equal to rather over £200,000. Russia fell from £5591 to £4660; Germany, from £13,427 to £12,574; Holland, from £7212 to £6425; France, from £12,152 to £10,900; Spain and Canaries, from £7006 to £6854; the United States, from £26,559 to £21,587; Foreign West Indies, from £4221 to £3742; Brazil, from £13,881 to £12,694; the Argentine Republic, from £10,513 to £8186; British North America, from £9559 to £7266; British Possessions in South Africa, £4909 to £4570; British East Indies, from £19,447 to £19,257. Australasian markets alone show an increase, the value having risen from £47,006 to £52,521. Heavy decreases are also reported in steel, chiefly with the United States and France, as well as in steel rails, the leading markets which show a decline being Spain and Canaries, Argentine Republic and Australasia; while the United States, Mexico, Brazil, and Peru, which were excellent customers in June, 1884, have taken nothing during last month.

The home trade in rails is expected to receive a fillip this year, or early in 1886, by the necessity several leading companies will be under of re-laying large portions of their lines. Stubbornly as steel rails stand the wear and tear of railway traffic, there is a limit to their endurance, and in the opinion of many principals of rail firms the time is at hand when the companies will be obliged to incur heavy expenditure on this account. The foreign demand will also be animated by the decision of the Indian Government to expend an additional £1,000,000 in railway extensions.

It may be mentioned as a noticeable feature of "The Cutleries"—the short name by which the Cutlers' Company's Industrial Exhibition is now known—that there are several female competitors in the sections. In one instance, the work of Mrs. E. Ashton, in hafting round tang table-knives, has been very highly commended by artisans themselves, although she has not succeeded in winning a prize. It is part of the Sheffield industrial system to have "small masters," *i.e.*, small manufacturers, whose employés are frequently limited to the members of their own household, and in these cases the girls as well as the boys learn a useful craft by which, if necessary, they may earn their livelihood in after years.

Messrs. Walker and Hall, of the Electro Works, Howard-street, Sheffield, have completed a splendid specimen of plated ware, in the form of a plateau for the bridecake, which is to form the present of Liverpool to the Princess Beatrice on her approaching marriage with Prince Henry of Battenberg. This massive plateau is 54in. in diameter, and is of a most tasteful and appropriate design, the workmanship reflecting the greatest possible credit on the artistic skill of Messrs. Walker and Hall's employés. The senior partner in the firm, Mr. J. E. Bingham, who is the Master Cutler for the year, had an opportunity while Prince Albert Victor was recently in Sheffield as his guest, of showing the present to his Royal Highness, who expressed himself as being highly pleased with the plateau. Messrs. Walker and Hall have a special reputation for this class of work, and have accomplished some notable examples of silver work in their time, not the least of which was the famous "Plimsoll Cup" in solid silver, to which the firm contributed the precious metal, and the workmen gave the labour.

The Denaby Main strike, which has now lasted for over thirty weeks, has culminated in a riot of some magnitude. Those who know the facts will not be surprised at this regrettable incident. The company has endeavoured to fill the places of its excited miners with strangers from Staffordshire and Cornwall, and there is no denying the desire of these new-comers to stay and work on the masters' terms, urging, as they do, that in their own districts they can get no work to do, and are glad to have the chance of earning 5s. a day. The Denaby Main men, while disavowing all intimidation, undoubtedly succeed somehow in preventing their old employers from keeping these new hands. On Saturday and Sunday the strained relations between a new body of Staffordshire men and the former workmen were ruptured by something like a real battle. A Staffordshire man, believing himself to be in peril from several of the locked-out miners, turned and fired on them. He hit two, and was subsequently arrested. Isolated encounters, in which several people were injured, afterwards took place. On Sunday the opposing forces met in hostile array, heavy missiles being employed on both sides. So serious was the disturbance that the police charged the Denaby men, who were driven from the field. Though thus worsted in the fight by the strong arm of the law, the Denaby men practically won what they had been contending for. Late at night 150 of the Staffordshire men, drawn up on one side of the Don, had an interview with the Denaby men—nearly 1000 strong—drawn up on the other. The Staffordshire miners told their former foes of the field that they had decided to throw up their work and return home, and that they would do their best to prevent others leaving their district for Denaby. The decision was received with tremendous cheering, and thus the Denaby men have once more succeeded in keeping their masters' pits idle, and preventing work-people from accepting a system of working which they will not even try for a month.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

THE outlook as regards the Cleveland pig iron trade is as gloomy as ever. There was but a poor attendance at the market held at Middlesbrough on Tuesday last, and scarcely any business was transacted. The price of No. 3 g.m.b. is maintained at 32s. per ton by merchants, and it is said that some makers will now accept the same figure. The leading firms do not, however, take less than 32s. 6d., and some ask even more. Where special brands are required the maximum price is naturally paid. Merchants are offering No. 3 at the same price for forward as for prompt delivery, but they make few sales, and only for small lots. Buyers are not easily tempted even by this low figure, as they expect less will yet be taken. Forge iron is in poor request, and the price has again fallen. It can now be bought at 31s. 6d. per ton, and in some cases it has even changed hands at 31s. 3d.

Holders of warrants show no desire to sell, and the price is firmly maintained at 32s. 9d. per ton.

The stock of Cleveland pig iron in Messrs. Connal's store at Middlesbrough has increased 1850 tons during the past week.

Shipments from the Tees continue to be unsatisfactory. They only amounted to 30,184 tons on Monday last, being about 7000 tons less than during the corresponding portion of June.

Nothing new or favourable is to be said with respect to the manufactured iron trade. Fresh orders are very scarce, and sufficient specifications to keep the mills running regularly are not to be obtained. Quotations are still £4 15s. per ton for ship plates and £5 for girder plates. Angles are offered at £4 10s., and common bars at £4 17s. 6d., as before. The demand for steel is also slacker, though the works are at present fully employed. Steel plates are £7 to £7 2s. 6d. per ton, and angles £6 12s. 6d.; all f.o.t. at makers' works, less 2½ per cent.

The value of goods exported from Middlesbrough during last month—exclusive of coal and coke—amounted to £210,214, being an increase of £424 over June, 1884. At Newcastle the returns show a decrease of £14,795, the total amount being £198,525.

At a meeting of Cleveland mineowners and miners, held at Middlesbrough on the 10th inst., the sliding scale for the regulation of miners' wages was renewed for a further period of two years.

It is extremely difficult at the present time to realise, by auction or privately, anything like reasonable prices for second-hand plant, tools, or machines. Within the last two or three weeks two such sales have been made, viz., one at the Perseverance Works, Leeds, and the other at Elsecar. Very poor prices were obtained in both cases, and many of the lots were literally given away. Machinery sales are largely attended by brokers from all parts, and only sparsely by *bonâ fide* purchasers. The brokers manage to work into each other's hands and do not compete. But when an unfortunate individual not known to them is seen to be eager for a lot, they bid against him, and run him up until he is satisfied he can get no benefit by attending sales. Unless previously disposed of by private treaty another engineer's plant is likely to be sold at Leeds in two or three weeks, viz., that of the late firm of Dawson and Nuneley, of Hunslet. It includes some good tools, and should have a better fate than those above referred to.

The shipping trade to Spain from the North of England is being adversely affected by the visitation of the cholera to that country. There are now 90 to 100 steamers lying idle at Bilbao waiting their turn. This is bad enough of itself, but when the extreme lowness of freights is considered, it becomes evident that nothing but loss can be the consequence of continuing to compete in such a trade.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

BUSINESS generally has been curtailed this week on account of the Glasgow Fair holidays, which began nominally on Monday, and actually on Thursday, when the works were closed for the next week or two. Several firms of shipbuilders and marine engineers, who are extra busy with Admiralty and other contracts, are desirous that their workmen should come back at the end of a week, but in other cases workshops will be closed for the greater part of a fortnight. There will be no business in the different markets until Tuesday next, and the whole of next week will be necessarily very quiet. The approach of the holidays caused extra animation in a number of departments early in the week, on account of the necessity of finishing up pressing orders, but the general tone of the markets has, on the whole, been quiet.

The demand for Scotch iron is poor even for this season of the year. A desire on the part of bears to cover over sales led to a considerable number of transactions in warrants, which are strongly held and not easy to obtain. The result was that quotations have been steady, the figures being on the average somewhat higher than in the preceding week. The past week's shipments of Scotch pig iron were 7044 tons, as compared with 7410 tons in the preceding week, and 10,199 tons in the corresponding week of 1884. At Calder an extra furnace has been put in blast, and there are now ninety-one in operation against ninety-six at the same date last year. The slow inquiry has led to a larger addition to stocks, the quantity added in Messrs. Connal and Co.'s Glasgow stores in the course of the week exceeding 2000 tons.

Business was done in the warrant market on Friday at 40s. 11d. cash. On Monday transactions occurred at from 40s. 10½d. to 40s. 11½d., and back to 40s. 11d. cash. Tuesday's market was quiet at 40s. 10d. to 40s. 11d. cash. Transactions were noted on Wednesday at 41s. 0½d. and 40s. 11d. cash. There was no market to-day (Thursday).

The backward demand for makers' iron has led to a slight reduction in some of the quotations. Free on board at Glasgow, Gartsherrie, No. 1, is quoted at 46s. 9d. per ton; No. 3, 44s.; Coltness, 48s. 6d. and 46s.; Langloan, 48s. and 46s. 6d.; Summerlee, 47s. and 44s.; Calder, No. 1, —; No. 3, 44s. 6d.; Carnbroe, 46s. and 44s.; Clyde, 46s. 3d. and 42s. 3d.; Monkland, 41s. and 39s.; Quarter, 40s. 6d. and 38s. 6d.; Govan, at Broomielaw, 41s. and 39s.; Shotts, at Leith, 48s. and 48s.; Carron, at Grangemouth, 51s. and 47s.; Kinneil, at Bo'ness, 43s. 6d. and 42s. 6d.; Glengarnock, at Ardrossan, 46s. and 41s.; Eglinton, 41s. and 38s. 6d.; Dalmellington, 43s. and 40s.

The past week's shipments of iron manufactures from the Clyde included four locomotives and engines, valued at £10,800, for Calcutta, and four ditto, valued at £11,724, for Huelva; a steam dredger worth £3900 for Melbourne, steam barge, £1000, for Port Said, and a screw steamer, £7000, for Alexandria; £9150 worth of machinery, £1420 sewing machines, £2600 steel manufactures, and £31,100 iron goods, including sleepers, wagons, galvanised sheets, &c., to the value of £10,540 for Calcutta.

The inquiry for shipping coals is pretty well maintained, the past week's shipments including 26,853 tons from Glasgow, 327 from Greenock, 2406 from Irvine, 6112 from Troon, 8341 from Ayr, 14,088 from Grangemouth, and 4807 from Bo'ness. In the Western district the inquiry for house coals is small, as indeed it is elsewhere. Miners in the Glasgow district have been making a large output in anticipation of the fair holidays, which began towards the end of the present week. The quotations of coals are still low, ranging at the ship's side from 5s. 9d. to 6s. 3d. for main, 5s. 3d. to 7s. 3d. for ell, 6s. 3d. to 7s. for splint, and 7s. to 8s. for steam. On both the East and West coasts freights are low for coals, with a slight tendency downwards in certain places, owing to there being a plentiful supply of tonnage.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

The old French saying that the unexpected generally comes to pass applies in a marked degree to the Welsh Railway Bills of the past few years. Schemes that are indispensable for the mineral development of the country, and upon which the prosperity of large populations depends are sent to the limbo of rejected Bills; while others, which jar with existing arrangements and infuse the bitterness of competitive rivalry into the social class, pass the Rubicon easily. What could be more needed than a railway to develope the great tract of coal from Risca? One of the first of mining engineers told me personally that such a line would prove another Taff Vale; yet two efforts have been made and unsuccessfully. It remains to be seen whether the Rhymney Railway Company will fare better. I note that the preamble of the Barry Dock and Railways Bill has passed the House of Commons Committee. It was the carefully expressed and elaborately supported argument of the counsel for the Marquis of Bute and the Taff Vale Railway that the line was totally unnecessary.

I am glad to hear that the Monmouthshire coal scheme, to which I referred last week, is solidifying. It is a big thing, which means working an extensive tract by a new company, and ultimately descending to the lower measures. The coal trade is not quite so buoyant, and can only be said to be partially active, some favoured coalowners being much more flourishing than others. Up to the present, however, the Cardiff district cannot be said to have done badly in 1885. The total coal shipments from January to June 30th, 1884, amounted to 4,137,851 tons. This half-year they have totalled 4,238,447 tons, thus showing an increase of 100,596 tons. The height to which the prosperity of the Welsh coalfield has arisen is well shown when we compare the totals with other ports of the kingdom. Thus the total of the whole of the Tyne ports for the same period in 1885 shows but 4,029,130 tons; Sunderland, 1,827,413 tons; Newport, 1,440,143 tons; Swansea, 788,590 tons; and Liverpool, 660,383 tons. The present coal trade of Cardiff shows now an annual shipment of ten million tons, and, in respect of quantity, is all that can be needed; but a shilling more per ton would be a great boon to master and man. House coal is sluggish, and the result is that some collieries are only working three to four days per week. Small steam is firm in price, and is being picked up readily in all quarters.

Patent fuel is in steady requirement. At Swansea, France, Italy, and Russia are good customers. Cardiff, too, is doing a large trade. Prices, 9s. 9d. to 10s., and firm.

I have no change to report in the iron and steel trades. A moderate make of rails and bars is going on. Cyfarthfa, Dowlais, and Tredegar, with some of the other large works, show something like the old activity, and at Tredegar especially hopes are strong of future business, as the management have successfully contended with the difficulties of making steel sleepers, and are now turning them out. This sleeper weighs 120 lb., and is rolled in such lengths as only to necessitate the cutting of two crop ends instead of six. I hear that good orders from India are to hand, and Wales may be congratulated upon initiating a new and promising industry.

Tin-plate is firmer in price, and inquiries are on the increase; but some degree of quietness prevails on account of stock-taking. The prevailing opinion is that the action of the masters in agreeing to a stoppage of one week in four will have a good effect. One thing is certain. Makers are putting prices up, and buyers are showing more anxiety to close for forward deliveries. The quality of the make at present is unexceptionally good. No fault can be found, and if the leading makers continue the excellence of their brands, they can be assured of getting an advanced price. A hopeful state prevails in the trade, though June sales were less by nearly 5000 tons than in May. Still this was not unexpected, and as compared with June, 1884, we show an increase of 5400 tons.

The Tin-plate Decorating Company, formerly Leech, Flower, and Co., is being floated. Their old repute for artistic decoration suggests a good feature for the company.

Iron ore is very dull.

House coal quotations, 8s. 3d. for No. 2 and 9s. for No. 3. Pitwood weaker owing to increased cargoes coming to hand.

The examination of colliery managers at Bristol has proved eminently satisfactory, seven having passed. The first of these was a working collier of the Aberdare Valley, and there is a fine and healthy stimulus in the fact that he was able to head the competition, and prove his capacity to govern in the pit where he had been an ordinary worker.

NEW COMPANIES.

THE following companies have just been registered:—

Heveenoid Syndicate, Limited.

This syndicate was constituted by deed of settlement on the 22nd ult., and registered as a limited company on the 8th inst. with a capital of £60,000, in £5 shares, 3750 of which are taken up and are fully paid. The object of the company is to acquire and work the patents No. 6232, of 30th December, 1882, sealed 22nd June, 1883, and No. 1571, of 16th January, 1884, granted respectively to Mr. Henry Gerner and Mr. Alfred Henry Huth, for inventions relating to the preparation and manufacture of india-rubber, gutta-percha, or any analogous gum. The members are:—

	Shares.
*A. H. Huth, Ennismore-gardens	400
F. Walters, 12, Tokenhouse-yard, merchant	200
*J. G. Minchin, 2, Metal Exchange-buildings, solicitor	200
R. B. Huth, Great Marlow	400
W. C. B. Munro, 64, West Cromwell-road	100
J. Findlater, 33, Wellington-street, wine merchant	300
D. Shearer, Park-hill, Croydon, merchant	200
*Walter Wood, 13, Delahay-street	200
M. T. Bradford, 52, Queen Anne's-gate, spinster	100
E. Huth, 29, Hereford-street, merchant	600
R. C. Eames, Cork, Ireland, barrister	200
H. D. Poole, 33, Chancery-lane, solicitor	200
Hon. H. C. Bruce, Neath	200
T. F. Campbell, 26, Devonshire-place	200
*W. Cotton, 28, Ampthil-square	200
F. W. Hendre, 11, Delahay-street, clerk	50

The number of directors is not to be less than three, nor more than five; qualification, £250 of paid-up capital; the first are the subscribers denoted by an asterisk. Mr. A. H. Huth is appointed chairman. The remuneration of the board for the year ending 25th March, 1886, is to be a maximum of 10 per cent. per annum on the profits for the current year, or in case the profits do not exceed that sum, a minimum of £150 for each director, and a minimum of £50 for each director for all subsequent years.

Mortgage Securities and Trust Corporation, Limited.

Upon terms of an agreement of the 26th ult. this company proposes to purchase from David Chadwick and James Boardman, carrying on business in London and Manchester as accountants, financial and insurance agents, under the style of Chadwicks, Boardman, and Company, such part of the said firm's business as relates to private mortgage agency, or the lending and borrowing of money on mortgage to or by individuals, firms, or municipal corporations. It was registered on the 3rd inst. with a capital of £50,000, divided into 2400 A shares of £20 each, and 100 B or deferred shares of £20 each. Messrs. D. Chadwick and James Boardman are appointed to act as managing directors for three years at a salary of £200 per annum each. The purchase consideration is 100 B shares. The subscribers are:—

	Shares.
*G. W. Hastings, M.P., Barnard's-green House, Worcester	20
*T. J. Bewick, C.E., Haydon Bridge, Northumberland	20
*C. B. Dobson, M.A., 72, West Cromwell-place	20
*D. Chadwick, The Poplars, Herne-hill, chartered accountant	20
*J. Huish, J.P., Smalley Hall, Derby	20
*J. Boardman, Redmond-terrace, Manchester, chartered accountant	20
J. Harcourt Smith, Barnes, Surrey	20

The number of directors is not to be less than three, nor more than twelve; qualification, 20 A shares; the first are the subscribers denoted by an asterisk. The remuneration of the ordinary directors will be at the rate of £100 per annum each, with £50 additional for the chairman.

New Explosives Company, Limited.

On the 2nd inst. this company was registered with a capital of £150,000, in £5 shares, to acquire the undertaking, business, and property of the Explosives Company, Limited, including their property at Stowmarket, Penrhyndendraeth, and Pembrey. The subscribers are:—

	Shares.
T. Large, 8, Coburg-road, Teddington	1
*A. J. Nutt, 133, Fenchurch-street, chemist	1
*E. H. Hindley, 126, Leadenhall-street, East India agent	1
J. S. Anderson, 36, Wellesley-street, Croydon, accountant	1
C. W. Bennett, 68, Coleman-street, solicitor	1
*F. Thorn, 8, Addison-road, W.	1
E. G. Saunders, 68, Coleman-street, solicitor	1

The number of directors is not to be less than three, nor more than six; qualification, 100 shares; the first are the subscribers denoted by an asterisk, and Messrs. H. D. Sandeman, Lawrence Heyworth, and W. H. Clarke. Rumuneration £500 per annum, with an additional £150 per annum for the chairman.

Patent Gum and Rubber Company, Limited.

Upon terms of an agreement of the 10th inst., this company proposes to purchase certain British and Foreign patent rights relating to methods of hardening resins and preparations therefrom. It was registered on the 6th inst. with a capital of £55,000 in £100 shares. The purchase consideration is £28,000 in fully paid shares. The subscribers are:—

	Shares.
*W. Hartmann, 10, Billiter-street, merchant	1
G. Hartmann, 10, Billiter-street, merchant	1
J. Hartmann, Cardiff, merchant	1
*H. Abbott, 66, Queen-street, E.C., merchant	1
A. Domeier, 13, St. Mary-at-Hill, merchant	1
J. Sauer, Ulmen Lodge, Lee-road, S.E., merchant	1
J. Seyd, Wiesbaden, merchant	1

The number of directors is not to be less than three, nor more than six; qualification, 25 shares; the first are the subscribers, denoted by an asterisk, Mr. Richard Le Doux. Remuneration, £105 per annum to each director.

Syrinx Gas Engine Company, Limited.

This company was registered on the 2nd inst. with a capital of £4000 in £1 shares, to acquire from Messrs. Clarke and Gillespie the patent of Edward Cotham and John Gillespie (No. 3495, 1884) for the manufacture of the Syrinx gas engine, and also the business of manufacturing the said engine, and the business of mechanical engineers, agricultural implement makers, and blacksmiths, carried on at the Meadowland Works, Stevenage, Hertford. The subscribers are:—

	Shares.
Charles D. Wickering, Langdon Lodge, Lincoln, engineer	1
W. Onslow Times, Hitchin, Herts, solicitor	1
W. Carling, Hitchin, newspaper proprietor	1
F. C. Pearce, Harpenden, solicitor	1
C. J. Times, 27, Leadenhall-street, merchant	1
E. F. Collins, Stevenage, clerk	1
J. Gillespie, Stevenage, engineer	1

Most of the regulations of Table A of the Companies' Act, 1862, apply.

RUST CEMENT.

ONE of the most adhesive and durable of cements known to mechanics who essay to unite iron surfaces is the oxide of iron itself; with this a joint can be made so perfect and sound that the iron will break before the cement will part. In removing the cast iron pipe of a bilge pump from a ship that had made four Atlantic voyages, it was necessary to take the sections apart. The flanges had been pasted with a cement of cast iron drillings and filings, mixed with sulphur and sal-ammoniac, moistened with water. Then the nuts—three in each flange—were set up on the bolts, and the union was completed. The four voyages—going and returning — occupied nearly a year. When the separation of the parts was attempted, even the cold chisel was unable to make a division between the solid castings and the intervening cements. The sulphur and ammoniacal salts are simply means to more rapidly oxidise the iron drillings and filings — the iron rust is really the cement. If time is allowed, ordinary water or salt water would act as a solvent.

All our iron ores are simply oxides, and when they are exposed to the atmosphere they show the ordinary colour of iron oxide—red. This oxide gives the red colour to the "brownstone"—red sandstone—so much affected for building purposes. These stones are only sand cohered in mass by iron rust. Their formation can be witnessed even now on some of the New England beaches. The narrow and slightly raised windrows of sand thrown up by some heavy storm or some very high tide, so that they are beyond the redestroying effects of common tides and ordinary winds, can be noticed slowly solidifying. Fragments may be gathered which are only sand slightly held by the oxide, but others may be found which are embryo stone—if such a term may be allowed—solid to the feeling, and capable of being thrown as missiles. Beyond these are the shingles of the beach and the cliffs that define the shores. In olden time this sand and this iron was mixed, subjected to pressure by outerlying layers, and at length became "solid rock," as we call it. And yet this quarried rock of sand cemented with iron is still somewhat soft, and for building purposes requires seasoning—the gradual reabsorption of the water given by the atmosphere; and this water is essentially salt or it has the oxidising effect of salt water, for its effect on iron is similar to that of salt water on iron under similar circumstances.

It is evident that any substance that induces rust in iron is not a safe one to use in connection with permanent structures of iron. Some years ago an instance of iron in connection with red sandstone — brownstone — was noticed, where wrought iron rods were secured into steps of brownstone. The stairway was removed, and the iron in the stone was disintegrated into mere threads. In this instance the holding of the iron balusters was sulphur. And sulphur is much worse than lead; it is impossible to secure iron in stone, or even in iron, by sulphur. Lead is perhaps as safe as any material that is not too expensive to use. In removing an iron fence, the embedment of the palings in lead lining the holes in the stone, making a superficies of about 14in. was readily overcome by lever action; while the cross section of the same paling through iron rails iron on iron, the area being less than 3½in., necessitated the use of hammer and cold chisel.—*Scientific American.*

SOUTH KENSINGTON MUSEUM.—Visitors during the week ending July 11th, 1885:—On Monday, Tuesday, and Saturday, free, from 10 a.m. to 10 p.m., Museum, 7246; mercantile marine, Indian section, and other collections, 2616. On Wednesday, Thursday, and Friday, admission 6d., from 10 a.m. to 6 p.m., Museum, 1651; mercantile marine, Indian section, and other collections, 201. Total, 11,714. Average of corresponding week in former years, 17,429. Total from the opening of the Museum, 24,139,550.

THE USE OF NATURAL GAS.—The town of Pittsburg, Pennsylvania, affords an illustration of what may be accomplished in the use of natural gas. This gas is now conveyed to the town through four lines of 5⅝in. pipe and one line of 8in. pipe. A line of 10in. pipe is also being laid. The pressure of the gas at the wells is from 150 lb. to 230 lb. to the square inch. As the wells are eighteen miles distant on the one side and about twenty-five miles on the other, and as the consumption is variable, the pressure at the city cannot be given. Greater pressure might be obtained at the wells, but this would increase liability to leakage and bursting of pipes. For the prevention of such casualties, safety valves are provided at the wells, permitting the escape of all superfluous gas. The enormous force of this gas may be appreciated from a comparison of, say, 200 lb. pressure at the wells, with a 2 oz. pressure of common gas for ordinary lighting. The amount of natural gas now furnished for use in Pittsburg is supposed to be something like 25,000,000 cubic feet per day; the 10in. pipe now being laid will, it is estimated, increase the supply to 40,000,000ft. The amount of manufactured gas used for lighting the same city probably falls below 3,000,000ft. About fifty mills and factories of various kinds in Pittsburg now use natural gas, and it is used for domestic purposes in 200 houses.

THE PATENT JOURNAL.

Condensed from the Journal of the Commissioners of Patents.

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

Applications for Letters Patent.

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

7th July, 1885.

8197. AUTOMATIC ELECTRIC TELL-TALE APPARATUS, A. Johnson and G. G. Rhodes, Manningham.
8198. SCREW NECK BOTTLES and STOPPERS, F. G. Riley, London.
8199. SKIPS, CASES, &c., T. Humphreys, Manchester.
8200. STEAMING WOVEN FABRICS, J. Hawthorn and J. P. Liddell, Manchester.
8201. SPADES and SHOVELS, D. Willetts, Birmingham.
8202. DRAUGHT REGULATORS and HEAT PRESERVERS, W. Hunter, London.
8203. POCKET INKSTANDS, W. J. Myatt, Birmingham.
8204. CLIPPING or SHEARING MACHINES, T. L. Phipps and W. Burman, Birmingham.
8205. SPRING CLOSING TONGS, &c., G. and C. Ball, Birmingham.
8206. PULLEYS or DRUMS, C. Longbottom, Bradford.
8207. STEAM TAPS, W. P. Thompson.—(*J. B. Erwin, United States.*)
8208. COAL-CUTTING MACHINES, R. Thompson, Liverpool.
8209. CHEMICAL PRINTING SYSTEM, H. Garnier, Paris.
8210. SPINNING, SLUBBING, &c., FRAMES, A. Dilthey, Manchester.
8211. WATCH ESCAPEMENTS, A. M. Clark.—(*G. Krichevski and A. Edmonds, United States.*)
8212. BOOT VARNISH, W. Sheppard, London.
8213. COLLARS, J. E. Minot, E. A. Price, and Welch, Margetson, and Co., London.
8214. CIGARETTES and CIGARETTE TUBES, E. L. Delaney, Fulham.
8215. DUPLEX STEAM ENGINES, L. B. Carricaburu, London.
8216. VALVE GEAR for DUPLEX STEAM ENGINES, L. B. Carricaburu, London.
8217. PULVERISING ORES, SEEDS, &c., H. J. Allison.—(*G. Frisbee, United States.*)
8218. PROJECTILE, C. Wells, London.
8219. CLIP PULLEYS, C. Parkin and G. Robinson, Liversedge.
8220. MULE SPINNING MACHINERY, J. and N. Greenwood, and D. Gledhill, Halifax.
8221. MILK CANS, W. H. Bulpitt, Birmingham.
8222. METALLIC SPECULA for TELESCOPES, V. Safarik, London.
8223. ARMY TRENCHING TOOLS, A. H. Storey, London.
8224. AUTOMATIC LOCK-FAST BRAKE, W. C. Brett, Homerton.
8225. SMOKE-CONSUMING FURNACES, H. C. Paterson, Glasgow.
8226. LEAD and CRAYON HOLDERS, J. H. Johnson.—(*The Eagle Pencil Company, United States.*)
8227. COCKS and VALVES, T. H. White and R. G. Brooke, Manchester.
8228. VOLTAIC BATTERIES, H. I. Harris, London.
8229. SUNSHADE or UMBRELLA, C. Wells, London.
8230. PERAMBULATORS, M. Moses, London.
8231. REFRIGERATORS, A. J. Askew, London.
8232. COFFEE-POTS, T. W. Arnall, London.
8233. FORMING SOLID CLIPS on WATCH CASES, C. Chabot, London.
8234. MOULDING CIGARS, W. R. Lake.—(*W. J. Fox and G. J. Taylor, United States.*)
8235. WIRE BANDS or TIES for BOXES, W. R. Lake.—(*A. Elkan, B. Lande, and H. Frank, United States.*)
8236. MACHINE GUNS, O. Jones, London.
8237. FOOD for POULTRY, W. R. Lake.—(*S. S. Myers, United States.*)
8238. BENDING, &c., EDGES of METAL SHEETS, W. R. Lake.—(*Van S. Sharp and W. W. Holcomb, U.S.*)
8239. STEAM BOILERS, A. M. Clark.—(*B. F. Wright, United States.*)
8240. BICYCLES and TRICYCLES, A. J. Boult.—(*W. S. Kelley, United States.*)
8241. INK from WASTE DYE LIQUORS, T. Frusher, London.
8242. MILLS for GRINDING ALMONDS, &c., W. T. Oschwald, London.
8243. LACE and other WINDOW CURTAINS, F. H. Goodyer, London.
8244. CARTRIDGE SHELLS from PAPER, &c., G. M. Peters, London.
8245. BOOTS and SHOES, L. and J. W. Haylock, London.
8246. STRAINERS for MILK, &c., J. L. Abell, London.
8247. SPIRALLING WIRE, A. J. Boult.—(*A. R. Benton, United States.*)
8248. FIRE-ESCAPES, D. Pattison, London.
8249. CATHETERS, J. Banks, London.
8250. OXIDISED or SOLIDIFIED OIL, &c., F. Walton, London.
8251. FURNACE GRATES, L. S. Dulac, London.

8th July, 1885.

8252. SPRING MATTRESSES, J. T. Barnett, Manchester.
8253. WEAVING of UPHOLSTERY GIMPS, G. P. Lee, Manchester.
8254. WEATHER BOARDS and DRAUGHT EXCLUDERS, W. B. Shorland, Manchester.
8255. BRAKES for WHEELED CARRIAGES, M. J. McGrath and R. A. Gardner, Manchester.
8256. GOVERNORS for TURBINES and WATER-WHEELS, C. L. Hett, Brigg.
8257. SPRING MOTOR for DRIVING SEWING MACHINES, W. A. Evans and J. McVey, Dublin.
8258. ELECTRIC INDICATOR and ALARM, &c., J. Fytton, Liverpool.
8259. BATHS and other WASHING VESSELS, J. Shanks, Glasgow.
8260. ALUM and SULPHATE of ALUMINA, T. Robinson, Glasgow.
8261. OPENING and CLOSING of BOTTLES, J. Webb, Manchester.
8262. BUTT DUPLEX STONE BREAKER, &c., R. Brook, Leeds.
8263. SELF-INDICATING TARGET, J. H. Jack, Edinburgh.
8264. RELIEVING BLOWN or INFLATED ANIMALS, J. Tovey, Birmingham.
8265. PREVENTING the UNCOILING of COTTON when NOT in USE, M. Moore, London.
8266. FLOORING and ROADWAY SUSTAINING PLATES, R. C. Braithwaite and W. Kirk, Birmingham.
8267. IMPRESSION TRAYS for DENTAL PURPOSES, T. W. F. Rowney, Derby.
8268. SUPPORTING, &c., CHEESES when in USE, J. Webb, London.
8269. WROUGHT IRON and STEEL CASTINGS, T. Nordenfelt.—(*C. G. Wittenström, Sweden.*)
8270. ELECTRIC BELL INDICATORS, &c., E. Thurkle, London.
8271. BREECH-LOADING and REPEATING FIRE-ARMS, A. J. Needham, London.
8272. TWISTING STRANDS of FIBROUS MATERIALS, J. N. and T. Jennings, London.
8273. WATERPROOF CAPS, B. Kempner, London.
8274. CHAINS for TRANSMITTING MOTIVE POWER, T. Kendrick, Greet.
8275. PIN-HOLDERS, E. A. Jahncke, N. M. Rapp, and H. W. Herbst, London.
8276. ELECTRIC BELL INDICATORS, J. Newton, London.
8277. STEELS for STAYS, A. Hentschel.—(*Lee and Schmidt, Germany.*)
8278. PLATE PRINTING PRESSES, &c., P. M. Justice.—(*E. R. Milligan, United States.*)
8279. FILTRATION, &c., of SUGAR LIQUOR, &c., H. H. Lake.—(*F. O. Matthiessen, United States.*)
8280. DISCONNECTING, &c., CLUTCHES, &c., J. G. Rockhill and F. Jones, London.
8281. MACHINE and other GUNS, H. S. Maxim, London.
8282. FILTERING MATERIAL for PURIFYING WATER, O. F. Oberg, London.
8283. EARTH BORING, F. J. Jarvis, London.
8284. UNDERFRAMES, &c., for VEHICLES, H. J. Haddan.—(*Col. F. C. Trench, Russia.*)
8285. FOLDING CHAIRS, H. J. Haddan.—(*Vopel and Heinemann, Saxony.*)
8286. TUBE EXPANDERS, R. Barnard and E. Miles, London.
8287. MATCH-BOX CASE, D. R. Kirkland, Glasgow.
8288. BRAKES or DRAGS for CARRIAGES, &c., J. Gardner, Glasgow.
8289. GRISWOLD'S STOCKING KNITTING MACHINES, R. Price, London.
8290. CONCERTINAS, J. Alsepti, Exeter, and R. Ballinger, London.
8291. ECONOMISING WATER in HYDRAULIC CRANES, &c., A. T. Walker, London.
8292. STEAM WINDLASSES, E. J. Eyres, London.
8293. DIGGING POTATOES, J. A. Lewis, London.
8294. PENHOLDER, T. J. McCartney, London.
8295. LEAD BURNING, P. J. Davies, London.
8296. SHIPS' RIDING BITTS, E. J. Eyres, London.
8297. ROTARY STEAM ENGINE, W. A. Barlow.—(*J. Oeschger, fils, and G. Morel, France.*)
8298. ANCHOR CAPSTANS, E. J. Eyres, London.

9th July, 1885.

8299. TOOLS for FORMING GROOVES in BOTTLE MOUTHS, D. Rylands and B. Stoner, Barnsley.
8300. BOXES, E. M. Knight, Halifax.
8301. MAKING SAGGERS, CRUCIBLES, &c., T. C. Fawcett, Halifax.
8302. BALL and ROLLER CASTORS, L. Sergeant, London.
8303. HALL, &c., LAMPS, W. Beal, Birmingham.
8304. GENERATING DRY HYDROCHLORIC ACID GAS, T. B. and A. V. Saunders, Bradford.
8305. ROTARY ENGINE, R. Whitehead, Sheffield.
8306. MOUTHPIECES and DIES for MAKING BRICKS, R. B. Vaughan, Liverpool.
8307. STAND for UMBRELLAS, &c., W. H. Gay and W. Davies, Birmingham.
8308. CHECK RIM HOOKS for HARNESS, A. P. Rockwell and F. T. Davis, London.
8309. SASH FASTENERS, A. P. Rockwell and F. T. Davis, London.
8310. HOLDING while GRINDING, SHAPING, &c., H. Besson and E. N. Kent, London.
8311. AXES, H. Hammond, London.
8312. MAKING ELECTRIC CONDUCTORS, J. G. Parker, London.
8313. CAMERA SLIDES, J. B. Holroyd, Halifax.
8314. GUN-LOCK, W. C. McEntee and J. Hughes, London.
8315. STANDARDS for FENCING, R. R. Main, Glasgow.
8316. HIGH-SPEED ENGINES, W. Lowrie, London.
8317. ARMOUR-PLATING SHIPS, E. P. Clayson, London.
8318. UTILISING SCRAP TIN-PLATES, T. Bayley, Birmingham.
8319. GENERATING ELECTRICITY, W. P. Thompson, Liverpool.
8320. RED CROSS BELT, L. Vignes.—(*E. Duros, France.*)
8321. ELECTRICAL MAGNET, H. S. Heath, London.
8322. BALLOT BOXES, &c., W. B. Williamson, London.
8323. SECURING RAILS to METALLIC SLEEPERS, F. E. Gilbert, London.
8324. PURIFIERS for FLOUR and SEMOLINA, S. Leetham, London.
8325. DECORATING CHINA and GLASS, A. M. F. Caspar, London.
8326. SAFETY TRICYCLE, J. Barrett, Godstone.
8327. KEEPING the BOTTOMS of SHIPS, &c., CLEAN, A. Myall.—(*W. Judd, China.*)
8328. ORDNANCE, E. E. H. Bradley, London.
8329. SUPPORTING and PACKING the AXIS of DRYING CYLINDERS, G. Howarth, London.
8330. MOTIVE POWER ENGINES, S. Butler, London.
8331. CARBON ELEMENT for GALVANIC BATTERIES, A. M. Clark.—(*C. R. Goodwin, France.*)
8332. COOKING APPARATUS, A. McCleverty, London.
8333. CLEANING GRAIN, W. R. Lake.—(*W. A. Cockrell, United States.*)
8334. PLIERS, W. Hardy, jun., London.
8335. COLOUR GAUGES for TINTED THREADS, C. D. Abel.—(*E. Vaquez-Fessart, France.*)
8336. BLOCKS of COMBINED INGOT IRON and PUDDLED or FAGOT IRON, C. D. Abel. (*F. C. Glaser, Germany.*)
8337. ADJUSTABLE MUSIC STOOL, W. Bevitt, Romford.—(*H. F. Merrill.*)

10th July, 1885.

8338. NAME, &c., PLATES, H. Franklin and B. W. Hornblower, Birmingham.
8339. SAFETY STEP-LADDER HINGE, A. Edmondson, J. B. Moorhouse, and T. A. Procter, Skipton-in-Craven.
8340. PUMPS, W. W. Fyfe, London.
8341. MANUFACTURE of GLASSWORK, W. E. Wiley, Birmingham.
8342. SAFETY ATTACHMENT for EARRINGS, &c., J. S. Whitten and H. G. Plant, Birmingham.
8343. EXPLOSIVE PROJECTILES, &c., D. R. Dawson, Glasgow.
8344. AIR PUMP AND CIRCULATING VALVES, M. Jones, Swansea.
8345. DYNAMO-ELECTRIC MACHINES, &c., S. W. Cuttriss, Leeds.
8346. LAMPS, J. Lucas, Birmingham.
8347. MACHINERY for MAKING BRICKS, &c., T. C. Fawcett, Halifax.
8348. TURNING TABLES for RAILWAYS, C. Robertson, Edinburgh.
8349. COCKING HAMMERLESS GUNS, W. Ford, R. Jackson, and G. W. Toney, Birmingham.
8350. COCKING and APPLYING SPRINGS to HAMMERLESS, GUNS, W. Ford, R. Jackson, and G. W. Toney, Birmingham.
8351. DISINFECTANT TABLET for CHARGING TANKS, W. H. Symons, London.
8352. BRUSHES, T. R. Anderson, Dundee.
8353. PRODUCING and CONDENSING VAPOURS, A. E. Robinson, Birmingham.
8354. SELF-ACTING VALVE, W. S. Gardner and A. H. Sheppard, Hove.
8355. JACQUARD HARNESS for WEAVING FABRICS, I. Thomis and M. Priestley, Bradford.
8356. DETACHABLE FORESIGHT for SHOOTING at NIGHT, M. Egelis, London.
8357. METAL ROOFING, C. Holden, London.
8358. AUTOMATIC FIRE-EXTINGUISHING SPRINKLERS, R. Dowson and J. Taylor, London.
8359. HAND-DRILLS, J. L. Shorrock, Halifax.
8360. WELDING COMPOUND, E. Watkins, California.
8361. FEMALE URINAL, C. M. Kühlmorgen, London.
8362. SPRINGLESS LOCKS and LATCHES, W. A. Rees London.
8363. PAPER-MAKING, T. Moffatt, Glasgow.
8364. TREATING STONE to produce a GLAZED SURFACE, J. Matthew, London.
8365. CLOSETS, &c., C. Cowney, London.
8366. BRACKETS for DISPLAYING BOOTS, &c., S. Harris, London.
8367. STAND for EXHIBITING PICTURES, F. Bishop.—(*J. F. Knipp and Co., Germany.*)
8368. WHIPPLE TREES, J. E. Ransome and J. Barker, London.
8369. NEEDLES, J. Long, London.
8370. SPOKES for VELOCIPEDES, &c., A. W. Minns and R. Sheward, London.
8371. HOPPER DREDGERS, A. Brown, London.
8372. SIRENS, C. Ingrey, London.
8373. RAIN WATER FLUSHING APPARATUS, W. D. Scott-Moncrieff, London.
8374. SCREW-STOPPERED BOTTLE, W. and T. A. Coultas, Blackheath.

11th July, 1885.

8375. Chimney-pot or Smoke Ventilator, W. P. Lane, Helston.
8376. Fixing Wicks in Lamps, P. P. Burt and S. B. Edmonds, Birmingham.
8377. Frames for Lamps, I. Sherwood, jun., and F. Sherwood, Birmingham.
8378. Combing Cotton, Silk, &c., J. Dugdill, Manchester.
8379. Securing Window Blinds, &c., to Rollers, G. F. Whittle, Manchester.
8380. Floats for Regulating the Motion of Valves, F. N. Mackay, Liverpool.
8381. Supporting and Levelling Photographic Cameras, &c., J. M. C. Grove, Letterkenny.
8382. Hydrate, Sulphate, &c., Salts of Alumina, H. Richardson, Jarrow-on-Tyne.
8383. Manufacturing Gas Hooks, A. E. Gorse, West Bromwich.
8384. Washing Machine, W. H. Tiplady and C. Wood, Manchester.
8385. Blower for Domestic Fire-grates, R. R. Roberts, Manchester.
8386. File Guide for Sharpening Saws, R. R. Roberts, Manchester.
8387. Musical Instruments, P. Tarbutt, London.
8388. Horse Collar Clasp, H. S. Fisher.—(*N. A. Fisher, United States.*)
8389. Sewing Needles, A. W. Adams, Penarth.
8390. Window Blind, S. H. Sharp, Halifax.
8391. Comet Globe Holder, W. Beale, Birmingham.
8392. Caustic Alkalies, W. P. Thompson.—(*B. Osann, Germany.*)
8393. Flushing Apparatus for Drains, &c., J. Morris, Liverpool.
8394. Cutting or Dressing Stone, E. Chatham, Liverpool.
8395. Communicating between Railway Passengers and the Guard and Driver, J. Tasker and A. M. Coates, London.
8396. Parchment Paper, H. Mason, London.
8397. Opening and Closing Fire-extinguishing Sprinklers, R. Dowson and J. Taylor, London.
8398. Winding and Reeling Cotton, &c., J. W. Makant and P. Parkinson, London.
8399. Links, T. White and G. H. Dixon, Sheffield.
8400. Bottle Necks, A. J. T. Wild, London.
8401. Lamp Chimneys, D. C. Defries.—(*L. Sépulchre, Belgium.*)
8402. Size for Sizing Raw Silk, J. F. Giraud, London.
8403. Treating Fatty Matters, A. Michel, London.
8404. Turning Over the Leaves of Music, G. Brockelbank, Anerley.
8405. Opening Boxes of Tinned Goods, B. Campbell, London.
8406. Disinfectants, W. D. Borland, Stowmarket.
8407. Indicator for Applying the Names to Streets, R. Essery, London.
8408. Making Packets of Cigarettes, &c., R. de M. Lawson, London.
8409. Constructing Floorings of Bridges, &c., C. S. Williams and H. Stanton, Cubitt Town.
8410. Incandescent Electric Lamps, H. I. Harris, London.
8411. Hydro-carburetted Air Engines, J. J. R. Humes, London.
8412. Fountain Pens, T. Noble, London.
8413. Spring or Weight Motor, G. M. Page, London.
8414. Umbrellas and Parasols, H. J. Haddan.—(*E. A. R. Geisler and Voeckler and Roh, Saxony.*)
8415. Gas Engines, C. W. Pinkney, London.
8416. Electrode Frames for Secondary Voltaic Batteries, A. Khotinsky, London.
8417. Face Plate and Lathe Chuck Attachment, A. M. Clark.—(*E. Pement, United States.*)
8418. Purifying Copper Precipitates, J. Y. Johnson.—(*E. Deligny, France.*)
8419. Stand for Carrying Rolls of Paper, P. Stewart, Glasgow.
8420. Controlling Device for Semaphores, C. Reitzius-Ekwall, London.
8421. Wire Fences, S. Pitt.—(*W. A. Murray, New Zealand.*)
8422. Gear for Driving Rollers, &c., E. Morewood, London.
8423. Fish Sausages, T. Nordenfelt, London.
8424. Cleaning Grain, G. Downing.—(*F. J. Sommer, Germany.*)

13th July, 1885.

8425. Floral Wreaths, J. C. Beyrodt, Germany.
8426. Locomotive Torpedoes, E. C. Peck, Old Charlton.
8427. Combination Letter Stamping, Arranging, and Printing Machine, W. C. Burton, Rochdale.
8428. Secondary or Storage Batteries, G. E. Dorman, Stafford.
8429. Gas Regulators, T. R. Anderson, Dundee.
8430. Automatic and Continuous Brakes, H. Brockelbank, Streatham.
8431. Connecting Fasteners to Driving Belts, I. Jackson, Glossop.
8432. Wire Cloth, R. Rowat, Glasgow.
8433. Fixing, &c., Marine Chronometers, R. Evans, Newcastle-on-Tyne.
8434. Pulp Strainer, J. Wood and R. Penman, Edinburgh.
8435. Furnaces, J. C. Brentnall, Manchester.
8436. Needle Springs for Sewing Machines, D. Young, Edinburgh.
8437. Wood-working Machinery, S. Ingham, W. Illingworth, and J. W. Haywood, Leeds.
8438. Steering Velocipedes, M. Woodhead and P. Angois, Nottingham.
8439. Slide Valves for Steam Engines, P. Baylis, London.
8440. Sulphuretted Hydrogen, E. W. Parnell and J. Simpson, Liverpool.
8441. Screw Propellers for Ships, G. A. Calvert, Liverpool.
8442. Pressing Hats, W. E. Carrington and R. Tipping, Manchester.
8443. Bleaching Apparatus, A. Whowell, London.
8444. Bakers' Ovens, J. T. Pearson, London.
8445. Venetian Blinds, S. Willoughby, London.
8446. Railway Signals, R. Hudson, London.
8447. Bottling Liquids, F. G. Riley, London.
8448. Doubling Machines, J. and J. Nightingale, London.
8449. Runners for Braces, &c., E. Farrow, London.
8450. Fastenings for Window Sashes, C. W. Watson, Willesden-green.
8451. Pneumatic Pump and Fluid Piston, J. W. Gordon, Lower Clapton.—13*th October*, 1884.
8452. Telephonic Apparatus, J. Munro, West Croydon.
8453. Wire Rope, H. Cheesman, London.
8454. Photographic Shutters, H. J. and E. J. Dale, and A. Newman, London.
8455. Electric Bells, H. J. and E. J. Dale, and A. Newman, London.
8456. Aerial Navigation, H. J. Dale, London.
8457. Justifying Matrices, Types, and Dies, A. J. Boult.—(*O. Mergenthaler, United States.*)
8458. Writing Pens, T. Maguire, Blackburn.
8459. Movable Targets, F. Clarke, London.
8460. Alarm Fastenings for Doors and Windows, F. Lebacq and J. Ponty, London.
8461. Instruments for Taking Soundings, A. J. Cooper and E. E. Wigzell, London.
8462. Stud Fastenings, O. Rafflenbeul, London.
8463. Fireplace, O. Imray.—(*D. A. Rosenstiehl, France.*)
8464. Scutching Fibrous Stems, &c., W. E. Death, London.
8465. Utilising the Motive Power of Steam, F. Prince.—(*H. J. E. Hennebutte, France.*)
8466. Velocipedes, T. Butler, London.
8467. Umbrellas and Parasols, W. R. Lake.—(*U. G. Steinmetz, United States.*)
8468. Nailing Machines, W. R. Lake.—(*F. F. Raymond, United States.*)
8469. Endless Bands and Cords, A. M. Clark.—(*L. Binns, United States.*)
8470. Chlorine, F. Maxwell-Lyte, London.
8471. Nut Lock, A. M. Clark.—(*W. M. Rice, U.S.*)
8472. Rendering Chalk Unbreakable, A. Brown.—(*A. Hamann, Germany.*)
8473. Balanced Spring Blinds, M. H. Robottom and J. H. Brough, London.
8474. Box, T. Bradford, London.
8475. Sounding Boards for Pianofortes, J. H. Dunkley, London.
8476. Vox Humana Mechanical Stop for American Organs, &c., J. Harrison, London.

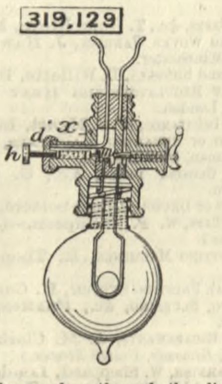
SELECTED AMERICAN PATENTS.

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

319,129. Incandescent Electric Lamp, *Emile L. Roussy, Vevay, Switzerland.—Filed April 26th*, 1884.

Claim.—The combination, with the electric lamp containing a carbon filament, of a holder *x* of insulating material, having a cavity and a resistance column of finely-divided carbon therein, the clip plate d^1 upon the exterior of the holder covering said cavity, a

319,129

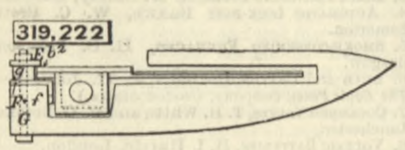


metallic screw *h*, passing through the clip plate and pressing upon the resistance column, a circuit closing key, a metal screw or plug *m*, closing the inner end of aforesaid cavity, and conducting wires so arranged that one of the conductors is connected with the clip plate and the other with the lamp, substantially as and for the purposes set forth.

319,222. Cutting Apparatus for Harvesters, *Charles Galle, Columbia, Mo.—Filed August 4th*, 1884.

Claim.—(1) The combination, with the finger bar, the sickle bar, the blades having boxes fitted on said bar, and the retaining nut turned on the sickle bar, of the wear and lock plate F, removably held to the finger bar, and having a wing *f* depending alongside of and locking the retaining nut on the sickle bar, substantially as set forth. (2) In a cutting apparatus, the combination of the finger bar, the sickle bar, the

319,222

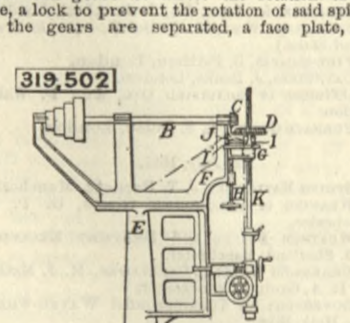


sickle blades having boxes fitted on said bar and provided with rearwardly-projecting flanges b^2, a nut on the sickle bar, the wear plate F, having a depending wing fitted alongside of and locking the nut on the sickle bar, the distance bar *g*, placed on the finger bar, the guide plate E, placed on the distance bar and projected over the flange b^2 of the sickle blade, and a fastening bolt G, substantially as set forth.

319,502. Combined Drilling and Boring Machine, *George G. Morrison, Philadelphia, Pa.—Filed January 2nd*, 1885.

Claim.—(1) In a combination tool comprising a drilling and boring machine in which either may be used separately, the combination of a drill or tool spindle, mechanism, substantially as set forth, to rotate or prevent rotation of said spindle, a face plate or table, and mechanism, substantially as set forth, to rotate or prevent rotation of said face plate, substantially as and for the purpose specified. (2) In a combination tool, a drill or tool spindle combined with gearing to rotate it, mechanism, substantially as set forth, to separate said gears to arrest the rotation of the spindle, and a lock to prevent the rotation of said spindle when the gears are separated, substantially as and for the purpose specified. (3) In a combination tool, a drill or tool spindle combined with gearing to rotate it, mechanism, substantially as set forth, to separate said gears to arrest the rotation of the spindle, a lock to prevent the rotation of said spindle when the gears are separated, a face plate, and

319,502

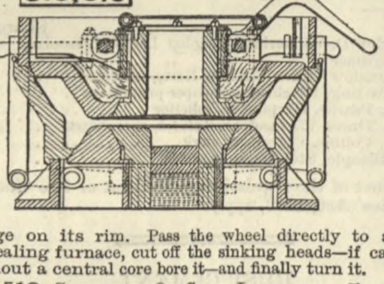


mechanism, substantially as set forth, to rotate or prevent rotation of said face plate, substantially as and for the purpose specified. (4) The combination of shaft B, having bevel pinion C, frame E, having a guide F, box G, screw H, to move said box, gear D, carried by said box, and spindle K, substantially as and for the purpose specified. (5) The combination of shaft B, having bevel pinion C, frame E, having a guide F, box G, screw H, to move said box, gear D, carried by said box, and a lock to prevent rotation of said gear D, substantially as and for the purpose specified. (6) The combination of shaft B, having bevel pinion C, frame E, having a guide F, box G, screw H, to move said box, gear D, carried by said box, lever I, spring I^1, pin J, and spindle K, substantially as and for the purpose specified. (7) The combination of frames E and N, face plate M, having gear M^1, pinion O, shaft O^1, gears O^2, shaft P, countersunk A, and connecting sleeve Q, substantially as and for the purpose specified.

319,515. Metal Mould for Casting Steel Wheels, *William Sellers, Philadelphia, Pa.—Filed June 8th*, 1883.

Brief.—The mould, being closed, as appears in Fig. 4, is moderately heated. The metal is poured rapidly at the hub to fill the mould and make one a sinking head at the hub and another at the rim. Air and gases escape between the loose fit at upper edge of the rim or through cross grooves there filed. Mould stands until skin is set enough to hold the casting in form—say one and a-half minute—and is then parted to permit shrinkage, the casting being then supported by the lower hub portion and a bottom

319,515

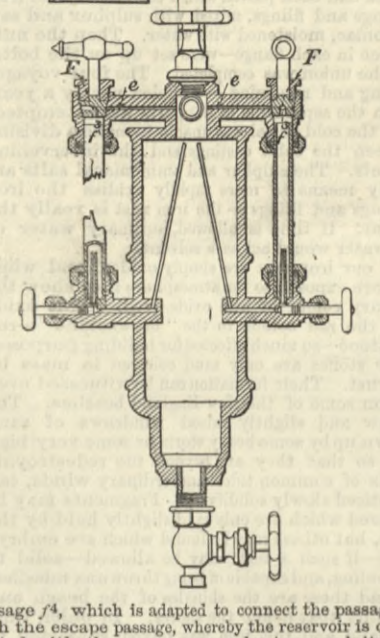


flange on its rim. Pass the wheel directly to an annealing furnace, cut off the sinking heads—if cast without a central core bore it—and finally turn it.

319,519. Sight-feed Oil Cup or Lubricator, *Charles W. Sherburne, Boston, Mass.—Filed February 17th*, 1885.

Claim.—In a sight feed lubricator for locomotives, the combination of a sight-feed chamber, the passage *e*, connecting the reservoir with the passage G, and a two-way cock F, having the passage f^3, which connects the side feed chamber with the escape passage and the

319,519

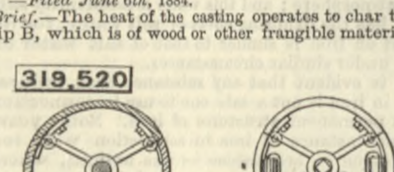


passage f^4, which is adapted to connect the passage *e* with the escape passage, whereby the reservoir is connected with the escape passage by two conduits or passages, both of which are controlled by the same valve, and the opening of one of which passages closes the other, all substantially as and for the purposes described.

319,520. Core-bar, *Frederick Shickle, St. Louis, Mo.—Filed June 6th*, 1884.

Brief.—The heat of the casting operates to char the strip B, which is of wood or other frangible material,

319,520

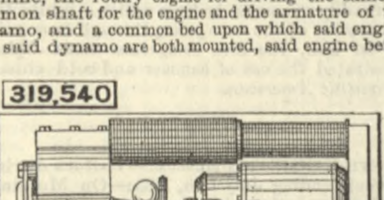


so as to enable it to drop from its position and allow the core bar to collapse.

319,540. Dynamo-electric Machine, *Leonidas G. Woolley, Indianapolis, Ind.—Filed April 15th*, 1884.

Claim.—(1) The combination of the dynamo-electric machine, the rotary engine for driving the same, a common shaft for the engine and the armature of the dynamo, and a common bed upon which said engine and said dynamo are both mounted, said engine being

319,540

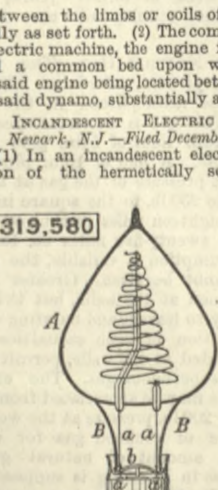


located between the limbs or coils of said dynamo, substantially as set forth. (2) The combination of the dynamo-electric machine, the engine for driving the same, and a common bed upon which both are mounted, said engine being located between the limbs or coils of said dynamo, substantially as set forth.

319,580. Incandescent Electric Lamp, *Louis Heinze, Newark, N.J.—Filed December 15th*, 1884.

Claim.—(1) In an incandescent electric lamp, the combination of the hermetically sealed bulb A,

319,580

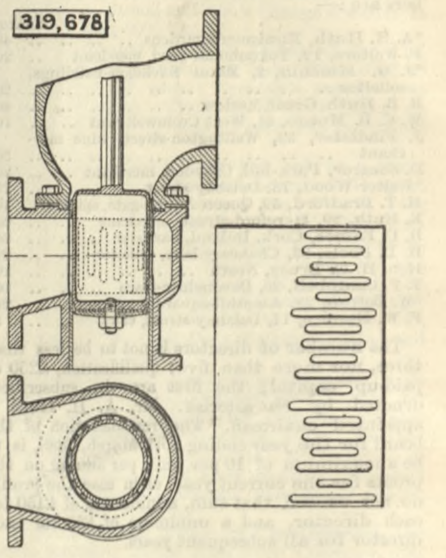


inclosing an incandescent filament, the neck B, and the conducting wires *a a*, provided with eyes in their ends, with the socket C and the wires a^1 a^1, having hooks in their ends for engaging said eyes, and the band spring *b* for detachably securing said neck within said socket, substantially as described. (2) In an incandescent lamp, the combination of an evacuated glass bulb, a helical filament within said bulb, holders or sockets for said filament, one of said sockets extending into the helix, and conducting wires connected to said sockets, substantially as described. (3) A filament for electric lamps, consisting of a cone-shaped helix, one end of said filament being at the base of the cone and the other end at the apex thereof, whereby said filament may be stamped out from a single flat sheet, substantially as described

319,678. Hydraulic Valves for Elevators and other Apparatus, *Charles R. Crane, Chicago, Ill.—Filed February 26th*, 1885.

Claim.—The combination, with a piston valve, of a cylinder to which the valve is fitted, and which is provided around its circumference with water passages, consisting of a series of slots, which extend lengthwise of the cylinder and are of different lengths, the

319,678

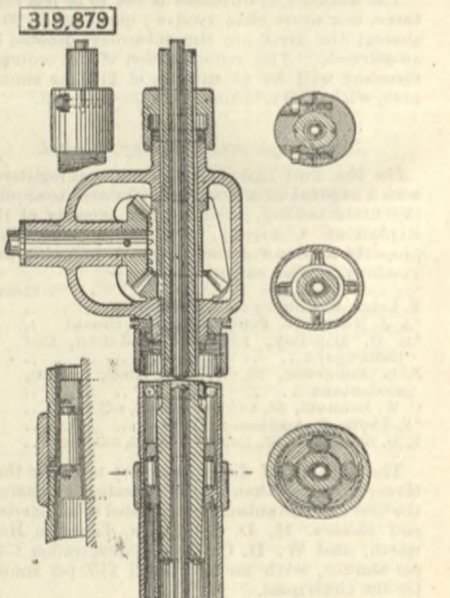


ends of slots forming an irregular line, as described, whereby the piston in its movement in the cylinder is made to close and open the slots one after another, or in succession, substantially as and for the purpose herein described.

319,879. Tube Expander, *William A. Bole, Pittsburg, Pa.—Filed February 4th*, 1885.

Claim.—(1) The combination, in a tube expander, of a tubular mandril having a conical or tapering expander head at one of its ends, a carrier fitted with a series of expander rollers and mounted upon the expander head with the capacity of end movement of the latter relatively to the carrier, and a spindle connected to the carrier and passing through the bore of the mandril to the opposite end thereof, substantially as set forth. (2) The combination, in a tube expander, of a mandril having a conical or tapering expander head at one of its ends, a carrier fitted with a series of expander rollers and mounted upon the expander head with the capacity of end movement of the latter relatively to the carrier, a supporting frame journalled upon the mandril, a driving shaft mounted in a bearing on the supporting frame and carrying a driving gear, and a gear fitting on the mandril and having a key or spline engaging a longitudinal keyway thereon, said gear meshing with the gear of the driving shaft, substantially as set forth. (3) The combination, in a tube expander, of a mandril having a conical or tapering expander head, a carrier fitted with a series of expander rollers and mounted upon the expander head with the capacity of end movement of the latter relatively to the carrier, driving gearing for imparting rotation to the mandril, and a compressible feed nut fitting around the mandril and engaging a thread on a fixed support, substantially as set forth. (4) The combination, in a tube expander, of a mandril having a conical or tapering

319,879



expander head at one of its ends, a carrier fitted with a series of expander rollers and mounted upon the expander head with the capacity of end movement of the latter relatively to the carrier, a carrier spindle connected by a strap or stirrup to the carrier and passing longitudinally through the mandril, driving gearing for rotating the mandril, and a series of centreing rollers journalled in a sleeve inclosing the mandril between the expander head and driving gear, substantially as set forth. (5) The combination, in a tube expander, of a mandril having a conical or tapering expander head at one of its ends, a carrier fitted with a series of expander rollers and mounted upon the expander head with the capacity of end movement of the latter relatively to the carrier, a driving gear supporting frame journalled on the mandril, a stop collar fitting adjustably upon the mandril and serving as an end abutment for the supporting frame, and an adjusting scale or index plate fixed upon the mandril, substantially as set forth. (6) The combination, in a tube expander, of a mandril having a conical or tapered expander head at one of its ends, a carrier fitted with a series of expander rollers and mounted upon the expander head with the capacity of end movement of the latter relatively to the carrier, a driving gear supporting frame journalled upon the mandril, gearing for rotating the mandril from a shaft in said frame, and a threaded sleeve fitting on the supporting frame concentrically with the mandril, and adapted to engage an internally threaded socket connected to a pipe which is to be expanded, substantially as set forth.