THE APPLICATION OF THE "THEOREM OF THE THREE MOMENTS" TO THE CALCULATION OF STRESSES IN CONTINUOUS GIRDERS.

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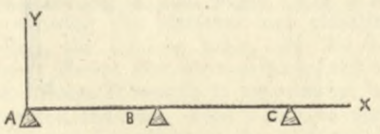
THE subject of continuous girders has already been recently treated at some length in the columns of THE ENGINEER, and also by Mr. Fidler in the "Proceedings" of the Institution of Civil Engineers. Neither writer has, however, made any reference to the very elegant and simple method invented by M. Clapeyron, and generally in use on the Continent. Without desiring to discuss the treatment of the subject adopted by either Mr. Max am Ende or Mr. Fidler, we think that the calculation of strains in girders by their methods would be found somewhat troublesome and confusing compared with that we are about to describe.

It will be seen that two formulæ only are used, that every case of distribution of the rolling load on the girder is separately considered, and that the calculation of all these cases simply consists in repeated application of these formulæ. The subject of continuous girders is one of considerable interest, and a simple accurate method of determining the strains on them is much to be desired; that Clapeyron's formula should be so little known in this country is difficult to account for, and the fact that it is not fully given by any of our authors on strains must be our apology for introducing the subject.

The method of determining the strains in continuous girders as usually given by English authors, viz., determining the reactions of the points of support directly, becomes so exceedingly intricate and cumbersome when the number of spans is large, as to be of little or no practical use.

About 1850, M. Clapeyron, a distinguished engineer of the Ecole des Ponts et Chaussées, adopted the expedient of using the bending moments with respect to the cross sections at the points of support, as auxiliary unknown terms, in order to determine the forces of reaction and the bending moments for any intermediate points between the supports, and from this deduced the formula known as the "Theorem of the three moments." M. Bresse, professor at the same college, extended the theorem still further in its practical application, and introduced it in detail into his "Cours des Mecaniqué Appliquée." The theorem considers the load in each span as uniformly distributed over it, and the moment of inertia of the section uniform throughout, which is not absolutely correct. However, the error arising from this consideration was shown to be very unimportant in the case of the Britannia Tubular Bridge, where the adverse conditions entered with much greater force than ordinarily happens, the inference being that Bresse's method may be confidently applied in all cases. Mr. Heppel, in a paper read before the Royal Society, modified the theorem so as to remove the defect referred to; not, however, without introducing some degree of complexity into the formula, which, from the reason just assigned, seems to be unnecessary.

The object of this paper is to give the theorem in its originality, as introduced by Bresse, and more particularly to show its practical application by a simple example, and we think that its comparative simplicity, and the facility with which the strains can be represented in a diagram, will commend it to the profession.



Let A B C be any three consecutive points of support of a beam; $l\ l'$ the lengths A B, B C; $w\ w'$ the weights per unit of length of the segments A B, B C; X′ X″ X‴ the bending moments for the cross sections at A, B, and C respectively; $x\ y$ the co-ordinates of any point in the mean fibre of the segment A B, referred to the rectangular axes A X, A Y; E the modulus of elasticity of the material; I the moment of inertia of the cross section. Taking a cross section at any point, at a distance x from the origin A, and finding the value of the bending moment for that point, we see that the moment of the uniformly distributed weight over the length $(l-x)$ is $-\frac{1}{2}w(l-x)^2$, considering the direction of rotation from A X towards A Y as positive. We also have the moments arising from the reactions of the points of support, and the weights of the other segments, which, being the products of the unit of weight into a distance, will be expressed in terms of x of the first degree and constants only. Thus the bending moment for the cross section can be expressed by a function of the form $A + Bx - \frac{1}{2}wx^2$, in which A and B are constants.

Taking then the general equation between the bending moment and the moment of flexibility, we have—

$$EI\frac{d^2y}{dx^2} = A + Bx - \tfrac{1}{2}wx^2 \quad \ldots\ldots \quad (1)$$

Integrating this equation between the limits $x = o$ and $x = l$, and calling the corresponding values of $\frac{dy}{dx}$, k' and k'', there obtains—

$$EI\left(\frac{dy}{dx} - k'\right) = Ax + \tfrac{1}{2}Bx^2 - \tfrac{1}{6}wx^3 \quad \ldots \quad (2)$$

$$EI(k'' - k') = Al + \tfrac{1}{2}Bl^2 - \tfrac{1}{6}wl^3 \quad \ldots\ldots \quad (3)$$

Integrating equation (2), again, between the limits $x = o$ and $x = l$, there obtains—

$$EI(y - k'x) = \tfrac{1}{2}Ax^2 + \tfrac{1}{6}Bx^3 - \tfrac{1}{24}wx^4 + c$$

when $x = o$ or $= l$, $y = o$

$$\therefore -EIk' = \tfrac{1}{2}Al + \tfrac{1}{6}Bl^2 - \tfrac{1}{24}wl^3 \quad \ldots \quad (4)$$

Eliminating k' between equations (3) and (4)

$$EIk'' = \tfrac{1}{2}Al + \tfrac{1}{3}Bl^2 - \tfrac{1}{8}wl^3 \quad \ldots\ldots \quad (5)$$

Again, taking the origin of co-ordinates at B, and representing the bending moment for any cross section in the segment B C by the expression $A^1 + B^1x - \frac{1}{2}w^1x^2$ and proceeding in the same manner as before, since when $x = o$, k'' for this segment corresponds to k' for the first segment, we shall obtain—

$$EIk'' = \tfrac{1}{2}A'l' + \tfrac{1}{6}B'l'^2 - \tfrac{1}{24}w'l'^3 \quad \ldots\ldots \quad (6)$$

Adding these last equations, since the bending moment in the segment B C is opposed to that in A B, the term E I k'' disappears, and there obtains—

$$\tfrac{1}{2}Al + \tfrac{1}{2}A'l^1 + \tfrac{1}{3}Bl^2 + \tfrac{1}{6}B'l'^2 - \tfrac{1}{8}wl^3 - \tfrac{1}{24}w'l'^3 = o \quad (7)$$

Now, the quantities A B, A′ B′, can be expressed in terms of X′ X″ X‴, for the function $A + Bx - \frac{1}{2}wx^2$ must have the values X′ X″ for $x = o$ and $x = l$; making these substitutions, there obtains—

$$\left.\begin{array}{l} A = X',\ A + Bl - \frac{1}{2}wl^2 = X'', \\ \text{Hence } A = X', \\ \quad \text{and } B = \frac{1}{2}wl + \dfrac{X'' - X'}{l}. \end{array}\right\} \quad \ldots \quad (8)$$

Similarly—

$$A' = X'', \text{ and } B' = \tfrac{1}{2}w'l' + \frac{X''' - X''}{l'}.$$

Substituting these values of A B, A′ B′ in equation (7), there obtains—

$$\tfrac{1}{6}X'l + \tfrac{1}{3}X''(l + l') + \tfrac{1}{6}X'''l' + \tfrac{1}{24}wl^3 + \tfrac{1}{24}w'l'^3 = o.$$

Or, $\quad X'l + 2X''(l + l') + X'''l' + \frac{1}{4}(wl^3 + w'l'^3) = o.$

This is the relation which exists between the bending moments over three consecutive points of support. If we have $n + 1$ points of support, $A_0, A_1, A_2 \ldots\ldots A_n$ and $X_0, X_1, X_2 \ldots\ldots X_n$ be the corresponding bending moments, since the moments X_0 and X_n over the two end supports are, from the nature of the problem—zero—there only remains to determine $n - 1$ unknowns, which can be done from the $n - 1$ equations furnished by the above formula. When these moments have been calculated they can be substituted in equation (8), and by a double integration the equation to the mean fibre may be found. The shearing strain can be deduced from the bending moment in a very simple manner; for the bending moment at any point M consists of the sum of a number of terms, such as $Q(x_1 - x)$, being the product of a force into a distance, or—

$$X = \Sigma Q(x_1 - x),$$

Q being one of the forces acting on the segment, and x the abscissa of its point of application; then—

$$-\frac{dX}{dx} = \Sigma Q.$$

Σ Q is the shearing force at M; hence to obtain the shearing force at any point, it is only necessary to differentiate the bending moment for that point expressed as a function of x.

It will be seen that the expression—

$$A + Bx - \tfrac{1}{2}wx^2$$

is the equation to a parabola, and as the curve is unaltered by neglecting the first two terms, we may construct it from the equation—

$$X = \tfrac{1}{2}wx^2,$$

or, writing y for x and x for X—

$$\frac{2x}{w} = y^2.$$

The point where the moments change from positive to negative, or *vice versâ*, usually called the point of contrary flexure, is that point for which the bending moment vanishes. Thus, in order to obtain it, we have—

$$A + Bx - \tfrac{1}{2}wx^2 = o,$$

A and B being known coefficients found from substitution in equation (8).

We will now proceed to exemplify this method, by calculating the strains in a continuous girder of three spans, the two end ones being 95ft. each, and the middle one 110ft; we will suppose the weight of the structure itself to be one ton per foot run, and to be subject to a rolling load of two tons per foot run.

Permanent load on each girder, ½ ton per foot run;
Rolling load on each girder, 1 ton per foot run.

For the strains due to the permanent load alone we have—

$$X'l + 2X''(l + l') + X'''l' + \tfrac{1}{4}(wl^3 + w'l'^3) = o$$

and $X''l' + 2X'''(l' + l'') + X^{iv}l'' + \frac{1}{4}(w'l'^3 + w''l''^3) = o$

Now $X' = X^{iv} = o$, since the bending moment over the end supports is zero—

$$l = l'' = 95',\ l' = 110',$$
$$w = w' = w'' = \tfrac{1}{2}\text{ ton.}$$

Substituting these values, there obtains—

$$410X'' + 110X''' + \tfrac{1}{8}(95^3 + 110^3) = o$$
$$110X'' + 410X''' + \tfrac{1}{8}(110^3 + 95^3) = o.$$

Thus, as we might have expected, X″ = X‴—

$$X'' = X''' = -526.$$

Taking the general equation to the bending moment, and substituting these values—

$X = A + Bx - \frac{1}{2}wx^2$, when $x = o$, $X = o$,
when $x = 95$, $X = X'' = -526$

$$\therefore\ A = o,$$
$$-526 = o + 95B - \tfrac{1}{2}.\tfrac{1}{2}95^2.$$
$$B = 18{\cdot}2.$$

For the point of contrary flexure, substituting these values of A and B in the equation above, and equating to zero—

$$o = 18{\cdot}2x - \tfrac{1}{4}x^2.$$
$$\therefore x = 72{\cdot}8.$$

Taking now the second span—

$$X = A' + B'x - \tfrac{1}{2}wx^2,$$

when $x = o$, $X = X'' = -526$. ∴ $A' = -526$,
when $x = 110$, $X = X''' = -526$.

$$-526 = -526 + 110B' - \tfrac{1}{4}(110)^2.$$
$$B' = 27{\cdot}5.$$

For the point of contrary flexure—

$$o = -526 + 27{\cdot}5x - \tfrac{1}{4}x^2.$$
$$x = 24{\cdot}6 \text{ and } 85{\cdot}4.$$

Thus in the middle span there are two points of contrary flexure. The condition of the third span is similar to that of the first. To represent this in a diagram, we have the equation to the parabola— $\quad y^2 = \frac{2x}{w}$, or $y^2 = 4x$.

Taking a general scale of lengths, $\frac{1}{175}$, and a scale for moments 300 to an inch, we proceed to draw the parabola on cardboard, measuring values of y to the former scale and values of x to the latter. Having drawn a horizontal line and marked off the spans to the scale, the points of contrary flexure are marked on and the bending moments over the piers measured off to the proper scale, then moving the parabola till it passes through the points laid down, always keeping its axis perpendicular to the horizontal line, and drawing the curve, it will be found to pass through all the given points.

To obtain an accurate knowledge of the strains in the girder, it is necessary to consider the effect produced on it by the rolling load as different spans are loaded. Thus, there will be seven cases to consider. The rolling load may be on the three spans separately; on every pair of the segments; and on the whole bridge.

We shall now proceed to find the bending moments over the piers in each of these cases, and then the corresponding points of contrary flexure. With these data, all the strains on the girder can be graphically represented, so that the strain at any particular point can be determined by scaling—

Case 1.—First span loaded—

$$X'l + 2X''(l + l') + X'''l' + \tfrac{1}{4}(wl^3 + w'l'^3) = o \quad . \quad (A)$$
$$X''l' + 2X'''(l' + l'') + X^{iv}l'' + \tfrac{1}{4}(w'l'^3 + w''l''^3) = o \quad (B)$$

In all these cases $l = 95$ft., $l' = 110$ft., $l'' = 95$ft.

$\therefore l + l' = l' + l'' = 205'$.

In this particular case $w = \frac{3}{2}$ tons, $w' = w'' = \frac{1}{2}$ ton.

Substituting these values in (A) and (B), there obtains—

$$X'' = -1089,\ X''' = -375.$$

Now, taking the general equation to the bending moment to find the point of contrary flexure—

$$X = A + Bx - \tfrac{1}{2}wx^2 \quad \ldots\ldots\ldots\ldots \quad (C)$$

$w = \frac{3}{2}$ for first span.

When $x = o$, $X = X' = o$ ∴ $A = o$,
when $x = 95$, $X = X'' = -1089$.

$$\therefore -1089 = 95B - \tfrac{3}{4}(95)^2$$
$$B = 59{\cdot}8.$$

Substituting in (C) and equating the bending moment to zero, $o = 59{\cdot}8x - \frac{3}{4}x^2$, ∴ $x = 79{\cdot}75$.

To find the effect of this load on the second span; in equation (C) when $x = o$, $X = X'' = -1089$

$$\therefore A = -1089.$$

when $x = 110$, $X = X''' = -375$.

$$\therefore -375 = -1089 + 110B - \tfrac{1}{4}(110)^2$$
$$B = 34.$$

For the points of flexure—

$$o = -1089 + 34x - \tfrac{1}{4}x^2$$
$$\therefore x = 84{\cdot}4 \text{ and } 51{\cdot}6.$$

Effect on third span—

From equation C when $x = o$, $X = X''' = -375$.

$$\therefore A = -375$$

when $x = 95$, $X = X^{iv} = o$

$$\therefore o = -375 + 95B - \tfrac{1}{4}(95)^2$$
$$B = 27{\cdot}7.$$

Substituting and equating to zero—

$$o = -375 + 27{\cdot}7x - \tfrac{1}{4}x^2.$$

which gives $\quad x = 95$ and $15{\cdot}8$.

Case 2.—Third span loaded—the bending moments and points of flexure are the same in value as in the previous case.

Case 3.—Middle span loaded—

From equation A, remembering that for this case $w = w'' = \frac{1}{2}$, $w' = \frac{3}{2}$ we obtain—

$$410X'' + 110X''' = -\tfrac{1}{8}(95^3 + 3 \times 110^3).$$

By symmetry X″ = X‴ ∴ we obtain X″ = −1166.

Now, finding the values of A and B in equation C by means of this value of X″ and X‴, and then substituting them, and equating to zero we obtain for the points of contrary flexure—

$$x = 93{\cdot}4 \text{ and } 16{\cdot}6.$$

For the effect on the third span which is, of course, equal in value to that on the first, we obtain the equation—

$$o = -1166 + 36x - \tfrac{1}{4}x^2.$$
$$\therefore x = 95 \text{ and } 49.$$

$x = 95$ corresponds to the point of support; $x = 49$ is the required point of flexure.

Case 4.—First and second spans loaded—from equations A and B substituting the values $w = w' = \frac{3}{2}$, $w'' = \frac{1}{2}$ we obtain—

$$410X'' + 110X''' = -\tfrac{1}{8}(3 \times 95^3 + 3 \times 110^3).$$
$$110X'' + 410X''' = -\tfrac{1}{8}(3 \times 110^3 + 95^3).$$

Solving $\quad X'' = -1729,\ X''' = -1015.$

Then following the same steps as in Case 1 for the point of flexure, we obtain in the first span—

$$o = 53x - \tfrac{3}{4}x^2.$$
$$x = 70{\cdot}6.$$

In the second span—

$$o = -1729 + 89x - \tfrac{3}{4}x^2.$$
$$x = 94{\cdot}2 \text{ and } 24{\cdot}5.$$

In the third span—

$$o = -1015 + 34{\cdot}4x - \tfrac{1}{4}x^2.$$
$$x = 95 \text{ and } 42{\cdot}75.$$

Case 5.—Second and third spans loaded. The values will be the same as in the last case.

Case 6.—First and third spans loaded.

$w = w'' = \frac{3}{2}$, $w' = \frac{1}{2}$, evidently X″ = X‴.

Equation A becomes—

$$410X'' + 110X'' = -\tfrac{1}{8}(3 \times 95^3 + 110^3).$$
$$X'' = X''' = -938.$$

For the points of flexure, we have, in the first span—

$$o = 61{\cdot}4x - \tfrac{3}{4}x^2.$$
$$x = 81{\cdot}8.$$

In the second span—

$$o = -938 + 27{\cdot}5x - \tfrac{1}{4}x^2.$$

This equation gives an impossible root, therefore there is no point of flexure, and the bending moments have the same sign all over the span. The point of flexure in the third span will be symmetrical to that in the first.

Case 7.—All spans loaded. The bending moments will evidently be symmetrical with regard to the centre of the bridge, therefore—

$$X'' = X''', \quad w = w' = w'' = \tfrac{3}{2}.$$

∴ From equation A, $410X'' + 110X'' = -\frac{3}{8}(95 + 110^3)$.

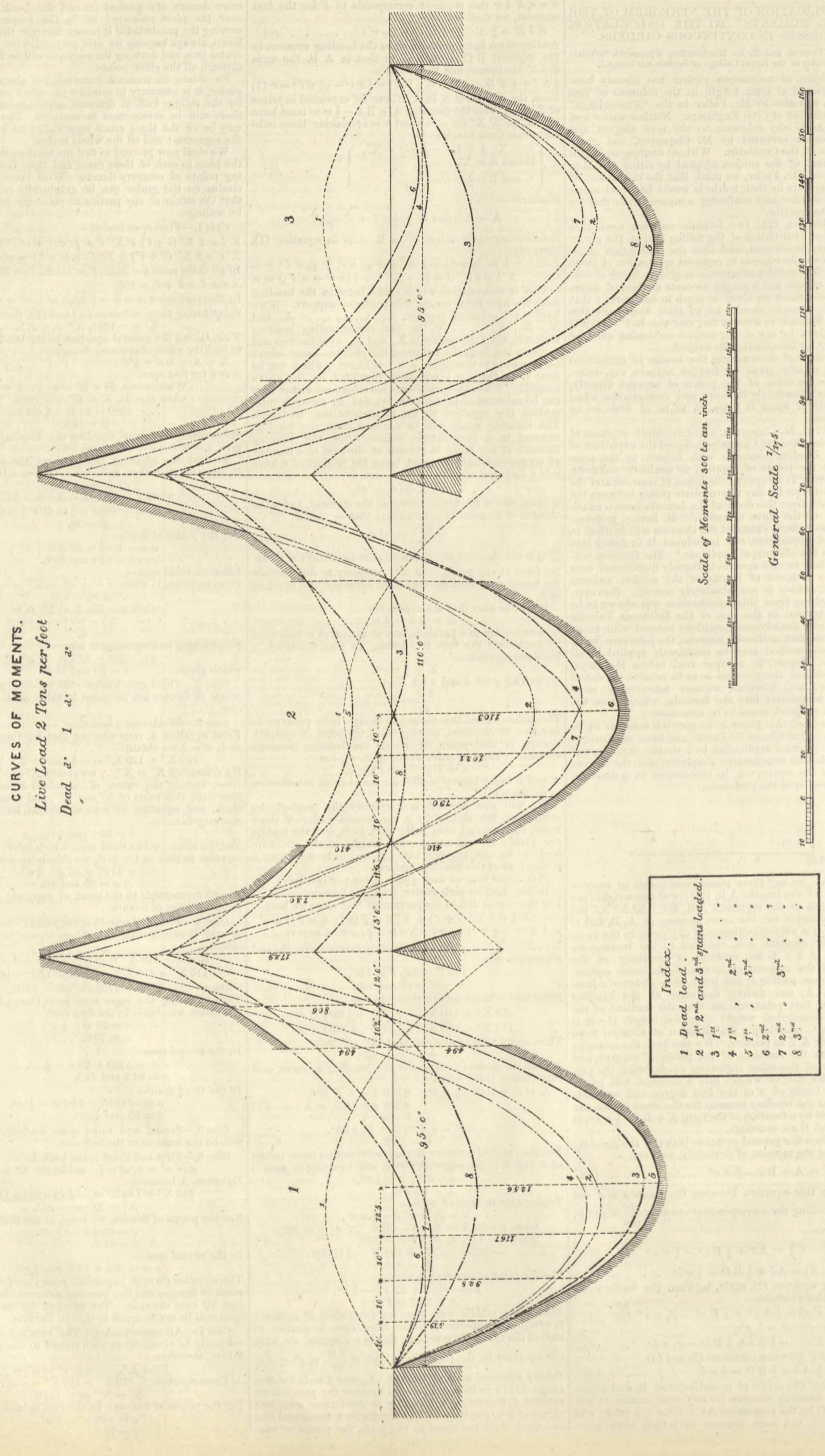
$$X'' = X''' = -1578.$$

For the points of flexure: In the first span—

$$o = 54{\cdot}6x - \tfrac{3}{4}x^2.$$
$$x = 72{\cdot}8.$$

DIAGRAM OF STRESSES IN CONTINUOUS GIRDERS.

(For description see page 171.)



In the second span—

$$o = -1578 + 82{\cdot}5\,x - \tfrac{3}{4}\,x^2.$$
$$x = 24{\cdot}6 \text{ and } 85{\cdot}4.$$

In the third span the point of flexure is symmetrical to that in the first. We must now construct another parabola from the equation—

$$y^2 = \frac{2\,x}{w}, \text{ giving to } w \text{ the value of } \tfrac{3}{2}.$$

In mapping the curves of moments from the data found in the seven cases just considered, one of these two parabolas must be used to draw the requisite curve, according as the segment in the case considered is subject to the permanent load only or to the additional rolling load. In the diagram accompanying this paper, the curves of moments for the different cases can be readily followed by reference to the index. The result of unequal loading on the girder is by this means rendered very apparent; by measuring from any point on the horizontal line to the hatched border, the greatest strain that the girder can be subjected to at that point can be found from the scale. It may be noted that the curve for the permanent load for the whole bridge, numbered 1 in the diagram, is drawn the reverse way to the others; this is because it has no connection with them, and is merely put in to show the strains due to the weight of the girder by itself.

We must point out that in these calculations we have differed in one particular from the method of M. Bresse, who, when considering the effect of the rolling load in the separate cases, does not take into account the permanent load as acting at the same time, but draws the two systems of curves on opposite sides of the line, and takes the double ordinate, as the total strain at any point. This is open to the objection that it does not represent what actually occurs, and probably our method of considering the permanent load as always existing conjointly with the rolling load is more correct.

Royal College of Science for Ireland, Dublin,
June 21st, 1884.

SHEAF-BINDING REAPING MACHINES.

No. III.

WE may now resume the task of giving a descriptive account of the string sheaf-binding reaping machines of 1884, but it must be admitted that this is not done without a certain amount of misgiving. There is at least hope, however, that before the several makes of machines which we intend to illustrate have passed through our pages, the different parts will, in one or other of the articles, have received some attention, so that what is not described with reference to one machine may be described with reference to another. We have already alluded to the complex nature of a string binding reaping machine, and it is not now necessary to show that in comparison one of them makes a thrashing machine appear as an emblem of simplicity. But this being near about the truth, it will perhaps be as well to refer in detail to some of the parts in Messrs. Hornsby's machine, which we did not touch upon in describing that of Messrs. Howard. This we are enabled to do by means of the very complete set of drawings and photographs placed at our disposal by Messrs. Hornsby, from some of which we have prepared our engravings, including the perspective showing the rear and off sides of the machine in the foreground, and Figs. 1 to 5, showing different parts.

Fig. 1 is a sectional plan taken at the level of the axle of the driving or land wheel. Fig. 2 is a skeleton drawing showing the platform and elevating webs on their rollers, the binding table, and the sheaf carrier. Fig. 3 shows Messrs. Hornsby's arrangement of their gear, which in Messrs. Howard's is represented in Figs. 6, 7, and 8, pp. 153, 154 *ante*. Figs. 4 and 4A show the gear for driving and for adjusting the reel, and Fig. 5 shows the larger apparatus for carrying several sheaves when it is desired to place them in close windrows. We shall more particularly describe the machine to which the judges awarded the first prize of £100 at the recent trials of sheaf binders at Shrewsbury. The main wheel marked 8 in Fig. 1 and 1 in Fig. 3 is 40in. in diameter, and the width of the tire is 9in. This wheel has a cast iron nave and two rows of wrought iron spokes fastened to an angle iron ring under the tire, which is made of steel. The gearing consists of a ring 9, Fig. 1, of external spur teeth gearing into a pinion 10 mounted loose on a first motion spindle, and which by a clutch fork 11 may be moved endwise on the spindle by the lever A, Fig. 6, to put it in or out of gear. On the first motion spindle is fixed a bevel wheel 13 that by a bevel pinion 14 drives a spindle 15 running to the back of the machine. A chain wheel 16 mounted on the extreme back end of this spindle drives the chain that works the elevator, the platform apron, and also the reel. This chain—see Fig. 6—passes over the spocket wheels H—same as 16 in Fig. 1—another behind spur wheel D, over E driving the reel, down and round F driving elevators, and over the tightening wheel G, back to H. Another bevel wheel 17, Fig. 1, on the first motion spindle 12 by a pinion 18 drives a spindle running forward, and by a crank disc or plate 20 on the extreme front end of this spindle, and a connecting rod 21 across the front end of the machine drives the knife. The end of the connecting rod is held in the knife-eye by a turnover slide secured in position by a spring bolt. The fingers are malleable cast iron fitted with steel linings, each finger is secured to an angle iron bar by a

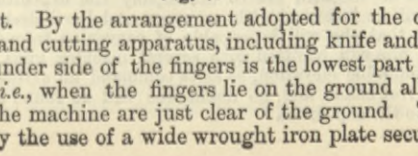


Fig. 7.

single bolt. By the arrangement adopted for the cutting platform and cutting apparatus, including knife and finger bar, the under side of the fingers is the lowest part of the machine, *i.e.*, when the fingers lie on the ground all other parts of the machine are just clear of the ground. This is effected by the use of a wide wrought iron plate secured to the platform and the under side of the finger bar, as shown in the accompanying section, Fig. 7. The spindles of the rollers carrying the canvas aprons or webs 3, 4, and 5, Fig. 2, all run in brass bushes, and the driver's seat, seen in Figs. 5 and 6, has two separate adjustments, one to suit the length of driver's leg, the other to suit the balance of machine. The reel 1, 1, Figs. 4 and 6, may be driven

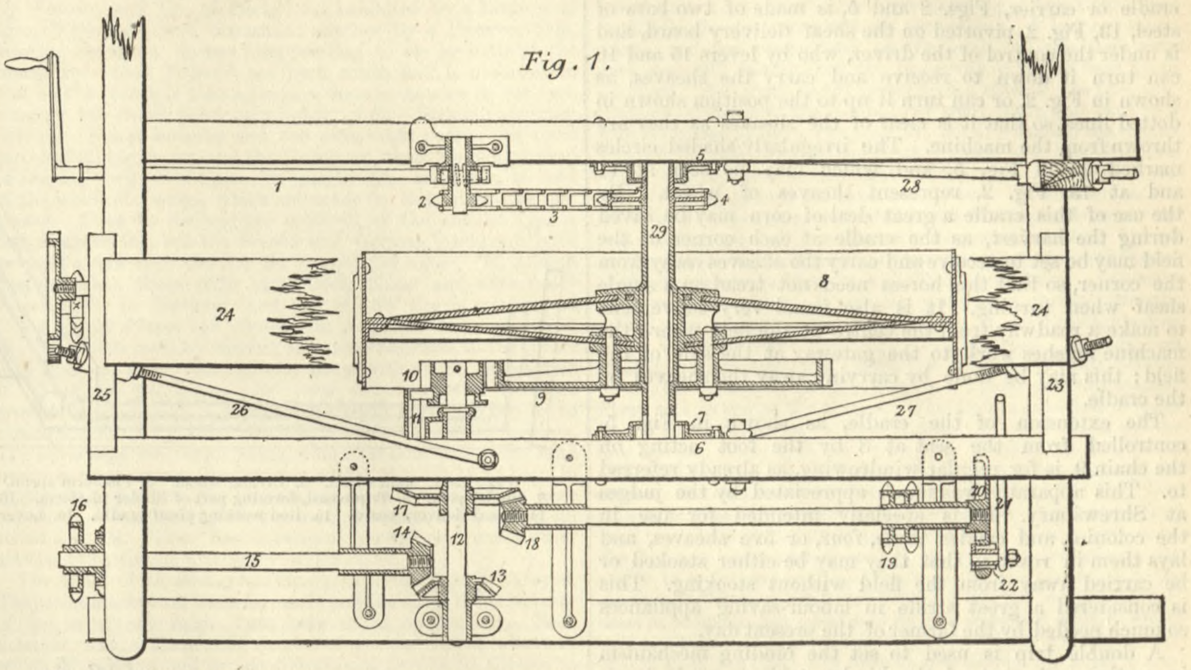


Fig. 1.—1. Spindle for raising worm. 2. Worm and chain wheel. 3. Raising chain (endless). 4. Chain wheel and raising pinion, made fast to axle 29. 5. Raising quadrant. 6. Ditto ditto. 7. Raising pinion, made fast to axle 29. 8. Main wheel. 9. Gear ring and bush in one piece. 10. Clutch pinion. 11. Clutch fork. 12. First-motion spindle. 13. Bevel wheel driving back spindle. 14. Bevel pinion, ditto ditto. 15. Back spindle. 16. Chain wheel driving elevator and platform aprons and reel. 17. Bevel wheel driving front spindle. 18. Bevel pinion, ditto ditto. 19. Double-chain wheel driving binder, on front spindle. 20. Crank plate. 21. Connecting rod. 22. Brass bush in crank plate. 23. Front elevator post. 24. Top board. 25. Back elevator board. 26. Back frame stay. 27. Front stay to front elevator post. 28. Front stay to tilting post. 29. Main axle.

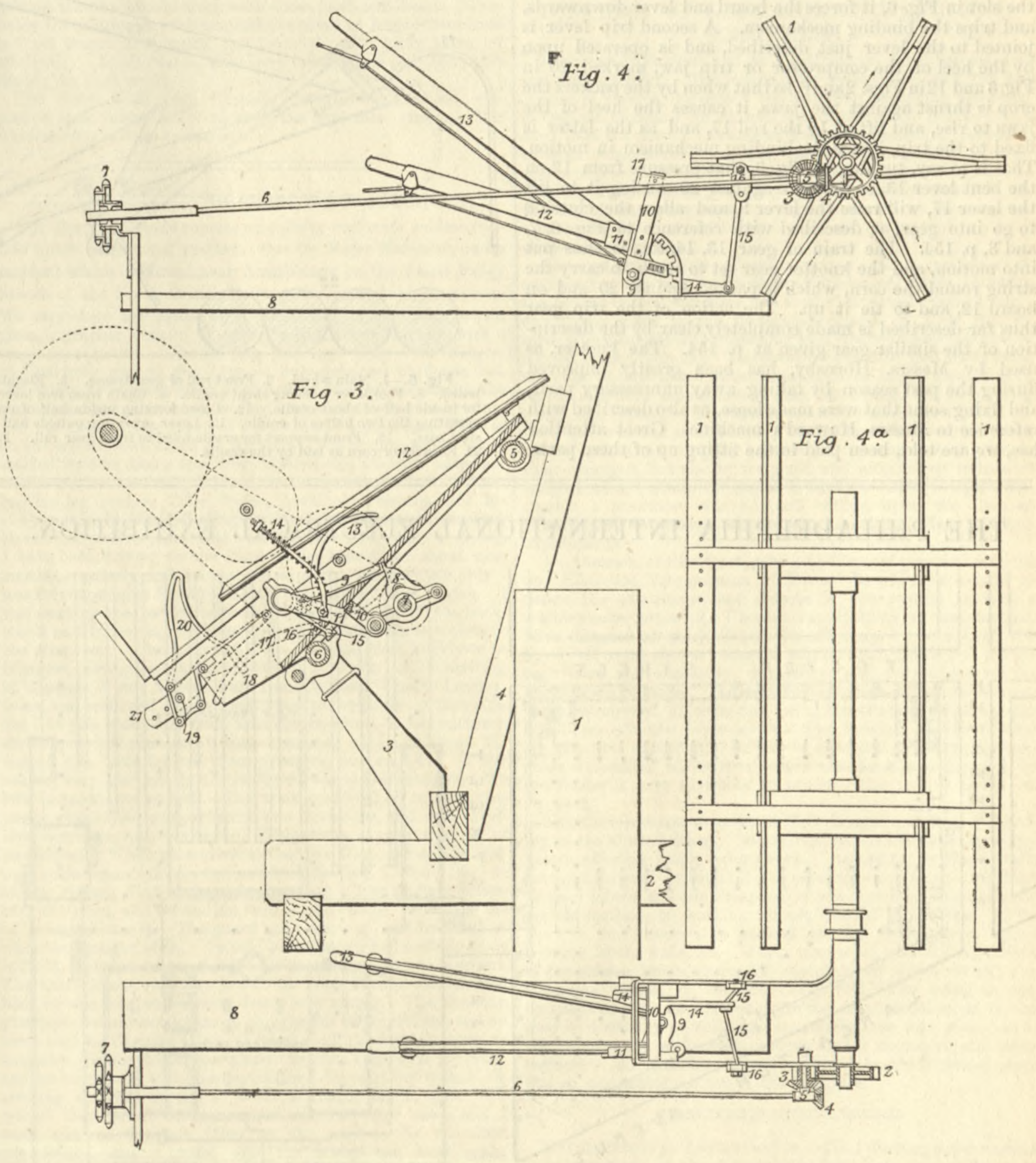


Fig. 3.—1. Main wheel. 2. Front rail of gear frame. 3. Binder post. 4. Elevator post. 5, 6. Frame tube carrying binder. 7. Packer spindle. 8. Shipping pawl. 9. Shipping lever. 10. Connecting rod working needle or binding arm. 11. Crank arm working needle. 12. Trip board, forming part of binder table. 13. Trip lever. 14. Shipping lever. 15. Trip spindle. 16. Joint where trip rod is jointed to trip lever. 17. Trip rod. 18. Heel of compressor jaw. 19. Pin on which compressor jaws pivot. 20. Compressor jaws. 21. Lever carrying compressor jaws.

Fig. 4.—1. Reel. 2. Spur wheel driving reel. 3. Spur and bevel pinions running loose on the stem of a T-ended bearing. 4. Bevel pinion screwed on reel drive spindles. 5. T-ended bearing carrying drive spindle; this bearing is free to vibrate in frame 17, so that spindle 6 always runs in line. 6. Reel drive spindles. 7. Double-chain wheel driving reel. 8. Foot-board. 9. Base bracket carrying reel supports. 10. Wrought iron bow carrying reel supports. 11. Socket for wood lever 12, to adjust reel back or forward. 12. Wood lever to adjust reel back or forward. 13. Wood lever to adjust reel up or down. 14. Socket for lever 13. 15. Parallel rods to adjust reel up or down. 16. Brackets to adjust weight of reel. 17. Wrought iron support for reel.

at two separate speeds to suit the crop, the spocket wheel marked 7 in Fig. 4, and E in Fig. 6, having two sets of teeth, as best seen at 7, Fig. 4. The gear that drives the reel consists of a spur wheel 2, Figs. 4 and 4A, mounted on the reel centre. A spur pinion and a bevel wheel 3, cast together, are mounted loose on the stem of a pivotted T-ended bearing 5, Figs. 4 and 4A, carried by the reel frame. This T-ended bearing 5 carries the end of a drive spindle 6, reaching to the back of the machine, where it is carried and driven by a hollow centre wheel 7, which is an ingenious means of rotating a spindle movable in all directions. This spindle is driven by the same chain that drives the elevator and platform aprons, as described above. On the front end of this spindle is screwed a bevel pinion 4 gearing with and driving the above-mentioned bevel wheel and spur pinion by which the reel is driven. The T-ended bearing is free to rotate in the reel-supporting frame; and this allows the reel to be worked in any position, and the bearing to accommodate itself to the line of the driving spindle. An adjustable wrought iron divider is mounted on the wood divider, and can be adjusted to suit the crop. The ear lifter, which is mounted at the inner end of the finger bar, lifts up the straggling or overlying ears of corn before they are cut, instead of allowing them to be cut off and left on the ground. This ear lifter is not seen in our engravings. It is pivotted so as to allow it to follow the undulations of the ground. The framework of the machine is wood—ash, and is strengthened by wrought iron adjustable stays—26, 27, 28, Fig. 1—connecting the gear and elevator frames. These stays can be adjusted to make the elevator aprons run in line with the frame. The sheaf cradle or carrier, Figs. 2 and 5, is made of two bars of steel, 13, Fig. 2, pivotted on the sheaf delivery board, and is under the control of the driver, who by levers 15 and 16 can turn it down to receive and carry the sheaves, as shown in Fig. 2, or can turn it up to the position shown in dotted lines, so that it is clear of the sheaves as they are thrown from the machine. The irregularly shaded circles marked 22 in Fig. 5, and which may be seen at 11 and at 13, Fig. 2, represent sheaves of wheat. By the use of this cradle a great deal of corn may be saved during the harvest, as the cradle at each corner of the field may be set to receive and carry the sheaves away from the corner, so that the horses need not tread on a single sheaf when turning. It is also found very convenient to make a roadway from the centre of the field where the machine finishes work to the gateway at the side of the field; this may be done by carrying away the sheaves by the cradle.

The extension of the cradle, as shown in Fig. 5, controlled from the seat at 8 by the foot acting on the chain 9, is for regular windrowing, as already referred to. This apparatus was much appreciated by the judges at Shrewsbury. It is specially intended for use in the colonies, and carries three, four, or five sheaves, and lays them in rows, so that they may be either stooked or be carried away from the field without stooking. This is considered a great stride in labour-saving appliances so much needed by the farmer of the present day.

A double trip is used to set the binding mechanism in motion. A part of the binder table is made loose, and jointed at the top end 9, Fig. 2. The bottom end of this loose board is mounted higher than the level of the binder table, and is carried by a lever 10, Fig. 2, made fast to the trip rod, so that when the crop is thrust downwards by the packers, one of which J is seen through the slot in Fig. 6, it forces the board and lever downwards, and trips the binding mechanism. A second trip lever is jointed to the lever just described, and is operated upon by the heel of the compressor or trip jaw, marked 20 in Fig. 3 and 12 in Figs. 2 and 6, so that when by the packers the crop is thrust against the jaws, it causes the heel of the jaws to rise, and lift at 18 the rod 17, and as the latter is fixed to the trip, it sets the binding mechanism in motion. That is to say, turning to Fig. 3, that pressure from 12 on the bent lever 13, or pressure against 20 causing it to lift the lever 17, will raise the lever 9, and allow the clutch 8 to go into gear, as described with reference to Fig. 6, 7, and 8, p. 154. The train of gear 13, 14, &c., is thus put into motion, and the knotter gear set to work to carry the string round the corn, which is packed against 20 and on board 12, and to tie it up. The action of the trip gear thus far described is made completely clear by the description of the similar gear given at p. 154. The knotter, as used by Messrs. Hornsby, has been greatly improved during the past season by taking away unnecessary parts, and fixing some that were made loose, as also described with reference to Messrs. Howard's machine. Great attention has, we are told, been paid to the fitting up of these parts, and we are informed that special tools have been prepared, and machinery built to make every part a correct duplicate. The width of the finger-bar of the machine described was 5ft., but the breadth of cut was 5ft. 3in. generally, and the width of the elevator is 5ft. The spindles in the machine are made of steel.

Fig. 2.

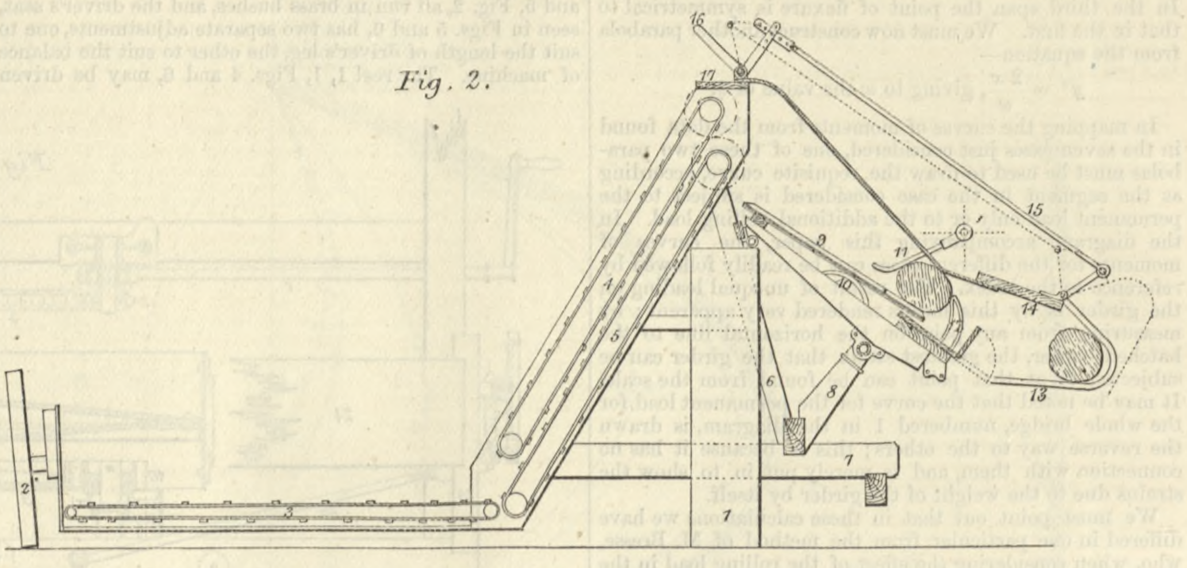


Fig. 2.—1. Main wheel. 2. Divider wheel. 3. Platform apron. 4. Elevator apron. 5. Ditto ditto. 6. Elevator post. 7. Gear frame. 8. Binder post. 9. Trip board, forming part of binder platform. 10. Trip lever. 11. Ejector. 12. Compressor jaws. 13. Sheaf cradle. 14. Sheaf delivery board. 15. Rod working sheaf cradle. 16. Lever working sheaf cradle. 17. Top board.

Fig. 5.

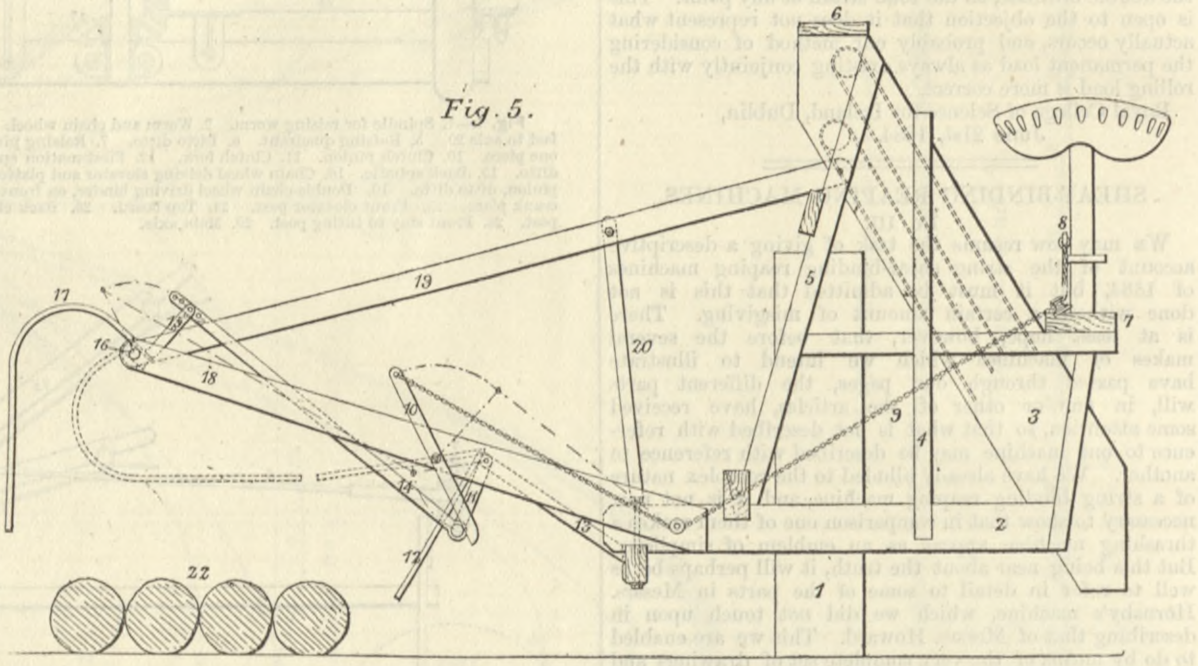
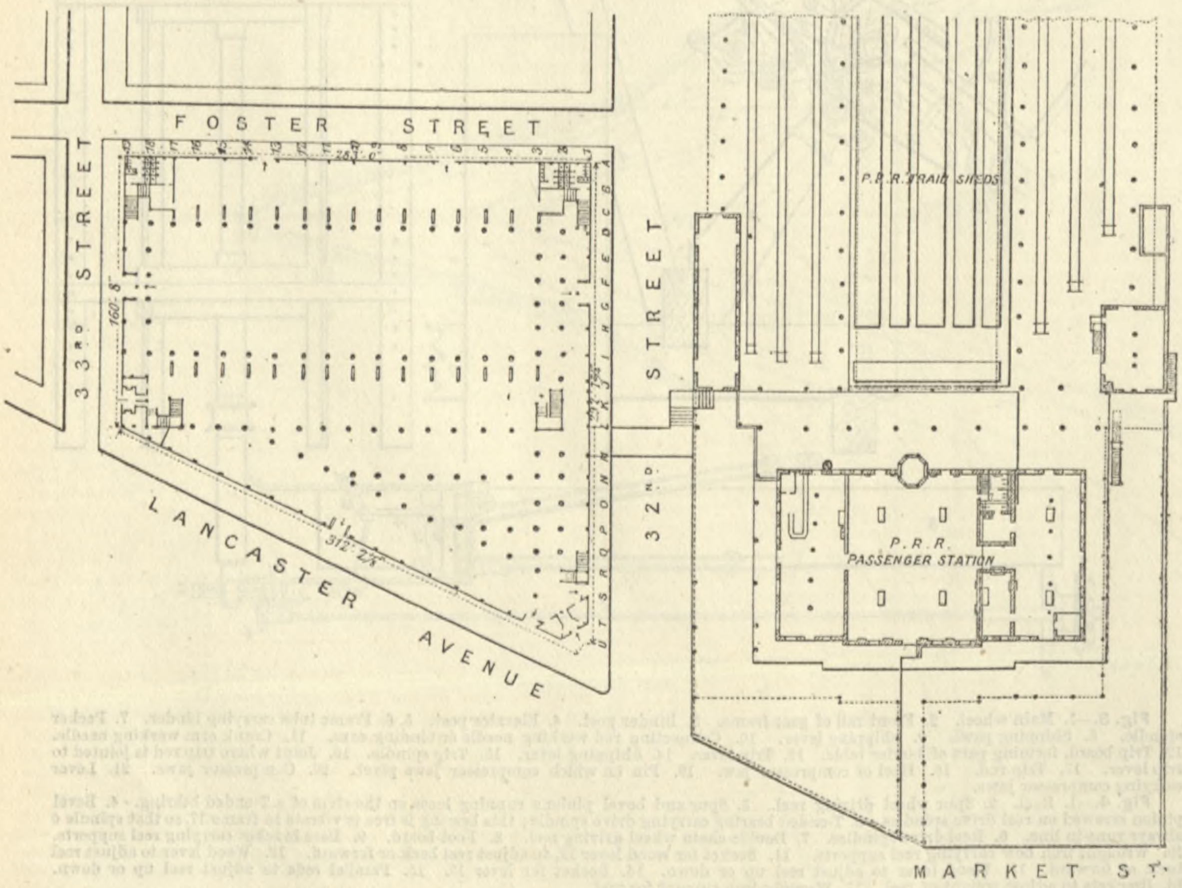


Fig. 5.—1. Main wheel. 2. Front rail of gear frame. 3. Elevator board. 4. Tilting post. 5. Elevator post. 6. Top board. 7. Footboard. 8. Foot lever working sheaf cradle. 9. Chain from foot lever working cradle. 10. Chain lever working cradle. 11. Wrought frame for inside half of sheaf cradle. 12. Board forming inside half of cradle. 13. Support for inside half of cradle. 14. Rod connecting and operating the two halves of cradle. 15. Lever operating outside half of cradle. 16. Centre of outside half of cradle. 17. Cradle teeth ½in. steel bars. 18. Front support for cradle fixed to front gear rail. 19. Back support for cradle. 20. Wrought iron stay to back support. 22. Sheaves of corn as laid by the cradle.

THE PHILADELPHIA INTERNATIONAL ELECTRICAL EXHIBITION.



This Exhibition, which opened on September 2nd, is being energetically developed, and bids fair to change the reputation which has hitherto attended similar exhibitions, where the opening ceremony has been a display of bare stands and unpacked exhibits. The main building is already completed, and is of the shape shown on the plan, covering a space of 67,000 square feet. The site is within a few squares of the Market-street Bridge on the west bank of the Schuykill River, and is easily reached by steam and street railways. A tower, about 60ft. high, rises from each corner of the structure. A central arch of 100ft. span and 200ft. in length, of Gothic style of architecture, covers the greater part of the floor space, while two smaller arches, 30ft. wide, running parallel to it on either side, join the towers. The remainder of the ground is occupied by a triangular building connected with the main hall. In addition to these the old Pennsylvania Railway depôt across the street will be used as an annexe. The space has been allotted to the exhibitors, but as the entry of goods did not close until August 30th, the exact position cannot be given. Among those already on the ground are the Baltimore and Ohio Telegraph Company, who have a fine exhibit of telegraph instruments, which will show their method of doing business. The Western Union Telegraph Company will contribute to the historical collection by sending their first instruments, including those made by Morse, and interesting contributions are also promised from the Ordnance and Signal Service Departments; also the Lighthouse Board. The project of holding an Electrical Exhibition is due to the auspices of the Franklin Institute, who have elected a Board of Examiners to conduct the electrical tests, which will be all the more reliable on account of the painstaking way all experiments undertaken by the Franklin Institute are carried out.

The programme which has been issued by the Wolverhampton Chamber of Commerce in connection with the visit of the Associated Chambers to that town at the end of September is very complete.

Stern-wheel Steamer for the Nile.—The great experience of Messrs. Yarrow and Co., of Poplar, in the construction of shallow draught steamers is, we are glad to see, being utilised by the War-office for the Khartoum expedition. In addition to the flotilla of river craft which is being constructed by various builders, the Government have entered into a contract with Messrs. Yarrow and Co., for the immediate supply of a steel stern-wheel steamer for service on the Nile, and we understand that she will be shipped in the course of the next few days from Woolwich. In design she is very similar to Le Stanley, built by the same firm for the Association Internationale for the navigation of the upper waters of the Congo, and which, it may be remembered, was tested on the Thames in the early part of this year with great success, and illustrated in our pages. The steamer just purchased by the Government was built for Central America. She is 80ft. in length by 18ft. beam, and will have a draught of 16in. only. She is being shipped in pieces, all of a size suitable for hand portearge, so that she can be sent on to any section of the Upper Nile that may ultimately be decided upon, and there put together and launched. Military authorities, after much consideration, have come to the conclusion that the steamer is the one best suited for overcoming the difficulties incidental to the navigation of the shallow portions of the Nile, and especially for ascending the rapids. In order that there shall be the greatest possible despatch in rivetting up and starting the vessel, a large staff of engineers and shipbuilders from the works of the firm are to accompany the expedition. The steamer will be furnished with an upper and lower deck, and it is estimated that she will be capable of conveying from 400 to 500 soldiers. She will be fitted with several machine guns, mounted at a considerable elevation, so as to command an extensive range over the river banks, and, no doubt, she will be found a valuable addition to the expedition

THE INTERNATIONAL AGRICULTURAL EXHIBITION AT AMSTERDAM.

THE Dutch are waking up. Only last year they had an International Exhibition, and now again they invite the world to come and see what the Dutch can do in the way of agriculture, and the world is invited to bring the best of its tools and implements, and to let the Dutchmen see them. On the whole, the world has responded very fairly, but with three or four International Exhibitions going last year in Europe and America, and one in Asia, the pace begins to tell. Engineers and machinists after all live for something else than to show their wares. Exhibitions are very well up to a certain point, but beyond that point they must be a loss to the exhibitors. Trade cannot be stimulated much beyond the general wants of the community, though it may be by the introduction of novelties in districts where their advantages of one sort or another are not known until an exhibition directs attention to them.

However, the Dutch have once more got together a good show of machines, implements, animals, and products relating to agriculture. In a wide open space on the west side of the city of Amsterdam—the site of last year's Exhibition in fact—the tents are pitched for the finest collection of live stock ever seen in Holland. But though the site is the same, this year's visitors have an advantage, in that the Royal Museum of Arts is now nearly finished. The entrance to the show-ground is through the great central hall of this building—a hall which may vie with that other vast chamber in the Stadthouse. The museum is in what the Dutch regard as the best period of their art—the seventeenth century style. The walls are of brick, neatly set, but there is much stone in panels and quoins to relieve the façade of the monotony which is inseparable from brickwork alone. Along the front of the central block runs a broad series of panels carved in bold relief to illustrate Science and Art, and one or two panels of scripture subjects. The hall is immediately beneath this work, and is entered by a centre and two side arches. The interior is divided in a similar manner, and the general effect is precisely that of a long cathedral nave of the later Norman style, or at the point of changing to early English. The roof is groined, the ribs of the central nave being of stone, and those of the aisles of moulded brick. Need we say that the brickwork is set with Dutch neatness? The columns supporting the roof are of dressed granite, and are alternately massive stacked columns and slender shafts, ending in both cases with heavy and boldly carved capitals. On either hand, about midway, is a large square lofty hall lighted from the roof, and intended for picture and sculpture galleries, in which are to be placed national works. When completed the building will be a worthy monument of the skill and genius of the men of the nineteenth century, though it is but a reproduction of the art of two centuries since. The architect is Meinheer Cuypers, who is well known in the low countries as the exponent of Dutch architecture.

A good example was afforded the other day of the difficulties with which the Dutch people have to contend for want of a good breadth of solid earth. When they build they manage to get a foundation by piling or other artificial means of reaching through the thin skin of alluvial deposit, which we call Holland, to something sufficiently solid to bear the weight of such a building as the museum. Even this method fails at times, and it is said that the noble Stadthouse, built upon many thousands of piles two centuries ago, shows signs of yielding. The piles decay, and a heavy building gives way. But the matter to which we call attention is of to-day.

Prizes were offered by the committee of the Exhibition for grinding mills.

Amongst other things Messrs. Robey, of Lincoln, had for trial a pair of Derbyshire stones, driven by a portable steam engine in the usual way. The hurst, on which the stones lay, was placed on a flooring of planks, bedded a few inches into the sand. In England, or, indeed, in almost any other country of Europe, this would have been sufficiently firm for all practical purposes, but Holland is altogether another sort of place. No sooner was the mill at work than it rocked and reeled as though it stood upon water, as indeed it did, for the crust of yielding sand was only a few inches thick. The judges ought to have made some allowance for the difficulty under which the trial was made, for the rocking motion was so great that the man who fed the hopper on the top of the hurst could scarcely preserve his balance without holding on. As for the trial, it was rather severe in other respects; for the corn given out to grind was oats, which of all grains feed the worst, and are the most difficult to clear through the meal spout. But there are oats and there are oats. These were such as English ostlers sometimes sarcastically say might be "tied up in a halter." They were long, skinny, full-bearded, and to grind them was like grinding straw. When the stones were at full speed, the oats hung in the eye by centrifugal force, and when the meal was delivered, it blocked the vat and spout, which were quite wide enough for ordinary meal, but not for the chaff-like stuff that these Dutch oats made in grinding. The next day a trial was made of some grinding mills of French make, and they certainly tore the oats to pieces in fine style. One of these mills was a pair of metal discs. One of these was fixed, and the other running. These discs are fitted with teeth, so arranged that the moving ones pass through the others concentrically. The grooves or teeth are in series, radiating from the centre of each disc, and so fitted that they are not only fewer near the centre, but are also coarser, the cutting process becoming finer as the edge of the disc is reached. The discs work on edges, and the corn enters at the centre, and is distributed by centrifugal force generated by the moving disc. It is only just to say that this mill cut the long-bearded oats to powder. The tough husk was cut through and divided most effectually, but of the power required nothing could be learned, as a dynamometer was not applied, and no record was made of the power required to grind or cut a few pounds of oats. Possibly the dynamometer would have revealed the weak point in this very showy machine. Another point is that the working surface must be mathematically accurate, or a great waste of power and loss of efficiency must ensue. While they are in the hands of skilled machinists and engineers, and in a show ground, such mills may produce good results, but it is when they come to the barn and granary, to be worked by men who have no more mechanical skill than will suffice to keep a grindstone in going order, that the matter is altogether different. Probably the "Excelsior Molen" of H. Gruson, of Buckau, Magdeburg—for that is the name of the inventor of this mill—might not come out of the practical test so well as from the trial before judges. Herr Gruson is rather proud of a magnetic appliance fixed in the hopper of his mill to arrest nails and bits of iron. Of course such things would play sad havoc with the chilled iron grooves of his discs, and the magnetic bars stop them most effectually. In order to render the magnetic bars useful, the hopper has to be made large, so that only a trickling flow of corn passes over the magnets; a heavy stream would overcome the magnetic force.

Pumping machinery is not so strongly exhibited as might have been expected in a country like Holland, nor are pile-driving appliances shown. Amongst the water-raisers are some powerful steam pumps and pulsometers. A canal runs through the ground, and the heavier pumps are on the banks of this, lifting the water about 20ft. One of these, worked by an engine by Western and Co., of Derby, was exhibited by a Rotterdam firm, Wijumalen and Hausman; another by a Hanover firm, Körting Brothers. It was disappointing to see so little of the means by which Holland has been made and is maintained. But on the principle that a prophet finds no honour in his own country, the Dutch think only lightly of dam-building and pile-driving. The pulsometer and the centrifugal pumps are stock pieces of all big shows, and the Dutch set them up as a method of keeping their show up to the mark. The same may be said of the windmill pumps, which are made to look show-like and pretty. Even in Holland the windmill of the ancient type is fast disappearing, but the French and German machinists have brought a new type out for the pumping of water. M. Adolph Pieper makes these mills of 12-horse power and with wind-wheels 40ft. in diameter, and one of this size is working at Cologne. M. Pieper has chosen the American form of wheel, *i.e.*, one which reefs by turning the vanes edgewise to the wind. M. Pieper has a very pretty, lofty tower with a 12ft. wheel upon it. Nearly at the top of the tower, and about 30ft. from the ground, is a reservoir, into which the water is pumped so as to obtain pressure for garden fountains, cascades, and other matters. The advantage over steam seems somewhat doubtful. The wind motor is by no means inexpensive, either to make or to keep in repair, and, of course, the uncertainty of the winds might have the effect of establishing a water famine where they were at all relied on. M. Pieper has horse-gear pumps and many other articles of hydraulic machinery on his stand.

The trials of thrashing machinery have been greatly delayed. They commenced on Monday, and, judging from the simplicity of the test, they might have been ended on that day. Each machine was to thrash 200 sheaves of rye and 100 of wheat, of which fifty of rye and twenty-five of corn were to be allowed to settle down to the work. After commencing with Messrs. Ransome's machines, on the stand of Peignat and Co., Amsterdam, the dynamometer was brought out and the trial commenced in another part of the yard on a French machine. Here the driving bands were of webbing, and they were by no means sufficiently wide. Nearly all Tuesday afternoon was spent in getting this machine to work with these inefficient bands. Probably the gentlemen who conduct the trials at Amsterdam have not yet learnt how much has to be done to bring them off efficiently. At all events, they have taken a lesson on the point during the past week.

The King of Holland formally inaugurated the show, and made a close inspection of most of the implement stands. The Exhibition will close to-morrow.

AN ADVENTUROUS RAILWAY JOURNEY.

THE Board of Trade reports on railway accidents seldom contain much sensational matter. One by Major Marindin, on an accident which occurred near Strathblane on the Blane Valley branch of the North British Railway, is a remarkable exception. We reproduce the evidence of the driver of the train, which gives a graphic picture of a very adventurous journey, with a tragic termination. The 8.5 p.m. passenger train from Glasgow to Bucklyvie was on the 11th of July detained by floods, but ultimately proceeded; when approaching Strathblane station the engine ran into some earth washed out of the side of a cutting, and was upset. The guard of the train and a passenger who was on the engine were killed on the spot. The fireman was so badly scalded that he died a few hours afterwards; another passenger on the engine was badly injured, and a passenger in the train had his leg broken. The driver, Archibald Stirling, told his story nearly in the following words:—"I have been between eleven and twelve years in the service, and five years a driver. I have been driving on the Blane Valley branch for about nine months regularly, and know the road well. On the 10th July I was driving engine No. 228, a six-wheel coupled tank engine. I was working the service between Glasgow and Bucklyvie, backwards and forwards. It came on very wet after three o'clock in the afternoon. I brought the 8.40 a.m. train from Bucklyvie to Glasgow, passing Strathblane station at 9.20 a.m. After arriving at Glasgow, I took a goods train from Cowlairs West to Lennoxtown, and returned with a goods train to Sighthill. I then took the 5.45 p.m. passenger train from Queen-street to Lennoxtown, arriving at 6.22 p.m., and I then remained at Lennoxtown till the 8.5 p.m. train arrived from Glasgow, due at 8.41. It was raining very hard nearly all the time I was at Lennoxtown. We left Lennoxtown at 8.45. The train consisted of engine, composite with brake compartment, two first-class and one third-class carriages, and brake-van. There was a good number of passengers. When we arrived at Campsie Glen station the foreman surfaceman came to me, and told me that I would not be able to get any further because there was a tree under a bridge over the burn, and he was not sure of the bridge. He asked me to go up and see it. The guard and I went up, and he asked us what we thought of it. We told him that we had nothing to do with it, and that he must say whether we were to go on or not. The water was not then quite over the bridge, but it was dammed back by the tree, and coming down very strong. The foreman platelayer would not let us go on upon his responsibility, and we went back to Campsie Glen. I then sent my fireman back to Lennoxtown for written permission to come back with my train, and on his return with this permission I brought my train back, arriving at Lennoxtown at about a quarter to 11 p.m. We waited there until the permanent way inspector came, and I took him to Campsie Glen on the engine. He examined the bridge, and I went over the bridge and back again. The inspector said he considered it safe, and I brought him back to Lennoxtown. Mr. Denham, the acting district superintendent, was at the station, and he sent the guard to tell the passengers, who were waiting in the inn, that the train was going on. We started, when everything was ready, at about 12.20 on the morning of the 11th July. There were then six or seven passengers in the train. We were due at Bucklyvie at 9.25. When we got to Campsie Glen I went cautiously over the bridge. The permanent way men were there watching it. After proceeding for about half-a-mile I found the water over the line, and it put the fire out all at once. I kept steam on and went slowly forward. The water must have been 2ft. or 3ft. above the rails, and I must have run through the water for nearly a quarter of a mile. When nearly through the water I stopped to consult with the guard what to do. I went down one side of the train and he came up the other on the footboards, and when we came opposite to each other we consulted what to do. He asked me if I could make Strathblane, and I said I was doubtful if I could, and that if I did go that length I would use all my water. We then decided to light the fire again. We therefore drew forward for another quarter of a mile, to get near a farmhouse which we knew of. The guard and I, and a passenger—Robert Younger—who knew the farmer, went up to the house and got some paraffine oil and some sticks, and went back to the engine with them. We lighted the fire, and got away again about twenty minutes to two. The guard and Younger, who had been helping to break the sticks to kindle the fire, remained on the engine. I had not much steam, and we went slowly up the bank. It was then very dark and still raining, but not so heavily as it had been up to 1 o'clock. We went slowly owing to the state of the line, and, shutting off steam at the summit, we went down the bank at a speed of about fifteen miles an hour. All of a sudden the engine went off the rails, first to the right, I think, and then, lurching to the left, fell over to the right and lay with the wheels in the air. It all happened in a second or two. I had been on the left side of the engine, and I fell under the engine between the two weather boards. I crawled out through the water. I stood a minute, and could neither see nor hear anything of the other men, as the steam was rushing out and filling the cutting. I thought they were all killed. I saw the water was rushing over the side of the cutting and down the line. I went straight away down to Strathblane station to get assistance. My leg was scalded and my back hurt. I did not come back from Strathblane after getting some people up in a house near the station. There was no one at the station. There was a good deal of water on the line going down to Strathblane. When I came up the line in the morning it was all right. Besides those I have named, the son of the stationmaster at Strathblane was on the engine. He also had been helping at the fire. We had been obliged to break up some fencing, and he and the fireman had been to a platelayer's hut to try to find some keys or dry wood. The hut was some way ahead. I let the man remain on the engine to save them from walking back through the water to the carriages. When I left Lennoxtown I got no special instructions as to speed, but I had said to the inspector that I would take my time. He said it was more than likely his men would be out along the line. My fireman was told by his uncle, a surfaceman at Kirkintilloch, to watch the line at Strathblane and Blanefield. My fireman told me this after we left Lennoxtown. I do not know whether he told anyone else. I was running cautiously, but it was dark."

CONGRESS OF GERMAN ARCHITECTS AND ENGINEERS.

THE annual Congress met at Stuttgart on 22nd August, and was well attended. The business proceedings included the discussion of various important matters now occupying attention in German technical circles, and it was resolved to publish at an early date the normal conditions drawn up regarding contracts between professional men and those retaining their services, with a view of a more definite appreciation of mutual obligations than has hitherto been possible. The question of rules for the delivery of iron structures was again referred to the societies represented for final deliberation, and will be treated in detail at the next Congress.

Amongst the papers read which bear in a direct manner upon engineering was one by Professor Winkler, of Berlin, in which the testing of iron and steel was treated in detail; special reference being made to the system introduced by Herr Wöhler, upon which calculations regarding iron constructions are now to a great extent founded. The speaker remarked that these tests, although of undoubted value, required to be supplemented as to certain disputed points before they can be regarded as forming a complete system. The chief result of Herr Wöhler's investigations has been the establishment of the fact that iron and steel can be broken, not only by a burden at one time which exceeds their strength, but also by frequent and alternating influences which need not attain the limits of tension. After a short discussion a resolution was adopted calling upon the German Government to arrange for the continuation of Herr Wöhler's experiments.

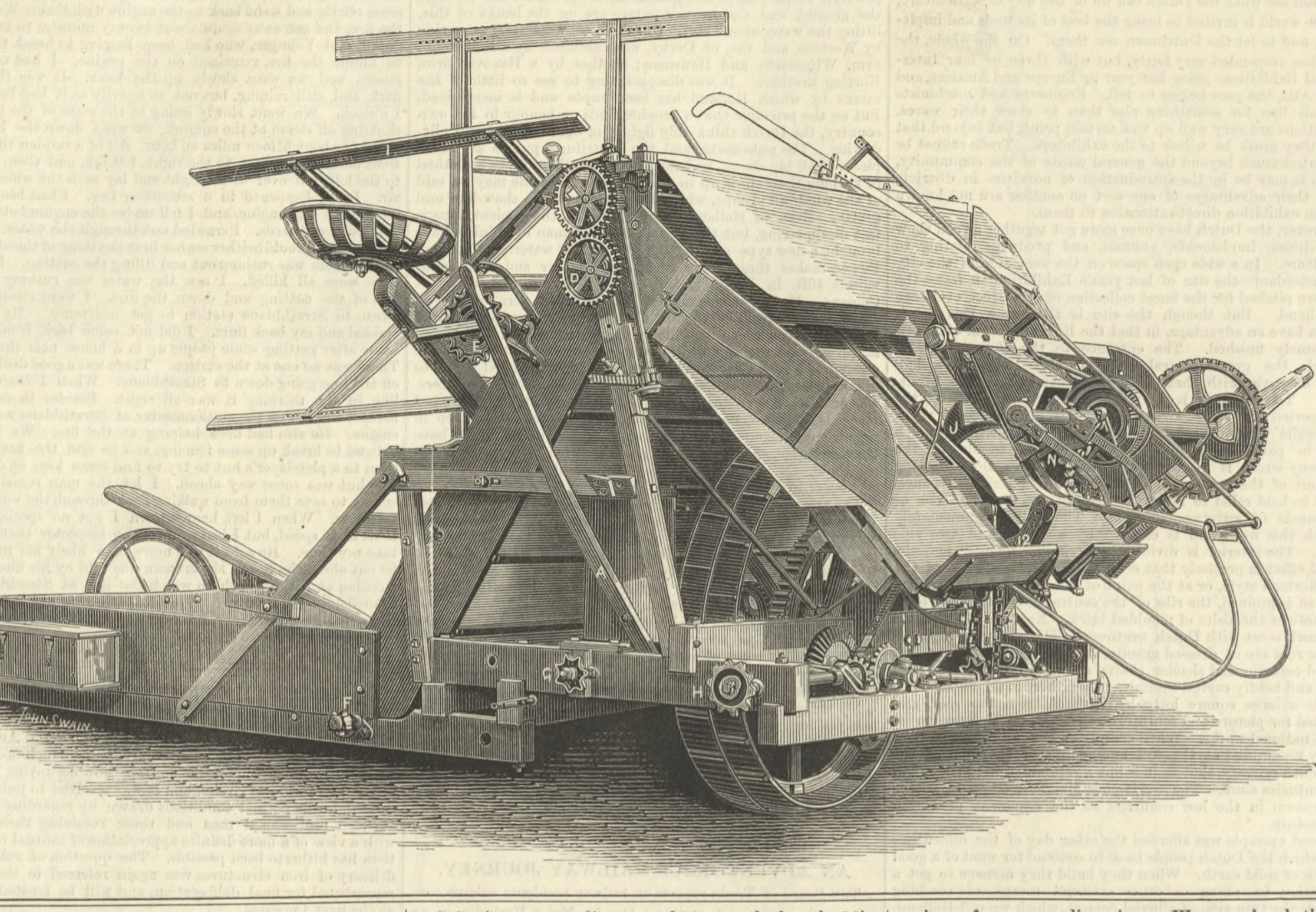
Dr. Dietrich, of Stuttgart, gave an address of practical interest on "Electrical Transmission of Force," in which he sought to define the advantages and defects of the system in such a manner as to correct the Utopian expectations at first created. Even divested of much speculative efficiency, he considered the force still applicable as being of considerable industrial advantage from the simplicity, durability, and portability of the necessary appliances. The relative lightness of electro-motors was also referred to, some now being constructed weighing only 92½ lb. per effective horse-power. The speaker considered that for distances exceeding 1100 yards, electrical transmission presents economical advantages, where the force and distance do not render it more advisable to produce the motive power on the spot.

Much interest was evinced in Herr Lange's paper on "Building in the United States," which referred incidentally to many points affecting engineering work. According to the details brought forward—gleaned from personal experience—the high price of labour and the cheapness of wood combine to perpetuate certain methods of working almost disused in Europe. Crib-work is, for instance, in general use for foundations, bridge columns, shore walls, &c. Works connected with the regulation of the stream are in course of execution on eleven rivers; the Chanoine system of movable weirs and locks being in use. Opinions seem to be divided as to the canal question, as is the case in Germany as well. Some details were also given as to the organisation of the Government staff of engineers, and other matters of an administrative character. An exhibition of plans was an interesting feature of the Congress.

NAVAL ENGINEER APPOINTMENTS.—The following appointments have been made at the Admiralty:—John Yeo, chief engineer, to the President, additional, for service at the Royal Naval College at Greenwich; Robert Browne Priston, engineer, to the Pembroke, additional, for service in the Rodney; George White, engineer, to the Pembroke, additional, for service in the Rambler; George Weight, engineer, to the Serapis; John Lake Michell, engineer, to the Duncan, additional, for service in the Hydra; John Hughes, engineer, to the Asia, additional, for service with the training school for engineer students; Henry Thomas Hammond, engineer, to the Asia, additional, for service in the Dreadnought; Henry Garwood, chief engineer, to the Hector; Henry Percival Vining, assistant engineer, to the Malabar; Robert Bacon, chief engineer, to the Osborne; David Wilson, chief engineer, to the Victoria and Albert; Geo. E. M. Keey, chief engineer, to the Indus, for the Hecate; George E. Bench, engineer, to the Malabar; Josiah H. Hunt, assistant engineer to the Asia, for service in the Devastation; Samuel A. Sereech, assistant engineer, to the Serapis; and G. T. Craddock chief engineer, to the Rapid.

HORNSBY'S STRING SHEAF-BINDING REAPING MACHINE.

(*For description see page 173.*)



ELECTRIC LIGHTING AT THE HEALTH EXHIBITION.

No. III.

"We will meet in old London. It is so lovely." The idea conveyed in this sentence frequently finds expression with visitors to the Health Exhibition. One may hear something similar to it continually, and great credit is due not only to those who started the conception of reproducing this picture of antiquity, but also to those who have so thoroughly carried the idea into effect. The whole is well supported in every detail, even to the omission of the gutters from the eaves of the houses, which those who happen to be caught in old London during a shower may have occasion to observe. But perhaps Mr. Mackie has had the hardest problem to attack in connection with this portion of the Exhibition. He has had to light old London with electric light, and yet to keep it old London. However, he has faced the anachronism, and overcome its difficulties with singular taste, and what is more, with complete success; for he has produced what is at night one of the most charming attractions of the place. But to do this he has boldly sacrificed commercial display to pictorial effect, and the public owes him a great debt of gratitude that this age of advertisement is for a time put to shame and forgotten in the glamour of a brace of electric moons. There are two moons, certainly, but no one need blame any other than himself if he sees more than one at a time, for it has been so arranged that the two steady arc lights which supply the moonlight are not both visible from any one spot in old London itself. They are run up to a height of 70ft. from the ground, and the light is surrounded by large spherical opalescent glass shades. Each of these moons gives a light of 2500 candles, and there are three other similar lights used for various illuminations in different parts of the old City. One having an orange-tinted globe is placed in such a way as to represent a fire in the guard-room over the entrance of the Bishops-gate. Another with a red glass does duty for a forge in the iron-worker's shop at Pye Corner.

There are thirty incandescent lamps distributed in various places inside the houses and shops, as well as outside, but the prominent lights are always placed in old-fashioned horn lanterns, and hung out of the windows, or suspended on brackets at the street corners and over the doorways, as was customary in the period represented by the houses and other surroundings. The balcony of Dick Whittington's house is thus lit up for the reception of musicians. Altogether the effect is most pleasing and accurate, and, as far as we can judge, thoroughly concordant with the spirit and tone of the place and time presented. The electric machinery producing all this excellent effect is composed of two Gramme machines, E type, whose fields are excited in series by another Gramme machine of the A pattern. One of these E machines supplies the five arc—Lee—lights in series with a current of 21 ampères, the difference of potential at the extremities of the lamp circuit being 185 volts. This would make the effective power 3885 watts for an illumination of 12,500 candles, the speed of the machine for this result being 1050 revolutions per minute. The carbons used are the cored Siemens or Berlin carbons, the upper one having a diameter of 14 mm., and the lower one a diameter of 20 mm., the lengths 12in. and 6in. respectively. These lamps are said to burn for something over seven hours without requiring adjustment or interference. They have been employed at other exhibitions, but have had subsequent improvements introduced, and now burn with far more than ordinary steadiness.

The other E machine supplies the incandescent lights to the number of about thirty. As it is constructed to supply 60 lamps, it is run at a speed of only 800 revolutions per minute. Mr. Mackie's lamps have the carbon filament twisted with a double spiral, so that the light emanation is fairly uniform on every side, and the light itself has a pointed flame-like form which admirably adapts it to the purposes for which it is here applied, viz., to represent flames in the old lanterns.

Six of the incandescent lamps on this circuit are employed in Mr. Humphrey's corrugated iron school-room and its offices. They hang in pendants, and the actual incandescent carbon is screened from view by thick opalescent globes with wide mouths opening downwards. The perfect way in which small print can be distinguished by this light is worth attention.

The dynamo-electric machines employed have also served at the Crystal Palace Gas and Electricity Exhibition and at the Fisheries, so that they have been working almost continuously from dusk till ten o'clock at night during nearly two years without requiring repairs. The steam engine is by Messrs. Davey Paxman and Co., which actuates the main shaft in the engine-shed, but the Grammes are driven from a countershaft.

Each incandescent lamp has a nominal power of 20 candles, but from the circumstances of the case is run to rather more than this. Some of those which were in former exhibitions have a tale of as much as 1780 hours to tell. They are all fitted with Mr. Mackie's patent holders, in which, by the pressure of a metal cylinder and the peculiar form of the hooks for gripping the platinum wires of the lamps, good, firm contact is obtained and the fusing of the platinum wire through sparking is prevented. All these incandescent lamps, as well as some which are exhibited by the Hammond and Gülcher Companies, have been blown and made by means of the Wright and Mackie machine.

If we turn from old London to Mr. Tayler-Smith's exhibition at the south-west corner of the south gallery, we shall observe a good example of what can be done by means of electric light to display and decorate a modern dwelling-house. The house itself is of the æsthetic type, to begin with, and is composed of a drawing-room, a dining-room, a bed-room, a hall, a fernery, and a card-room. Ninety lamps are distributed among these rooms, and many of them are removable from one part to another on a system which Mr. Tayler-Smith has done much to work out, but which, nevertheless, seems to entail a good deal of loose leading wire about the tables and floors.

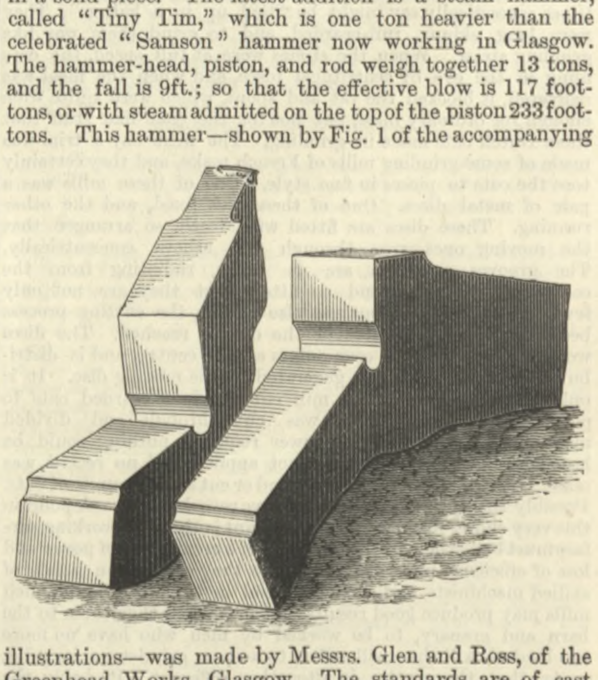
The exhibitor employs batteries of twenty-four cells; so the lamps do not require high pressure. The batteries are charged by means of Elwell-Parker silent dynamo machines, driven by gas engines. For some reason, there are three batteries, two small and one large, and there are besides three dynamo machines and three gas engines of corresponding sizes. We apprehend that so much machinery for such a moderate installation is not inherently necessary to Mr. Tayler-Smith's system, but may in this case be the result of unforeseen extensions in the lighting required.

VISITS IN THE PROVINCES.

THE DARLINGTON FORGE.

Among the works visited by the Iron and Steel Institute during their Middlesbrough meeting last autumn, the Darlington Forge was by no means the least interesting. It covers eight acres of ground, and employs from 400 to 500 men. The speciality is heavy forgings in iron and soft steel, chiefly for vessels and marine engines, but also for rolling-mill and other stationary engines, the work being sent out machine-finished when required. No less than 4500 tons of forgings are turned out yearly for German, Dutch, and Danish shipbuilders and engineers, as well as for the leading firms on the large rivers of the United Kingdom.

The Forge Department contains sixteen steam hammers, varying in weight from 20 cwt. to 13 tons, being capable of making any forging, from the smallest up to 40 tons, in a solid piece. The latest addition is a steam hammer, called "Tiny Tim," which is one ton heavier than the celebrated "Samson" hammer now working in Glasgow. The hammer-head, piston, and rod weigh together 13 tons, and the fall is 9ft.; so that the effective blow is 117 foot-tons, or with steam admitted on the top of the piston 233 foot-tons. This hammer—shown by Fig. 1 of the accompanying



illustrations—was made by Messrs. Glen and Ross, of the Greenhead Works, Glasgow. The standards are of cast iron, with end openings, as in the French hammers, for facility of working. The cross girder supporting the cylinder is built up of massive plates, strongly rivetted; and the foundations, both of the standards and of the anvil block, consist of 18in. balks of timber, all tied together. The hammer is served by two furnaces, and by two powerful plate-iron cranes, that lift up to 50 tons, all the motions being effected by steam power. During the Iron and

STEAM HAMMERS, DARLINGTON FORGE.

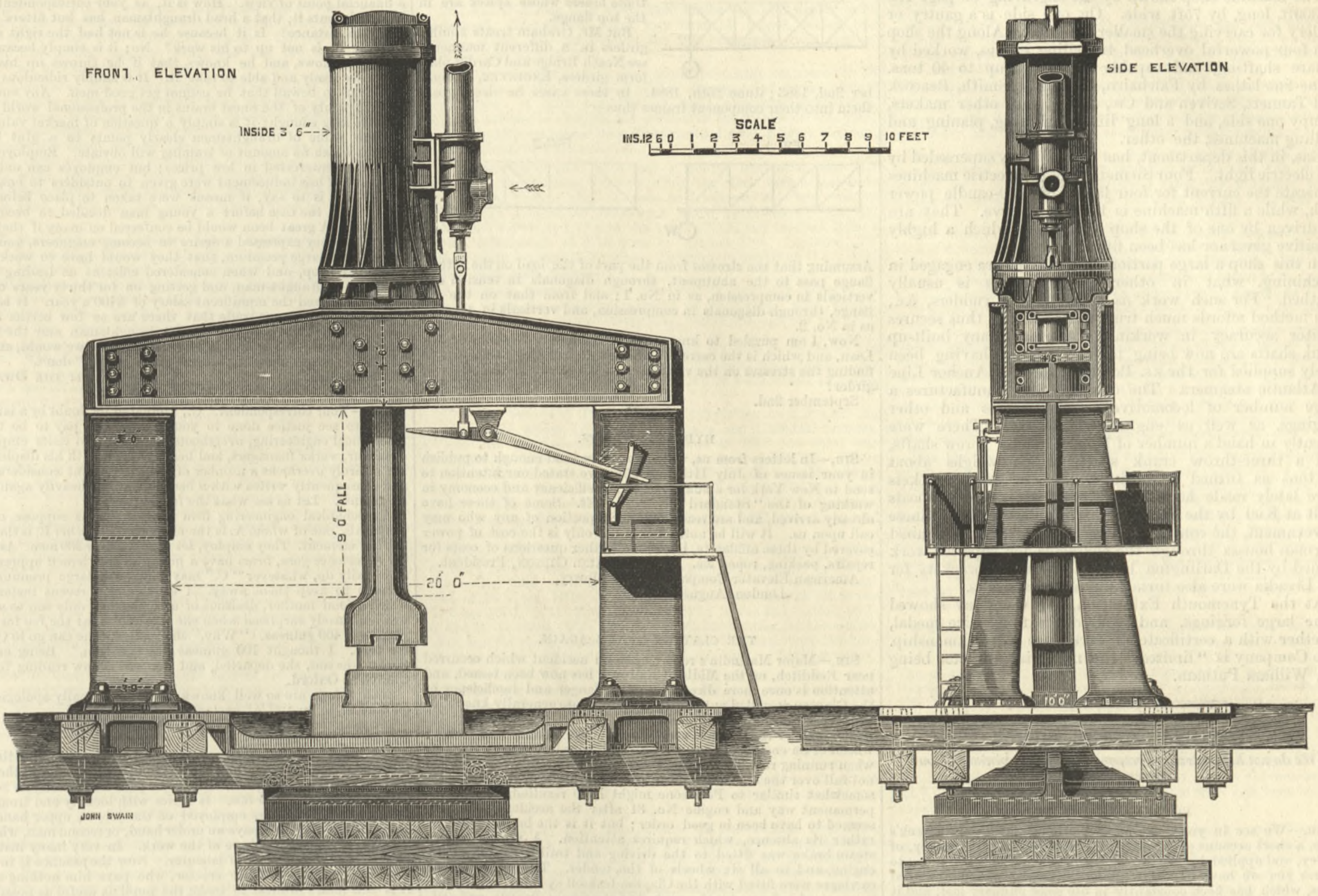


Fig. 1.—13-TON HAMMER.

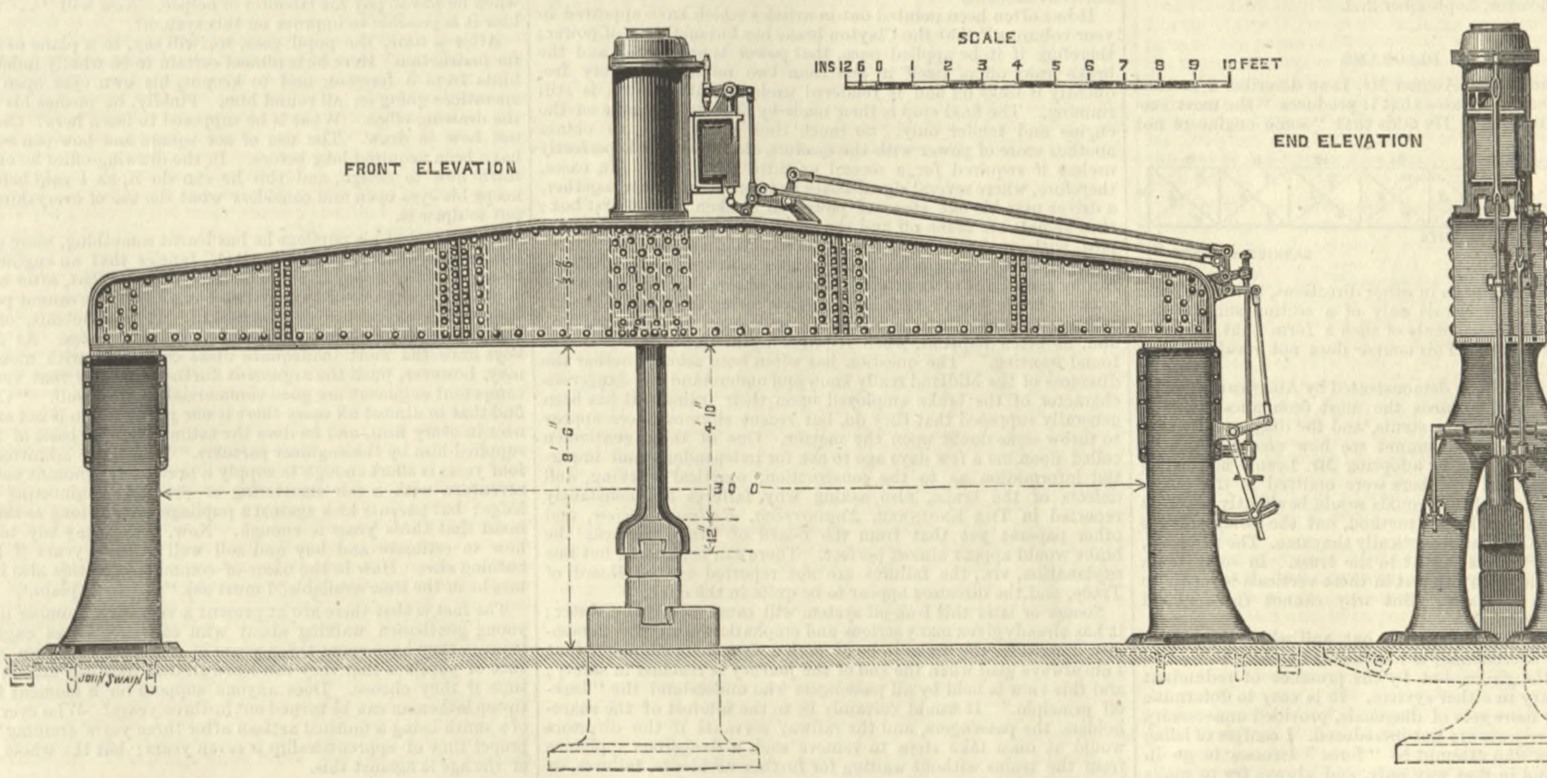
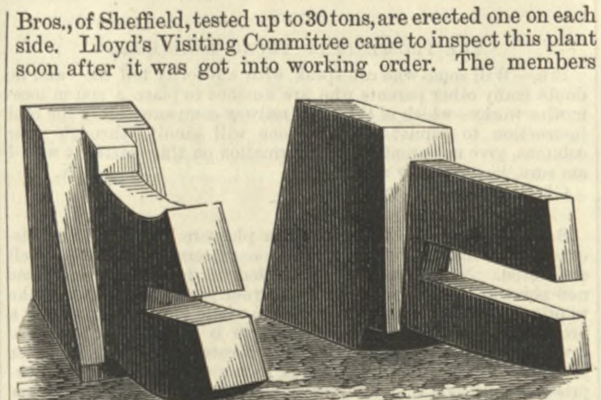


Fig. 2.—2-TON HAMMER

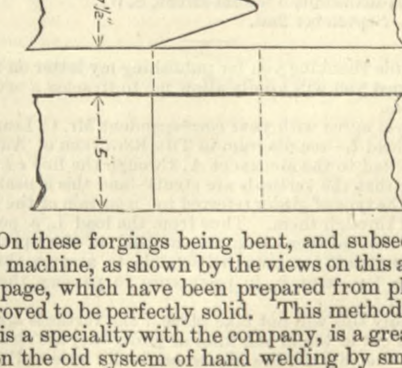
Steel Institute's visit, the hammer was engaged on a crank-shaft for the Clyde, to weigh about 17 tons when finished.

All the iron used is selected from locomotive scrap bought from the railway companies. It is freed from rust in revolving drums, piled and rolled into bars, which are then cut into short lengths and cross-piled to form the slabs and uses. In the case of crank shafts and the more important forgings, this method of dealing with the scrap iron is most essential, and produces a metal of great toughness and homogeneity.

A great many vessels are disabled owing to their stern frames giving way on account of their not being thoroughly and soundly welded up. To get over this difficulty, the company has erected and recently completed a smiths' shop 250ft. long by 50ft. wide, wherein is erected a special steam hammer, designed and constructed at the works, which, as it is 30ft. in the clear between standards, is capable of taking in and welding up solid the largest stern frames made. The piston, rod, and head of this hammer—shown by Fig. 2 above—weigh 2 tons and fall through 4ft., in addition to which steam can be admitted on to the top of the piston, if necessary, to increase the force of the blow. Steam cranes by Davy Bros., of Sheffield, tested up to 30 tons, are erected one on each side. Lloyd's Visiting Committee came to inspect this plant soon after it was got into working order. The members



expressed their thorough approval, and permitted reference to them on the subject. In order to set at rest any doubt that might exist as to the soundness of welds made thus under the steam hammer, the company, at the request of Lloyd's surveyors, made a couple of forgings, 15in. by 7½in., and 12in. by 6in., with welds in accordance with the annexed sketch, for the purpose of testing their soundness.



On these forgings being bent, and subsequently cut into by machine, as shown by the views on this and the preceding page, which have been prepared from photographs, they proved to be perfectly solid. This method of welding, which is a speciality with the company, is a great improvement on the old system of hand welding by smiths. The blast for urging the fires, when heating large ship forgings for welding, is afforded by one of Tannett, Walker, and Co.'s 3-cylinder blowers, which give a steady pressure up to 3 lb. per square inch.

The machine shop shown by the engraving on page 180 is 300ft. long, by 75ft. wide. On one side is a gantry or gallery for carrying the smaller machines. Along the shop run four powerful overhead travelling cranes, worked by square shafting, and capable of lifting up to 40 tons. Some fine lathes by Fairbairn, Kennedy, Smith, Beacock and Tannett, Scriven and Co., Berry, and other makers, occupy one side, and a long line of slotting, planing and drilling machines, the other.

Gas, in this department, has been entirely superseded by the electric light. Four Siemens dynamo-electric machines generate the current for four lamps of 2000-candle power each, while a fifth machine is held in reserve. They are all driven by one of the shop engines, to which a highly sensitive governor has been fitted.

In this shop a large portion of the tools are engaged in machining what in other establishments is usually smithed. For such work as stern frames, rudders, &c., this method affords much truer surfaces, and thus secures greater accuracy in working. A great many built-up crank shafts are now being turned out, one having been lately supplied for the s.s. Belgravia, of the Anchor Line of Atlantic steamers. The company also manufactures a large number of locomotive cranked axles and other forgings, as well as engine wheels, &c. There were recently in hand a number of 20in. diameter screw shafts, and a three-throw crank shaft, which weighs about 45 tons as turned and finished. The stern brackets were lately made here for the two twin-screw gunboats built at Kiel by the Gebrüder Howaldt, for the Chinese Government, the contract having been carried off against German houses through the character for superior work gained by the Darlington Forge. The stern brackets for the Livadia were also turned out at these works.

At the Tynemouth Exhibition, the Company showed some large forgings, and secured the first prize medal, together with a certificate of excellence in workmanship. The Company is "limited," the managing director being Mr. William Putnam.

LETTERS TO THE EDITOR.

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

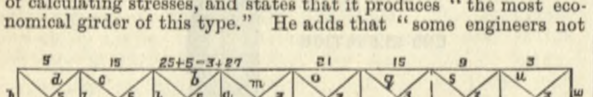
ROTARY AIR PUMPS.

SIR,—We see in your column of "Miscellanea," in last week's issue, a short account of a rotary air pump, by Mr. A. Brearley, of Batley, and applied by Messrs. J. Bagshaw and Sons. We beg to inform you we have one at work on the same principle, designed by us, which has been constantly in use since January last, and it is our intention to introduce the same arrangement for any size engine where practicable. DEATH AND ELLWOOD.

Albert Works, Leicester, September 2nd.

STRESS DIAGRAMS.

SIR,—In your issue of 29th August Mr. Lean describes a method of calculating stresses, and states that it produces "the most economical girder of this type." He adds that "some engineers not



only assume that the stresses go in other directions, but force them to do so, by making the verticals only of a section suitable for struts, and by making the diagonals of such a form that they can only sustain a tensile stress. This course does not result in producing an economical girder."

Now Sir, I think it has been demonstrated by American practice that for spans of 80ft. and upwards the most economical truss is attained by making the verticals, struts, and the diagonals so that they can only be ties. But I cannot see how economy can be secured, even in shorter spans, by adopting Mr. Lean's method of calculation. If the vertical members were omitted in the girder he sketches, the stresses in the diagonals would be slightly different from those obtained by Mr. Lean's method, but the total amount of metal in them would remain practically the same. The verticals, therefore, merely add useless weight to the truss. In some cases it may be considered necessary to put in these verticals in order to stiffen the top boom laterally. But why cannot the inclined members be made to do this?

The difficulty which "A. H." points out, and which Mr. Lean suggests a method of overcoming, is not caused by there being two sets of diagonals in the girder, but by the presence of redundant members, not necessary in either system. It is easy to determine the stresses in two or more sets of diagonals, provided unnecessary members like these verticals are not introduced. I confess to being one of those engineers who attempt to "force" stresses to go in one particular way, and in that way only, and always try to make that way consist of the fewest possible number of parts, and to proportion these parts accurately to do their own work, and resist either tension only or compression only, or both, as may be required.

It seems to me that strong, good, and at the same time cheap girders are most likely to be produced by adhering as closely as possible to this "one way" method of designing; and I, therefore, agree with "A. H." in thinking that the type of girder he refers to should be avoided. JAS. H. CUNNINGHAM.

2, Victoria-mansions, Victoria-street, S.W.,
September 2nd.

SIR,—While thanking you for publishing my letter on the above subject, I trust you will kindly allow me to trespass a second time on your space.

I cannot yet agree with your correspondent Mr. C. Lean, that no part of the load L—see diagram in THE ENGINEER of August 29th —is transmitted to the abutment A, through the line *e k c l g h*.

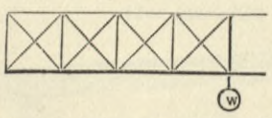
Assuming that the verticals are struts—and this is nearly always the case in the type of girder referred to—a portion of the load must be conveyed through them. Thus from the load L, a portion will be taken by the member *e* and transmitted to the apex 3. Now from that point is it not more reasonable to assume that it will follow down the strut *k*, in preference to passing through the inclined strut *f*?

Undoubtedly this will not take place if the verticals are ties, but in nine cases out of ten in this kind of girder they are struts; such, at least was the case in the girder originally referred to at the commencement of this discussion. A. H.

September 2nd.

SIR,—Mr. Lean has not quite satisfactorily answered my question as to the distribution of load and stress in a girder with vertical and diagonal bracing. He considers that in a girder of this type the stresses pass to the abutments through the diagonals only; and that the verticals merely transfer a portion of the load to those braces whose apices are in the top flange.

FIG. 3



But Mr. Graham treats similar girders in a different manner—see Neath Bridge and Cardiff platform girders, ENGINEER, November 2nd, 1883; June 20th, 1884. In these cases he decomposes them into their component frames thus—

FIG. 1

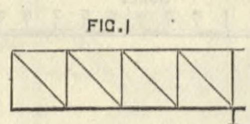
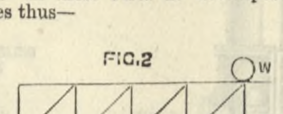


FIG. 2



Assuming that the stresses from the part of the load on the bottom flange pass to the abutment, through diagonals in tension and verticals in compression, as in No. 1; and from that on the top flange, through diagonals in compression, and verticals in tension, as in No. 2.

Now, I am puzzled to know who is right, Mr. Graham or Mr. Lean, and which is the correct method of distributing the loads and finding the stresses on the verticals and diagonals of this class of girder? C. S.

September 2nd.

HYDRAULIC LIFTS.

SIR,—In letters from us, which you were kind enough to publish in your issues of July 11th and 25th, we stated our intention to send to New York for affidavits as to the efficiency and economy in working of the "Standard" hydraulic lift. Some of these have already arrived, and are ready for the inspection of any who may call upon us. It will be noticed that not only is the cost of power covered by these affidavits, but also all other questions of costs for repairs, packing, ropes, &c. WM. AUG. GIBSON, President.

American Elevator Company, 38, Old Jewry,
London, August 30th.

THE CLAYTON BRAKE AGAIN.

SIR,—Major Marindin's report upon an accident which occurred near Redditch, on the Midland Railway, has now been issued, and attention is once more directed to the danger and inefficiency of the Clayton so-called automatic vacuum, more generally known as the "two-minute leak-off brake."

The facts of the case are very simple. The leading and trailing wheels of an engine having a long rigid wheel base left the line when running round a very sharp curve. Fortunately the train did not fall over the embankment or bridge at this spot, or a disaster somewhat similar to Penistone might have resulted. I saw the permanent way and engine No. 81 after the accident, but both seemed to have been in good order; but it is the brake power, or rather its absence, which requires attention. A non-automatic steam brake was fitted to the driving and trailing wheels of the engine, and to all six wheels of the tender. The whole of the carriages were fitted with the Clayton leak-off system. This brake is supposed to be under the control of the driver, guards, and self-acting in case of accident. The facts, however, furnish a very different account.

It has often been pointed out in articles which have appeared in your columns "that the Clayton brake has but one store of power; therefore if it be applied once, that power is exhausted, and the brake leaks off of itself in less than two minutes." Very frequently it leaks off and is rendered useless while a train is still running. The final stop is then made by the steam brake on the engine and tender only. So much time is required to obtain another store of power with the ejectors, that the brake is perfectly useless if required for a second or third application. In cases, therefore, where several signal-boxes or junctions are near together, a driver uses his one store of power to slacken at the first box; then signals are taken off and the train runs forward to the next post, without there having been time to obtain a second vacuum.

Major Marindin reports: "The evidence, as well as the distance run by the engine after leaving the rails, shows that the automatic vacuum brake was of very little service, owing to want of power. It had been used just previously to check speed at the signal-box, and, as often happens, when required again immediately it was found wanting." The question has often been asked whether the directors of the Midland really know and understand the dangerous character of the brake employed upon their trains. It has been generally supposed that they do, but recent circumstances appear to throw some doubt upon the matter. One of these gentlemen called upon me a few days ago to ask for independent and impartial information as to the construction, practical working, and defects of the brake, also asking why failures are constantly reported in THE ENGINEER, *Engineering*, *Railway Review*, and other papers; yet that from the Board of Trade Returns the brake would appear almost perfect. There can be, and is, but one explanation, viz., the failures are not reported to the Board of Trade, and the directors appear to be quite in the dark.

Sooner or later this leak-off system will cause a fearful disaster; it has already given many serious and emphatic warnings. Personally, I consider the brake to be of such a dangerous character that I am always glad when the end of the journey is reached in safety; and this view is held by all passengers who understand the "leak-off principle." It would certainly be to the interest of the shareholders, the passengers, and the railway servants if the directors would at once take steps to remove such a dangerous appliance from the trains without waiting for further accidents, failures, or loss of life. CLEMENT E. STRETTON.

40, Saxe Coburg-street, Leicester, August 30th.

THE PROSPECTS OF YOUNG ENGINEERS.

SIR,—Will some who can speak with authority tell me—and no doubt many other parents who are anxious to place a son in locomotive works—which of the great railway companies gives the best instruction to pupils? If some one will kindly, through your columns, give us parents some information on this matter it will, I am sure, be gratefully received. X. Y.

Glasbury, September 1st.

SIR,—I should like to express the pleasure I feel that the discussion on the prospects of young engineers has been so well ventilated. Nearly all your correspondents have advanced some new point in the argument, and with your permission I should like to offer a few remarks. No doubt the whole question is simply a problem in political economy, and there is always a tendency to overstock the market in all employments that are genteel or professional, and the remedy seems to me so clear that I am surprised older heads than mine have not broached it before. Space will only allow me to touch on one or two points. It is only when fellows like myself get out of the nest and knock about a bit that they find there is a substantial difference between a genteel employment and one that pays; we get disgusted, and feel we would like to be doing something that, although not perhaps so dignified as engineering, would bring in more of the means than empty name of gentleman. Having got so far, however, few care to start fresh at any other venture, and we can only leave our case to warn others off the rocks.

The tendency of the arguments of some of your correspondents would lead one to suppose that young engineers cannot get berths because they are not trained properly. With all due respect to your article and their opinions, I think that if they had the Utopian training spoken of they would not be a cent better off in a financial point of view. How is it, as your correspondent "C." so rightly puts it, that a head draughtsman has but fitters' pay in many an instance? Is it because he is not had the right sort of training or is not up to his work? No; it is simply because the employer knows, and he knows, that if he throws up his job, a dozen are ready and able to take it. It is simply ridiculous for an employer to bewail that he cannot get good men. Any employer can get plenty of the finest brains in the professional world if his purse is long enough; it is simply a question of market value, and the low value of draughtsmen clearly points to a glut in the market which no amount of training will obviate. Employers are, of course, interested in low prices; but employés can only hold their own if less inducement were given to outsiders to enter the trade—that is to say, if means were taken to place before him the facts of the case before a young man decided to become an engineer. A great boon would be conferred on many if they were told when they expressed a desire to become engineers, and could not afford a large premium, that they would have to work many years in a shop, and when considered efficient as leading hand, foreman, or draughtsman, and getting on for thirty years of age, would be offered the munificent salary of £100 a year. It seems a great drawback to our trade that there are so few berths in the majority of shops between the £2 draughtsman and the £500 a year manager. We cannot all be managers if we would, and my advice to persons about to become engineers is, "don't."

August 28th. ZIT THE DWARF.

SIR,—Your correspondent "C.," actuated no doubt by a laudable desire to see justice done to young men who pay to be taught mechanical engineering, overshoots his mark, and visits employers of labour, works' managers, and heads of firms with his displeasure. He entirely overlooks a number of very important considerations, and consequently writes with a bias which tells heavily against his arguments. Let us see what the facts are.

A mechanical engineering firm consists, let us suppose, of two principals, one of whom A. is the engineer; the other B. is the commercial element. They employ, let us say, 250 or 300 men. As far as my experience goes, firms have a horror of gentlemen apprentices, and really do, whatever "C." may think, ask large premiums on purpose to keep them away. I could cite a recent instance in which a fond mother, desirous of articling her only son to a firm, was immensely surprised when she was told that the fee for three years was 400 guineas. "Why," she replied, "he can go to Oxford for that. I thought 100 guineas was the sum." Being assured that it was not, she departed, and her son is now reading for the Church at Oxford.

Such things are so well known that I must really apologise for quoting them for "C.'s" exclusive benefit.

Let us suppose that the pupil is articled to Messrs. A. B. How and what is he to be taught?

Nearly all the work is piecework, and no one has the time to take the pupil and teach him for teaching sake. Suppose the work is erecting portable engines. The price paid for erecting an 8-horse power engine is 25s. or 30s. It varies with locality and from time to time. Two men are employed on the job, an upper hand who draws all the pay, and pays an under hand, or second man, who gets from 7s. to 8s. for his share of the work. In very many instances he is only a superior sort of labourer. Now the practice is to hand the new pupil over to the erector, who pays him nothing at all. It is this man's interest to make the pupil as useful as possible to him as soon as possible, because when he has been well trained the erector can get on fast, and earn more money than he can when he has to pay his labourer or helper. Now will "C." tell me how it is possible to improve on this system?

After a time, the pupil goes, we will say, to a plane or a lathe for instruction. Here he is almost certain to be wholly indebted to hints from a foreman and to keeping his own eyes open to the operations going on all round him. Finally, he pushes his way to the drawing-office. What is he supposed to learn here? Certainly not how to draw. The use of set square and bow pen ought to have been acquired long before. In the drawing-office he ought to learn how to design, and this he can do if, as I said before, he keeps his eyes open and considers what the use of everything he is put to draw is.

At the end of his pupilage he has learnt something, more or less, but no one, except, I suppose, "C." fancies that an engineer can be made out of a boy in three or four years. What, after all, is a youth of twenty-one or twenty-two but a boy? He cannot possibly have much experience or much skill. It is, I submit, of little use to teach boys how to estimate or get out prices. As a rule, boys have the most inadequate ideas connected with money. I may, however, push the argument further, and say that very few competent engineers are good commercial men as well. "C." will find that in almost all cases there is one partner who is not an engineer in every firm, and he does the estimating on a basis of figures supplied him by the engineer partners. It will be admitted that four years is short enough to supply a previously ignorant youth of seventeen with a fair smattering of practical engineering knowledge; but parents kick against a pupilage even as long as this, and insist that three years is enough. Now, I defy any boy to learn how to estimate and buy and sell well in three years if he did nothing else. How in the name of common sense this also is to be taught in the time available, I must ask "C." to explain.

The fact is that there are at present a very large number of very young gentlemen walking about who call themselves engineers, because they have spent three years in a works. My own experience of pupils is that they can learn all that they can take in in the time if they choose. Does anyone suppose for a moment that a tiptop latheman can be turned out in three years? Who ever heard of a smith being a finished artisan after three years' training? The proper time of apprenticeship is seven years; but the whole spirit of the age is against this.

Finally, it may be pointed out that as the system of instruction or no instruction is universal in its method, no boy can complain that he has been worse treated than his neighbour. The notion that a firm ought to be prosecuted for not teaching is simply nonsense. I am not speaking now of "office" engineers but of manufacturing firms. There is not, I boldly assert, a respectable firm of the kind in England or Scotland in whose works a boy cannot, if he is so disposed, learn all that can be learned in three years. Nay, more, in nearly all cases pressure will be brought to bear on him to compel him to learn.

To assume that manufacturing firms should convert their works into training colleges, and keep a staff of instructors, is to assume an absurdity. It may be urged that, if they do not take pupils, the supply of assistants will soon fall off. This is not true, because heads of firms have always sons or other relatives in number sufficient to more than supply the demand. The outside public are not wanted at all, and will do well to avoid the business.

Oldham, September 1st. OLD HAND.

"PARTICULARS OF MARINE ENGINES, BOILERS, &C."—This is a note-book, which contains printed headings for recording the dimensions, weights, and other particulars of steamship engines, boilers, and deck machinery, and has been published to meet an expressed want. The headings are so arranged as to cover all types of marine engines and boilers, whether paddle or screw, simple or compound. Each book admits of tabulating particulars of 100 sets of engines and boilers, with one blank page to each set for special notes, and an index at beginning. This book seems likely to prove so useful that we fancy no superintending engineer will be without it. It is published by Mr. John Thomlinson, Partick, Glasgow.

RAILWAY MATTERS.

SIGNS of a speedy completion of the new railway between Sutton Coldfield and Lichfield are noticeable this week. The company began to run goods traffic on Monday, and it is expected that in the course of two or three months everything will be ready and the line in a fit condition for passenger traffic. The bridges were tested on Saturday with satisfactory results. Several heavy goods engines had passed together along the line of route, and had stopped all together on the bridge.

THE humour of this, from *Harper's Magazine*, lies in its truth:—A conductor on one of the main lines running between two of our prominent Western cities was one Sunday persuaded to attend church by his cousin, who was then visiting at his house. The day was unusually warm, and he being very tired, having been in two railroad disasters through the week, fell asleep. The minister waxing warm with his subject, began to shout, and as he finished his sentence with a shout and stamp, the conductor rose at once and shouted, "Put on the brakes, John, quick! we're off the track."

THE Southport and Cheshire Lines Extension Railway was opened for traffic on Monday. It will afford additional accommodation between Liverpool and Southport, and Manchester—Central Station—and Southport, besides bringing Southport into direct railway communication with the Manchester, Sheffield, and Lincolnshire, Great Northern, and Midland Railway systems. The new line, which extends from Southport through Birkdale Palace and Altcar to Aintree Junction, is 14 miles 7 chains in length. The Southport and Cheshire Lines Extension Railway Company is the owner, and the Cheshire Lines Committee will, under a special arrangement, work it as part of their own system. The committee will take a certain percentage of the gross receipts, and in their hands is the appointment of the officers of the line.

WE learn from a recent official report from Salonica—Turkey—that for some time past the Beys of Monastir have had the idea of connecting that town by a line of rails with the Salonica-Mitrovitza Railway, and for this purpose they proposed to offer a sum of money as a subvention to this railway company to undertake the matter, at the same time requesting the Christian population to contribute towards the expenses. Difficulties, however, arose in respect to raising the necessary funds, and the project for a time made no progress. But it has recently been mooted again, and this time in an official form, as Ahmet Eyoub Pasha, the Governor-General, has taken the matter in hand, and has submitted the proposal officially to the Ministry of Public Works. In reply, he has been informed by the Minister of Public Works that the map of the vilayet of Monastir has already been studied by the War-office, and the project for the railway branch has been submitted to the Council of Ministers; that the Imperial sanction only is required in order to carry it out, and that several contracting companies have already made offers. The town and district of Monastir would gain immensely if the branch line were made, as it would then become the commercial centre of Southern Macedonia and of a great part of Albania.

THE Russian railways are reported to have earned in 1883 five per cent. more per mile than in 1882, and 13⅓ per cent. more than in 1881, which is very remarkable progress for Russian lines to make. At the beginning of 1883 there were 14,390 miles of line, and during the year 412 miles more were opened—all the additions being parts of the Transcaucasian Railroad, 343 miles completing it eastward to the Caspian Sea at Baku, and 69 miles continuing it southward along the east end of the Black Sea, from the very bad port of Poti to the better one of Batoum, which was acquired of Turkey in the last war. This brought the length worked up to 14,802 miles at the beginning of this year. The number of tons of freight delivered by shippers at stations—not including that transferred from one railroad to another—was 26,000,000 tons last year, which is 5¾ per cent. more than in 1882. The largest earnings on Russian railways last year, as well as the largest earnings per mile, were by the Nicholas Railroad from St. Petersburg to Moscow, 406 miles long, which earned £590 per mile. But the next largest were but £440 per mile. Two others made as much as £400, but only five made as much as £200 per mile. The company with the largest mileage has 1530 miles of road, and earnings per mile a little less than the average. No other road has more than 800 miles. The 626 miles of the Transcaucasian Railroad, which connects the Black Sea with the Caspian, earned but £705 per mile; twelve roads earned less than £600, and nine less than £400 per mile; six less than £300, and two less than £200 per mile.

IN connection with the Argentine Exhibition lately held at Bremen, various details were officially published as to existing and projected railways in the Argentine Republic. Twenty years ago, three short lines from Buenos Ayres formed the sole available communication of this kind. Now, the province of Buenos Ayres contains a network of railways of about 1000 miles in length. The East Argentine line has overcome the difficulties of transport caused in the Entre Rios district by the rapids of the Uruguay. The prolongation of this line as far as Pasadas—the capital of the Misiones territory—is now decided upon. In the south-western portions of the Republic, railway enterprise is active. The most important lines are those which are intended to bring the western and north-western regions into connection with the world's commerce by means of the Harbour of Rosario, and the extension of these as far as Bolina is being now designed. Branches from the main line—Cordoba to Tucuman—will open up communications with Santiago, Rioja, and Catamarca, the mineral wealth of the last-named district thus being favourably developed. The line now running to San Luis and Mendoza will be extended within a year as far as San Juan. With a view to the ultimate establishment of interoceanic traffic with the Pacific coast, the line from Buenos Ayres to Villa Mercedes will shorten the route as compared with that which passes through Rosario. The prolongation of the Andes Railway from Mendoza to Santiago—Chili—has also been arranged for. A specimen of the Quebracho Colorado wood was exhibited. This is said to be much used for railway sleepers, as it does not rot.

A RETURN is published containing the gross receipts and the working expenses of the twelve chief railway companies during the first six months of this year, as compared with the corresponding period of last year. The gross receipts of these twelve companies for the whole six months are £25,609,075, a diminution of nearly £20,000 since last year; the working expenses are £13,748,990, an increase of nearly £80,000. The net receipts, therefore, £11,880,985, this year, are less by nearly £100,000 than those of last year. The following six companies show an increase in net receipts since last year:—London and Brighton has increased from £455,193 to £457,289; South-Eastern, from £469,129 to £486,136; Great Eastern, from £673,373 to £746,259; London and South-Western, from £559,295 to £573,012; Lancashire and Yorkshire, from £802,325 to £831,782; Great Northern, from £722,057 to £734,767. On the other hand, six companies have diminished in net receipts. Manchester, Sheffield, and Lincoln, from £459,109 to £441,622; London, Chatham, and Dover, from £242,989 to £242,248; North-Eastern, from £1,594,955 to £1,470,997; Great Western, from £1,875,216 to £1,869,769; Midland, from £1,668,450 to £1,653,882; and London and North-Western, from £2,437,380 to £2,353,222. If now we look to the proportion that working expenses bear to gross receipts, we shall find that this year the expenses of the twelve companies, taken together, have slightly increased from 53·4 to 53·7 per cent. of the gross receipts. If we take each company separately, we shall find the working expenses bear the following proportion to the gross receipts:—Great Northern, 58·9; London and South-Western, 57·7; London, Chatham, and Dover, 57·2; Great Eastern, 55·4; Lancashire and Yorkshire, and London, Brighton, and South Coast, 54·5 each; Midland, 53·4; Manchester, Sheffield, and Lincoln, 53·2; North-Eastern, 51·3; South-Eastern, 52·3; London and North-Western, 52·1; Great Western, 51. In each case the percentage is given.

NOTES AND MEMORANDA.

IN Greater London during last week 3192 births and 1949 deaths were registered, equal to annual rates of 32·7 and 20·0 per 1000 of the population.

IN London during last week 2460 births and 1542 deaths were registered. The annual death rate from all causes, which had been 21·2 and 20·5 per 1000 in the two preceding weeks, further declined last week to 20·0.

FOR the week ending August 30th the deaths registered in 28 great towns of England and Wales corresponded to an annual death rate of 25·3 per 1000 of their aggregate population, which is estimated at 8,762,354 persons in the middle of this year. The six healthiest places were Birkenhead, Derby, Bristol, London, Huddersfield, and Portsmouth.

IT is worthy of note as a feat in animal mechanics that Mr. Nixon, of the London Tricycle Club, the week before last rode from Land's End to John o'Groats, and followed this last week by riding from London to Edinburgh under three days. He left Holborn Viaduct at 2.15 p.m. on August 28th, and reached Milne's Hotel, Edinburgh, at 1.15 p.m. on August 31st. Distance, 396 miles; daily average, 132 miles. The tricycle used is an "Imperial Club," with 46in. wheels.

A CURIOUS instance of the behaviour of lightning occurred recently, when the Artillery barracks at Nassirabad were struck. The flash struck the upper story first, passed through the wall, and injured two men. It then crossed to the other side of the building, leaving no trace of its path, but killing six men in its course out through the open door. The buildings sustained scarcely any damage, and although the men last struck were sitting in a line, the centre man escaped unhurt.

THE last census of Paris gives the population as 2,239,928 inhabitants, of whom 1,113,326 were males and 1,126,602 females. When the previous census was taken in 1876 the total was 1,988,806, so that there had been an increase of 251,122. There were 68,126 inhabited houses, and 2,075,800 of the inhabitants were French by birth, the foreigners numbering 91,872 males and 75,542 females, consisting of 45,281 Belgians, 31,190 Germans, 21,547 Italians, 20,810 Swiss, 10,789 English, 5987 Americans, and 65 Chinese.

DURING the week ending August 9th, 1884, in thirty-two cities of the United States, having an aggregate population of 6,862,300, there died 3218 persons, which is equivalent to an annual death rate of 24·4 per 1000. The rate in the North Atlantic cities was 25·6 per 1000; in the Eastern cities, 24·8; in the Lake cities, 28·8; in the River cities, 20·9; and in the Southern cities, for the whites, 18·9, and for the coloured, 34·3 per 1000. The American *Sanitary Engineer* says of the decedents over one-half, or 51·2 per cent., were under five years of age.

THERE is a hard-working electric railway in one of the main cross-cuts of the Oppel Colliery, Saxony. The cross-cut is 2365ft. long, and is the outlet for the coal mined in the vein, the quantity delivered to it being six hundred mine cars per day of sixteen hours, each car weighing loaded 1594 lb. A train of fifteen cars is moved at a speed of from nearly five to nearly seven miles per hour, the steam engine at the mouth of the shaft making from 225 to 250 revolutions during the run, lasting from three and one-half to four and one-half minutes, through the cross-cut.

THE following, from the returns of the British Iron Trade Association, gives the production of Bessemer steel ingots in the United Kingdom during the half-year ending the 30th June, 1884. The production during the first half of 1884 is compared with that for the whole of the preceding year, the statistics of the trade not having been collected for the first half of 1883. The first row of figures gives the production for the first half of 1884, and the second for the year ended 31st December, 1883, in tons.

South Wales and Monmouth	221,316	504,966
North-East Coast	164,475	285,763
Lancashire, Cheshire, &c.	81,141	304,606
West Cumberland	88,851	247,440
Sheffield	82,060	210,605

These give a total of 637,843 tons and 1,553,380 tons, so that the production to end of June was less than half of the year 1883. The production of Bessemer steel rails in the United Kingdom during the same periods was:—

South Wales	182,271	410,676
North-East Coast	105,326	142,665
Lancashire, Cheshire, &c.	45,127	245,386
West Cumberland	68,328	125,011
Sheffield	25,363	173,436

Here, again, the total for the half-year, 426,415 tons, is less than half of the 1,097,174 tons for the whole year 1883.

WHEN submitting the Baku naphtha to fractional distillation carried on at each 2 deg., Professor Mendeléeff had shown that the specific weight of the products of distillation, while rising on the whole together with temperature, decreases however three times, namely, between 55 deg. and 62 deg., between 80 deg. and 90 deg., and between 105 deg. and 110 deg. He now shows, that the same decrease of specific weights is displayed also by the American naphtha, if this last be submitted to fractional distillation at each 2 deg., and that the phenomenon is produced at nearly the same temperatures. The products that boil below 60 deg. were insufficiently represented in Professor Mendeléeff's samples; but from 60 deg.—where the specific weight, reduced to 17 deg., like all following, was 0·6642—until 124 deg.—where it was 0·7322—there are two decreases of specific weight. Thus, at 80 deg. it was 0·7347, but only 0·7069 at 92 deg., that is, the same as at 75 deg. After that it increases until 104 deg., where it reaches 0·7543; but it soon decreases for a second time, and at 115 deg. to 117 deg. it reaches 0·7270, that is, the same figure as it had between 85 deg. and 98 deg. Beyond 117 deg. it continues to rise. Both kinds of naphtha—Caucasian and American—however different their origin, thus display the same phenomena at nearly the same temperatures; the corresponding specific weights, however, are not the same; the portion at 80 deg. has, in the Baku naphtha, a specific weight of 0·7486, and only 0·7347 in the American; and at 100 deg. the respective densities are 0·7607 and 0·7380. The amounts of substance distilled at each temperature are also different. The researches will be continued in Professor Mendeléeff's laboratory.

IN a former paper to the Russian Chemical Society, Professor Mendeléeff had arrived at the conclusion, *Nature* says, that the dilatation of liquids can be expressed by the formula $V = \frac{1}{1-kt}$, where k is a module which varies for different liquids, and increases with their volatility. The researches of M. Van der Vaals, combined with the above, have enabled Messrs. Thorpe and Rücker, in the April number of the *Journal* of the London Chemical Society, to establish the remarkable relation between the absolute temperature of boiling t_1, reckoned from the absolute zero (—273 deg.), the volume V_t, measured at a temperature t, and a constant a, which seems to be near to 1·995 or 2. Now, in a communication to the Russian Chemical Society, vol. xvi., fasc. 5, Professor Mendeléef shows that, if the dilatation of gases and that of liquids be expressed by the formulæ $V_t = 1 + at$ and $V_t = \frac{1}{1-kt}$, which would give $2t_1 = \frac{1}{k} - \frac{1}{a}$, and the constant a be taken equal to 2, we receive $\frac{1}{k} = 2t_1 + 273$, where k and t_1 are determining one another. This deduction is confirmed, in fact, by direct measurements. The further progress in the mechanics of liquids, he says, must be expected from new experimental and theoretical researches into the compressibility of liquids at different temperatures and into its relations to the modulus of dilatation; the fundamental equation of liquids must express the relations between their volume, temperature, and pressure, as is the case for gases. As to a complete conception of the ideal state of bodies, it must contain also the relations to their molecular weight and composition.

MISCELLANEA.

A GOLD MEDAL has been awarded the Willesden Waterproof Paper Company at the Amsterdam Exhibition for its roofing and structural materials, with which the Exhibition buildings are, as also at the Healtheries, covered.

MR. F. BAKER, of Vyse-street, Birmingham, has been awarded a medal for his engineers' name-plates, letters, &c., at an International Exhibition which has, though it is not generally known, been held in the Crystal Palace this year.

AT the Amsterdam Exhibition, Mr. T. Corbett, of Shrewsbury, has been awarded a gold medal, two silver medals, and three bronze medals, for his cheese presses, turnip slicer, his collection of machinery, and for winnowing and turnip cutting machines.

IN our recent account of the machinery at the Health Exhibition it should have been mentioned that the fine 18in. double leather belt, transmitting the power from the 112-horse power engine by Messrs. Galloway, is made by Messrs. Hepburn and Gale.

THE Indian troopship Malabar, which leaves England on the 10th inst. with drafts for Bombay, made a two hours' full-power trial of her machinery in the Solent on the 28th ult. Her mean draught was 19ft. 11in. The mean pressure of steam in the boilers was 52 lb., and with 48 revolutions and a vacuum as high as 27⅛in., 2700-horse power was indicated and a speed of 12 knots realised.

MR. THOS. FLETCHER, F.C.S., Warrington, has made a gas-tight elastic rubber tubing. The tubing is made of two layers of rubber with pure soft tinfoil vulcanised between. It is said to be perfectly and permanently gas-tight and free from smell under all circumstances, whilst it retains sufficiently for all purposes the flexibility and elasticity of an ordinary rubber tube. A sample sent us consists of an inner white and an exterior red rubber tube, the tinfoil being between. At present it is made in lengths up to 6ft.

THE Sydney *Morning Herald* says:—"The Royal Commission which was appointed to inquire into the stability of railway bridges and the existing lines of railway—consisting of Mr. G. A. Morell, president; Mr. W. C. Kernot, Professor of Engineering at the Melbourne University; Mr. W. M. D. Courtney, C.E., M.I.C.E.; Mr. W. H. Warren, C.E., A.M.I.C.E.; and Mr. Owen Blacket, president of the Engineering Association of New South Wales—has been sitting for the last few weeks, and the commissioners have been closely engaged in the consideration of the matters referred to them for inquiry. They are now about to test some of the bridges by personal inspection."

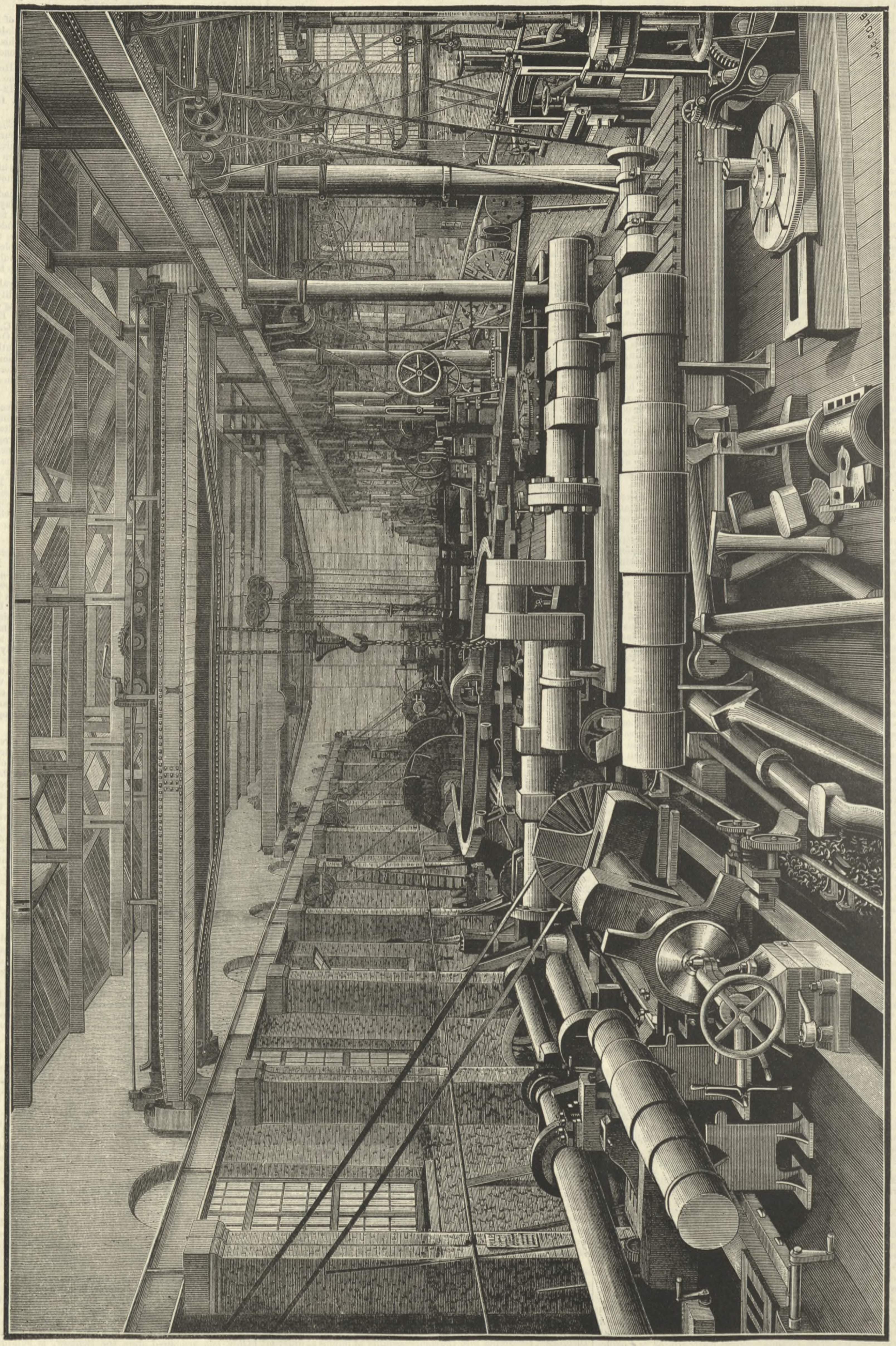
WE learn from Portland, Oregon, U.S., that the canal and locks around the cascades of the Columbia river are being constructed under the supervision of Captain Powell, United States engineer. The object is to improve the river at the minor rapids and give lockage round the principal rapids of the cascades, for stages of 20ft. of water at the foot of the canal, during the busy boating season. The plan is arranged for any extension for higher stages of the river; the canal will be about 3000ft. long. The low-water lock will have a lift of about 24ft., and the lock capacity will be 90ft. by 462ft., with a least draught of 8ft. The project for its construction was adopted by the United States Government in 1877, and modified in 1880, and a large sum has been already expended on the work.

AN American official report just published refers to improvements being effected in the port of Buenos Ayres. Nearly all the shipping from the United States, instead of anchoring in the outer roads of Buenos Ayres, now enters the Boca or port of the Rio Chuelo, a small stream which empties into the La Plata, just on the south of the city. The work of dredging the channel which leads to this port is not yet completed, but the opinion is expressed that this Boca improvement fully solves the problem of a port for Buenos Ayres. The work is being accomplished under the auspices of the national Government, and will probably be finished in the course of another year or two. The intention is to construct a basin to the northward of the north of the Rio Chuelo along the city front, with adjacent warehouses. The whole work will be a grand improvement for Buenos Ayres, whose commerce during the last 300 years has been transacted entirely by means of lighters, the cost of landing cargoes after their arrival having been greater than that of the entire ocean passage.

WRITING from Erzeroum, Turkey, Mr. Consul Everitt points out that the copper mines of Arghani Maden are very rich, and capable of producing, if properly worked, millions of okes annually. Under the present straitened circumstances of the Treasury, it is obvious that the Government is unable to expropriate an adequate sum of money for working them, and the consequence is the ruin of all those who were formerly engaged in the enterprise. The miners, though working on account of the Government, work by contract, *i.e.*, they have to dig out the ore, burn, smelt it, and hand the proceeds to the Government for the sum of 17 pias, together with 3 okes of wheat, for every 6 okes. The furnaces in which the ore is smelted were built by the Government. The metal smelted at Maden is not sufficiently pure, according to the Government test. Formerly it contained 63 per cent. copper, and the rest foreign matter; but during the last two years, a more careful process having been adopted, it has yielded from 75 per cent. to 83 per cent.; but to purify it perfectly, it has to be smelted again at Tokat.

A METHOD of painting has been patented by Mr. F. Maxwell-Lyte, F.C.S., based upon the hypothesis that the oxidation of iron and steel is much accelerated by, if not wholly due to, voltaic action. The metal to be protected is first coated with one or two primings of an oxide of a metal electro-positive to iron, upon which any of the ordinary anti-fouling or oxide paints may be applied. These latter always contain the oxide of a metal electro-negative to iron; and this oxide will consequently always be reduced, and the iron oxidised in time. The priming employed by Mr. Maxwell-Lyte is composed of oxide of zinc, or magnesia, particularly the latter; and this not only protects the iron, but keeps it from contact with the outer coat. It is claimed that something of this kind has always been used whenever painting of iron has been even partially successful; but that the guiding principle—the use, in the first place, of a material electro-positive to iron—has been overlooked. Red lead as a priming does fairly well for a time, because, though lead is electro-negative in iron, it is only slightly so. Better protection is assured by the use of a distinctly basic material.

A RETURN has been issued of the amount of shipping—tons weight of hull—estimated for and calculated to have been built from the year 1855-56 to the year 1883-84, with an appendix showing the amount of money spent for labour during the last year on ships building in the Government dockyards and by contract. Altogether, 19,279 tons weight of hull were built in the course of the last financial year, as against a total of 19,424 tons provided for in the estimates. Of these 19,279 tons, 12,864 were for ironclads and 6415 for wooden, iron, and composite vessels. Ten ironclad ships are now in progress towards completion, to say nothing of the Hero, Benbow, Agamemnon, and Ajax, which have hardly been begun. Of the others, £19,000 was spent in labour on the Anson, £31,000 on the Camperdown, £48,000 on the Collingwood, £23,000 on the Conqueror, £39,000 on the Colossus, £20,000 on the Edinburgh, £39,000 on the Howe, £44,000 on the Impérieuse, £52,000 on the Rodney, and £62,000 on the Warspite. On 27 unarmoured vessels of various classes, of which 4494 tons were built in the course of the year, £174,000 was spent in labour. Only one armoured ship, the Benbow, is building by contract. She advanced last year by 1222 tons, at a cost for labour of £95,000. Of unarmoured ships, 2843 tons were built by contract, at a cost for labour of £196,000. The total tonnage built by contract fell short of the estimate by 1259 tons; in the Government dockyard, on the other hand, the amount actually built exceeded the estimate by 1114 tons.



INTERIOR OF MACHINE SHOP, DARLINGTON FORGE.

(For description see page 176.)

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TO CORRESPONDENTS.

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

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

A. B.—*You will find all the information you want about explosives in* THE ENGINEER *for May 30th*, 1884, *page* 411.

H. E.—*You must not make a patented machine for your own use or that of a friend. If you do, you will be liable to an action. What right have you to steal the ideas of another man for your own private use?*

H. K.—*Under the new law the list would take up more space than we could devote to it. You can obtain the fullest information by applying at the Great Seal Patent-office, Southampton-buildings, Chancery-lane, London.*

H. J. W.—*Thanks. There is nothing new in the matter. The use of petroleum for making steam has been described over and over again in our columns. There are very considerable practical difficulties in the way, however, which cannot be lightly dismissed.*

E. P.—*Engine and boiler alike seem to be a bad job.* (1) *You can balance the excentric by bolting a plate of lead to it if there is room. The balance weight in the fly-wheel can be increased in the same way. The steam port ought to be open about* $\frac{1}{20}$ *of an inch when the crank is on the dead centre.* (2) *A small Giffard injector will feed at any pressure, provided it has not to lift the water more than a few inches. There must be a check valve between it and the boiler.* (3) *Your boiler is of a bad type. The only remedy we can suggest is that you should make the steam pipe terminate in a coil carried round the boiler close to the top, and perforated on the upper side with many small holes.*

CALICO PRINTING.

(*To the Editor of The Engineer.*)

SIR,—I should be glad if any readers of THE ENGINEER could inform me of the best system and makers of appliances for printing calico.

Milan, August 30th. E. C.

HEATING BUILDINGS.

(*To the Editor of The Engineer.*)

SIR,—Could some of your numerous subscribers kindly help me to find out makers of the best, most economical, and safe heating apparatuses for ordinary chapels, heated by hot air, gas, or otherwise? ENQUIRER.

Tredegar, September 2nd.

BALL-BEARINGS FOR VELOCIPEDES.

(*To the Editor of The Engineer.*)

SIR,—The manufacturers of velocipedes are, I think, entitled to the credit of having shown how ball-bearings may be made practically useful. Can any reader tell me how the balls are made? As they are sold retail at half a crown a dozen, they must be manufactured in some very simple way; but whilst they are cheap, they are very accurate. Selecting half a dozen at random, I found that the weights were respectively 7·11, 7·38, 7·63, 7·67, 7·68, 7·74 grains, the diameters being ·193, ·195, ·197, ·197, ·197, ·198 inches. R. B. P.

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THE ENGINEER.

SEPTEMBER 5, 1884.

OUTSIDE AND INSIDE CYLINDER LOCOMOTIVES.

THE relative merits of outside and inside cylinder locomotives formed a subject for controversy at a very early period in the history of railways. Bitter feuds have been fought out on paper; and at this moment the questions raised are as far as ever from a definite settlement. To the dispassionate observer the truth seems to be that one type of engine is just as good as the other. Nothing can be done by one type that cannot be accomplished by the other; and so far as the cost of repairs can be ascertained, it does not appear that there is anything to choose between them. Concerning the consumption of fuel, opinions differ, and facts for comparison are scarce and difficult to come at. It is argued by some persons that outside cylinders are harder on the road than inside cylinders, while others urge that they give a lighter running engine. So much can be said on both sides, indeed, that of late years nothing at all has been said. The whole controversy has been regarded as dead and buried, and engineers have chosen which type they pleased, with the pleasant feeling that it was impossible to prove that they had made a mistake. The deplorable catastrophe on the Manchester, Sheffield, and Lincolnshire Railway, and Major Marindin's report thereon, has once more resuscitated the dispute, and the merits of the outside cylinder engine are being again advocated with more zeal than discretion. The basis of argument is that crank axles are weaker than straight axles, and much more likely to break with disastrous results. This is, of course, a very important proposition, and demands careful consideration. The first thing to be done, however, is to make certain of facts. Is it true that crank axles are more liable to break than straight axles?

In collecting statistics on this point, it must be borne in mind that there are more inside than outside cylinder engines working in this country, and caution must be used in accepting figures. If, for example, it were proved that twice as many cranks as plain axles broke, it does not follow that this would show any superiority on the part of the plain axle, if, for instance, there were only half the number of them at work. Some persons assume that straight axles never break; this at all events is a complete mistake, and the number of broken or cracked plain axles met with on some railways is very much greater than would be supposed. This fact effectually demolishes the theory that a straight axle gives, humanly speaking, complete immunity from accident. Men are very much imposed on by their prejudices, which are often based solely on appearances, and because a crank axle *looks* as though it was weaker than a straight axle, it is quietly taken for granted that it is weaker. When iron axles were in use there was some ground for this opinion, because it was more difficult to make a crank axle sound than a straight axle; but since steel was introduced this argument ceases to have any force, and the only question to be decided is, does the shape of a crank axle and the stresses to which it is subjected make it weaker than a straight axle? Now this is really a very complex problem, and several points have to be taken into consideration in dealing with it. We may ask in the first place what breaks a crank axle or a straight axle? Both are subjected to torsional stress from the action of the steam in the cylinders, but it does not appear that this is ever sufficient to break a sound crank. The total effort due to an 18in. piston with a pressure of 150 lb. per square inch on it is about 17 tons. The moment being 13in. long, such a stress is quite incompetent to twist the crank shaft across, but it does, no doubt, spring it to an almost imperceptible extent. But the straight axle is no better off, so far as torsional stress is concerned. The strains which ultimately break axles, whether cranked or straight, come not from within the engine, if we may use the word, but from without; and they are mainly due to side strains on the wheels. Thus, in running at high speeds over points or crossings, a powerful action is frequently set up, which can only be compared to that of pinching the lower portions of the driving wheels together, which tends to raise the axle in the middle. Experience goes to show that it is useless to attempt to combat this action by brute strength. The safest, indeed the only, plan is to make the axle as elastic as possible; and this can best be accomplished by making the crank webs very thin and very broad. If an excessively stiff axle is used, the rails may be burst; but whether they actually give way or not, the permanent-way, at all events, will be submitted to violent strains and shocks, which are best avoided. To show how essential it is that crank axles should have flexibility, we may state that of two engines, one with outside and the other with inside bearings, the crank shafts of the latter will run just twice as many miles as those of the former.

Some locomotive superintendents assert that they never break straight axles. This means, of course, not that fractures do not occur, but that they never happen while an engine is running, incipient flaws always being detected in time, and that in any case the number of such fractures is extremely small. On other lines fractures are frequent, and the cause of this disparity must be sought in the conditions under which the axles are used, and in the shape given to them. It has been found, for example, that the breakage of straight axles has been almost entirely stopped by reducing their diameter in the middle—that is to say, paradoxical as it may appear, the axles have been made stronger by weakening them. The influence of collars, of the shape of the wheel seats—nay, even of the wheel itself, and the way it is dished—must all be regarded as likely to modify the results. Given enough metal, and not too much, and a proper disposition of it, it is not certain that the crank axle is weaker or more likely to fail than the straight axle; but it is easier to make mistakes in designing crank than straight axles. The relative cost of the two likewise deserves attention; but the extra cost of a crank shaft may perhaps be saved in other things. It is highly desirable that drawings of the crank and straight axles in use on British railways should be collected, with precise statistics concerning the durability of the various types illustrated. A paper embodying such information would be just the thing to read before the Institution of Civil Engineers, and would, we think, be highly appreciated.

SIR WILLIAM THOMSON'S ADDRESS.

SIR WILLIAM THOMSON is President this year of Section A—Mathematical and Physical Science—of the British Association. The address which he delivered last week in this capacity will be read with some disappointment. Those who fully understand the subjects which the speaker dealt with will note the extreme vagueness of his discourse in many important respects; while those not familiar with the problems he attacked will find that they have received no enlightenment whatever. Sir W. Thomson is an admirable lecturer, but he lacks the power of putting his thoughts on paper in terse, forcible, intelligible English. This is the more to be regretted because Sir William made certain important admissions, and put forward a new theory, roughly hewn, it is true, but hardly the less valuable or important. In another page we reproduce portions of his address which appear to be most lucid and noteworthy; and it is therefore unnecessary that we should follow him step by step here. We propose, however, to put some of his ideas into a form which may perhaps be more intelligible to the general reader than that which he has used, and to point out some of the defects in his methods which we think deserve adverse criticism.

For a very long period thoughtful men have perplexed themselves with questions concerning the ultimate constitution or nature of matter. To the untutored mind, wood is wood, stone is stone, a bar of iron is a bar of iron, and nothing more. Those whose education is more advanced, know that wood is a compound substance, consisting mainly of carbon and nitrogen. They know that a stone may be an extremely complex affair, and that a bar of iron is anything but pure metal. Yet another body of men refuse to rest content with this much knowledge, and they want to learn what oxygen and carbon are made of. In fact, they want to know what "matter" is. The chemist asserts that there are about sixty-three elements—that is to say, simple substances—that cannot be cut up or divided into other substances. Thus, for example, silver and carbon cannot be converted into anything else, although they can be combined with something else. Water can be divided into two gases, oxygen and hydrogen, but these two gases cannot be further split up. Of what are they made? Of what is silver made? A numerous body of chemists hold that the elements are composed of atoms, or excessively minute particles, and that the silver particle or atom is different from the oxygen particle, and so on. Furthermore it is held that the weights of the atoms differ, that of hydrogen, which is the lightest, being 1; that of oxygen is 16; that of chlorine 32, and so on; and it may be well here to call attention to a curious fact, namely, that elements whose weights vary as powers of eight possess many points of similarity. In other words, the atomic theory as laid down by Dalton assumes that every substance is composed of atoms; that these atoms in the same element are exactly the same, alike in size, weight, and every other property; that the atoms of any one element differ from the atoms of every other element in weight and chemical properties; and that when union takes place it must be between atom and atom, or between definite numbers of atoms—as, for example, two atoms of hydrogen combine with one of oxygen, and form water. This hypothesis was greedily accepted by chemists. It has proved so useful that almost the whole structure of modern chemistry has been built upon it. As progress was made not only in methods of thought, but in chemical and physical science, it became apparent that however convenient this atomic theory may be, it is probably not true. We cannot here stop to explain the nature of the difficulties met with in every attempt made to apply it universally of late years. At last another hypothesis has been put forward which bids fair to be that universally accepted in a few years. It is extremely simple. According to it, the ultimate atom is the same in all substances—a hydrogen atom is identical with that of oxygen or iron, and so on; the physical differences being all due to the energy of the atom. It must be admitted that physicists have been very slow to accept this theory. As we have taken pains to point out ere now in this journal, the atom of the physicist has nothing in common with that of the chemist, and he has not the trouble of reconciling difficulties which for him do not exist. Sir W. Thomson, however, has apparently given in his adhesion to this view, and he seems to have very nearly reached the point of admitting that there is nothing in the physical universe save matter and motion. The first words of his address are pregnant with this idea—"The now well-known kinetic theory of gases is a step so important in the way of explaining seemingly static properties of matter by motion, that it is scarcely possible to help anticipating in idea the arrival at a complete theory of matter, *in which all its properties will be seen to be merely attributes of motion.*" Sir William then goes on to point out that this is not a novel idea; it is at least 1800 years old. "Early last century we find in Malebranche's 'Recherche de la Verité,' the statement that 'La dureté de corps' depends on petits tourbillons" or vortices. We may add that the theory has always hitherto been rejected, save by a few, and we do not know of the existence of a modern text-book in which it is more than barely mentioned. Sir W. Thomson has now stamped the theory with his seal, and we shall probably hear more about it in future. It has already been given prominence in this journal, at a time when it required some courage to set forth so heterodox a notion. Sir William sets himself to show how it is possible that a perfectly inelastic body may behave as though it were elastic, and the illustration which he has used is about as elegant as anything to be met with in the range of science. When a heavy disc of metal is caused to rotate rapidly on its own plane, it acquires stability, as illustrated by the gyroscope, or, indeed, by a common spinning top. If a system of links be provided, each fitted with a gyroscope, then the system will behave precisely as though it were elastic if any attempt be made to alter the shape of the system. An illustration of the arrangement will be found on another page. In this way one of the great arguments urged against the matter and motion theory is set at rest, and no doubt the remainder will follow this one.

The second remarkable admission made by Sir W. Thomson refers to a proposition long since urged in our pages, namely, that the kinetic theory of gas was not satisfactory—that it was, in fact, but a convenient working hypothesis, probably very far from the truth. Nothing more heterodox in science was perhaps ever written. Yet let us hear what Sir William Thomson has to say concerning the theory now:—"It would be a very pleasant temporary resting place if we could, as it were, make a mechanical model of a gas out of little pieces of round, perfectly elastic, solid matter flying about through the space occupied by the gas, and colliding with one another and against the sides of the containing vessel. This is, in fact, all we have of the kinetic theory of gases up to the present time, and this has done for us, in the hands of

Clausius and Maxwell, the great things which constitute our first step towards a molecular theory of matter. . . . . . But alas! for our mechanical model consisting of the cloud of little elastic solids flying about among each other. . . . . . Let us, then, leave the kinetic theory of gases for a time with this difficulty unsolved. . . . . . Thus, even if the fatal fault in the theory to which I have alluded," and so on. Exit the kinetic theory of gases as taught by Clausius and Maxwell; enter the new theory—"we must look distinctly on each molecule as being either a little elastic solid or a configuration of motion in a continuous all-pervading fluid. I do not myself see how we can ever permanently rest anywhere short of this last view." So much must suffice concerning the opinions and theories which Sir William Thomson has enunciated at Montreal.

Let us now consider briefly the objections which may be taken to certain portions of his address. We have said that he was vague, and this statement refers more to the use of individual words than to the arrangement of them. Thus, for example, he actually uses the words "potential energy" possibly by a slip of the pen. He speaks of distances as being "infinitely" small. We presume that he employs the word as a superlative of very. Thus, instead of saying that a given magnitude is "very" small, he calls it "infinitely" small. This is an extremely vague and unscientific use of the term. Again, he uses the word "force" in the most surprising fashion, and without the smallest attempt at defining what he means by it. Apparently he employs it, not in Tait's sense, but simply to convey the notion of push or impulse. As a matter of fact, force of this kind, standing alone, could produce no effect whatever; because the maximum limit of the force which can be exerted is invariably and of necessity defined by the resistance. Thus, for example, the pull at one end of the drawbar of a locomotive is precisely equal to the resistance at the other end, and Pambour years ago showed that the resistance of the piston of an engine was just equal to the effort of the steam on it, and can be neither smaller nor larger. We presume that Sir William Thomson is aware that this is a natural law, yet he makes no attempt whatever to deal with it, although any kinetic or other theory of gases or matter based on the assumption that force—in the sense of push or pull—can by itself produce an effect, must be absolutely worthless. But the most astounding passages in the whole address are those in which he speaks of molecules or atoms "attracting" or "repelling" each other on the action-at-a-distance principle. It is demonstrable that if a body can attract another body, the theory of the conservation of energy must be rejected. What are we to think when we find a leader of modern scientific thought writing and speaking in this loose fashion?

We have no reason on our part to be otherwise than quite contented with Sir William Thomson's address; he has granted much that we have long since contended for; nor do we now despair of seeing the day when the misleading word "energy" will be expunged from the vocabulary of science and replaced by "motion." The change would do more toward simplifying the teaching of physical science than any other which we can think of.

THE INDUSTRIES OF SOUTH WALES.

MR. J. COLQUHOUN, F.G.S., took the past and present conditions of the industries of South Wales as the text of his presidential address, delivered at the last meeting of the Institute of Engineers of that district. As might be expected from its title, the address consisted of a review of things past, and a comparison drawn between them and things present. Certain points touched upon by Mr. Colquhoun deserve notice. Beginning his address by directing attention to the important place occupied by coal in the wealth of the district, he proceeded to point out the expediency of developing its output by every improvement attainable; he noticed many adopted of late years, in the method of working the coal, in ventilation, in sundry appliances affording greater safety to workmen, and finally in preventing disastrous accidents in mines.

Although the terrible tale of colliery explosions may fairly be regarded as a matter of national regret, yet out of evil springs good, and the very magnitude of these catastrophes has stimulated research into their causes and the best means of removing them. It requires no great effort of memory to recall the time when the frequency of colliery explosions at particular periods, occurring, as it were, in groups, was regarded with a species of superstition on the part of some, and as constituting curious examples of the operation of a supposed law of coincidences by others. Thoughtful men, however, educated in a faith in the simple principle of cause and effect, reasoned that there must be a cause for this grouping of explosions, and the result of their investigations has demonstrated that explosions depend largely for their occurrence on the rapidity with which gas can escape from the seams. Assuming the pressure tending to expel gas from the seams to be tolerably uniform, and knowing, as we do, that the barometric pressure of the atmosphere varies, it becomes evident that the rapidity with which gas will escape depends entirely on the ratio existing at a given time between the expelling pressure in the seams and that of the atmosphere opposing its expulsion. What, therefore, was formerly regarded with superstition is now known to be governed by a fixed natural law; and, therefore, especially in all fiery pits, the barometer and its indications are attentively studied, and if a reduced atmospheric pressure is observable, measures are taken to guard against the consequent extra influx of gas.

In sinking operations two remarkable examples of the successful use of improved appliances exist. For in the Aberdare Valley and in Monmouth rock drills and dynamite have been employed to such good effect that the coal was reached with a rapidity unsurpassed in South Wales. Another point touched upon in the address under notice is the necessity, for economy sake, of working large areas of coal, in consequence of the great depth of shafts and the difficulties attendant upon the haulage of the coal; and experience has shown that machinery effects this more economically than horse-power can. We presume that the economy attending on working a given area of coal mine depends upon the relations existing between the interest on the capital expended upon sinking the shaft, fitting the requisite hoisting gear, and annual cost of maintenance, and the cost of hauling the coal underground. We do not gather from Mr. Colquhoun whether any data exist such as would enable a coalmaster to judge when his mine area became so large as to render the sinking of a second shaft into the workings a less expensive process than hauling the coal underground. Indeed, on the contrary, we gather from the address that no such data exists, for we are told that nothing is certainly known as to which system of mechanical haulage is least expensive. We read that "there is a sufficient variety of mechanical haulage at work in the district to give practical results as to the best and most economical system, and the author suggests that experiments should be made to determine which of these is the best." We must observe, however, that here also the term best must be taken in a relative sense. For example, a colliery may be provided with a system of mechanical haulage more expensive to work than would be the working of some other system; but then the maxim that possession is nine points of the law may hold good here. The removal of the existing and substitution of the new method may be attended with so much direct cost, as well as with that due to interruption of business, that the hoped-for saving would vanish. Therefore, if a committee were appointed to investigate the matter, it should be instructed to examine it in all its bearings; but we fully agree with the author of the address, that inquiry into the question would be an excellent step to take.

Another point treated of was the coke trade and the growing need for devising some means of coking the small coal of steam and bituminous seams. This may be done by washing and grinding the coal. We learn one rather mortifying thing in reference to this, namely, that although the German machine for separating the different sizes of coal preparatory to its being washed, is one alike elaborate and expensive, "it is unquestionably superior to all others yet invented for removing the earthy matters from coal." Carr's disintegrator, we learn, is extensively employed to crush dry coal, but clogs if wet coal is put through it.

A remarkable increase in the output of blast furnaces is observable, for whereas not very many years ago 100 tons per week per furnace was considered large, now, by increasing the size of the furnace and the temperature of the blast, 600 to 700 tons is a usual output. We are unable, from limits of space, to notice all the heads of the address, but one or two we cannot pass over. One is the record of the extraordinary progress being made in the manufacture and use of steel. One of the latest uses to which steel has been adapted is for tin-plates, for which it is employed instead of coke bars, and its introduction is so satisfactory to the tin-plate traders that it is displacing the old material. The growth of the steel rail trade steadily increases in South Wales, and of a total make in the United Kingdom of 1,097,174 tons in 1883, that district produced 410,676 tons. In comparison with the iron rail, a saving of fuel of 67 per cent. is effected and of labour cost about 60 per cent. Of open hearth steel South Wales produces about one-fourth of the total make of the country. Now in the present dull condition of many branches of business, the figures and data supplied in such an address as the one under notice are encouraging, and go far to silence those pessimists and grumblers who delight to tell us the country has seen its best days, and nothing but poverty, if not national extinction, awaits us. At the same time, however, we are induced to consider certain things that need amending. Mr. Colquhoun observes that although a system of boiler inspection exists in South Wales and is of use, yet he also points out that the Board of Trade under the Boiler Explosions Act states that inspectors should have a better training than many of them at present possess; that they ought to have a theoretical knowledge of boiler construction, to be capable of taking rough diagrams, and be competent to make rough sketches. We are quite in accord with the Board of Trade in this, and would suggest that a system of licensing, or of granting certificates by that Department, might easily and advantageously be introduced. Under this system, which could be based upon lines resembling those existing for sea-going engineers, for mates and captains of merchant ships, candidates for employment as boiler inspectors might have it in their power to ask to be examined by a proper body constituted by the Board of Trade, and such body of examiners should have the power to grant at least two classes of certificates; the granting of such certificates to be dependent upon compliance with certain standing orders, even as with the examinations of captains, marine engineers, or pilots. In the case of coroners' inquests on deaths caused by boiler explosions, the coroner might have power to call men holding certificates as boiler inspectors to examine and report on the cases, such evidence being paid for.

We turn now to a point which in the present stagnation of business deserves some comment. The author of the address under notice told his audience that "the gross tonnage of vessels built of iron and steel in the United Kingdom during the past three years is as follows:—In 1881, 730,686; in 1882, 913,519; in 1883, 1,012,735. The number and tonnage of iron and steel vessels built during the same time for classification at Lloyd's on the Bristol Channel was: In 1881, one vessel of 179 tons; in 1882, seven vessels, or 2446; and in 1883, seventeen vessels, or 9009 tons. The number of vessels being built on 31st March, 1884, was five of steel, or 2705 tons, and seventeen of iron, or 4695 tons, Chepstow being the most important shipbuilding place. Here is a matter that deserves the attention of all who are concerned in developing our industries. Why should Bristol, a seaport whose name is almost a household word as regards seafaring, possess virtually no shipbuilding industry? It appears that the primary cause is that until the iron and steel manufacturers of the South Wales district compete with those in the North of England in their prices, and deliver the plates with equal promptitude, no ships can be built. Now, it is familiar to every one that the shipbuilding trade of the Thames is dead, and has been so for some years. The cause was not difficult to find. The expense of bringing the plates and material generally to London was high, and as the expense of living in London entailed very high-priced labour, as a matter of course the trade on the Thames could not hold its own with the Clyde. The same conditions do not, however, operate on the Bristol seaboard. It is a locality at least as provincial as the Clyde or the Tyne; therefore, labour ought not to be more expensive. It is as close, if not closer, than are the Clyde shipyards to the raw material; therefore, it may be assumed to be equally favoured, so far as transport expenses are concerned. The chief, but not the only difficulty or obstacle exists then in the price charged by the ironmasters. This is a point that in the interests, not only of individuals but of the nation, deserves investigation. If so unlucky an event took place as our being involved in a European war, we would need all the shipbuilding machinery at our disposal, and the ability to build and equip ships at a southern port might become of much importance to the nation at large. Besides this, every possible chance of enlarging our home industries deserves attention; and if any inquiry would probably discover means whereby our Welsh ironmasters could be enabled to compete in price and speed of delivery with their north-country rivals, and thus that a shipbuilding trade could be developed at Bristol, then such inquiry should be instituted. It must not be forgotten, however, that the river at Bristol, and in its neighbourhood, is not very suitable for the shipbuilding trade—a fact which Mr. Colquhoun seems to have overlooked.

LIGHTNING AND LIGHTNING PROTECTORS.

THE readers of the weather forecasts, issued by the Meteorological Office, do not always obtain much instruction, though they may be amused. What can be the good of such information as "perhaps thunder," "with thunderstorms locally," "perhaps thunder," given in the forecast for Monday week last. The present year has given us a hot, dry summer—by dry, we mean no heavy rainfall. It has been exceptional in this respect, and perhaps exceptional also in the numerous fatal accidents from lightning. The annual damage through thunderstorms is considerable, especially if loss of life and destruction of property be considered. So far as we know, there has been no systematic observation of thunderstorms in Great Britain, nor are scientific men agreed upon any method of protection. The value of lightning-rods in the protection of buildings is acknowledged, and that is all. No disinterested person feels called upon to promote a short Bill in Parliament to render protection from lightning compulsory upon landlords, as is the providing of certain sanitary apparatus. Yet it is, perhaps, difficult to understand why a man should not be allowed to poison people by means of water from contaminated wells, while he is allowed to leave his house unprotected from lightning. Professor Tait, in the last edition of the "Encyclopedia Britannica," says three things are necessary effectually to protect buildings from lightning: (1) The points should so project from the building or ship to be protected as to prevent any great development of electrical density elsewhere than on themselves; (2) they should be effectually connected with the earth; and (3) the connecting-rod ought to be so good a conductor as not to be injured even by a powerful electric discharge. The area protected by a lightning-rod is an undetermined quantity. Authorities differ very considerably in their estimation, but it may almost be taken for certain that there is no hard and fast rule. The area protected varies in each case with the conditions of the case. Further, according to various observers, thunderstorms in some countries are essentially winter phenomena; in others, they are unknown in the winter, and only occur in the summer. There is something so singularly meagre in our information about thunderstorms, that it is hoped those who have any ideas upon the subject may be sufficiently interested to express their opinions.

Let us assume that the ordinary theory as to the atmospheric conditions is correct, and that the cause of a thunderstorm is the natural discharge of two differently electrified bodies. A Leyden jar or condenser is an apparatus well known in the laboratory, and consists of two conductors separated by a non-conductor. If the conductors be connected with the poles of a battery or other source, a charge accumulates upon the opposed surfaces, the amount of accumulation depending upon the distance between the conducting surfaces and the electro-motive force of the source. The tendency of the opposed surfaces is to return to the normal condition, and if the resistance of the non-conductor be sufficiently small, or if the difference of potential between the surfaces be sufficiently great, a discharge takes place, shown by what is known as the electric spark. The essentials to this electric phenomena, then, are two opposed and charged conducting surfaces separated by a non-conductor or dielectric. In the natural phenomena, we have conducting bodies in the shape of clouds and the earth. Two clouds may be charged to different potentials, and separated by the air. They must be sufficiently distant from the earth for that to take little or no part in the phenomenon of discharge. When the distance between these clouds—or rather, when the stratum of air between the opposing surfaces—diminishes below a certain limit—that is, below a certain resistance—discharge takes place, giving rise to the phenomenon of lightning, and it may be thunder. No doubt the thunder depends for loudness not only upon the distance from the listener, but also upon the difference of potential between the opposing surfaces. If the difference is very great, a much greater resistance of air is overcome, with a greater effect in the shape of lightning intensity and noise of thunder. Undoubtedly there are constantly terrific thunderstorms in which the earth and its inhabitants are little interested. They are only concerned when the earth forms one of the active opposing surfaces. This may be the case when the two clouds are in pretty close proximity to the earth, or it may be that a cloud forms one opposing conducting body, the earth the other, when the stratum of air between is the dielectric.

It has been pointed out that the intensity of the action depends principally upon the difference of potential between these opposed surfaces. In thunderstorms this difference is always great; in violent storms it must be so great as almost to pass the bounds of our understanding. The line of discharge between these opposing surfaces is always the line of least resistance. Professor Tait contends that the person who imagines that a lightning flash begins in one place and ends in another is misled by not understanding the science of light. Returning, however, to the question of the line of least resistance. If we could have a perfectly level plain opposed to a cloud, the opposed surfaces being absolutely parallel, and the air between perfectly homogeneous, the resistance throughout would be the same, and if discharge occurred there would be no preference of one point over another, but discharge would take place over the whole surface at one and the same time. These conditions never exist. A tree upon the plain, a hillock, a house, a man, a sheep, &c., gives a line of least resistance, and through this line goes the discharge. In the majority of cases, being in the line of discharge means death to any animal. The accidents of land configuration, of cloud configuration, of position with regard to other conductors, an infinity of possibilities may bring a body into the line of least resistance, and so into a fatal position.

Accurate information about thunderstorm phenomena is wanted. When and where does the storm commence? In what direction does it travel? What is the height of the cloud? and so on. Then what is the electrical resistance of various trees at different times of the year? Some trees have far less resistance than others, and it might be perfectly safe to take shelter under one tree, but very dangerous to take shelter under another. It may be well here to specially remark—that when the earth forms one of the opposing surface—the discharge always takes place between the cloud and the earth and danger always exists. Danger cannot be completely overcome, but it may be minimised. Buildings and their contents may almost certainly be protected, preferably by inclosing them in a metallic cage, according to the suggestion of Clerk-Maxwell or M. Melsen, and, of course, having the cage in good contact with the earth. Isolated lightning rods will eventually be considered as frail protections. Suggestions as to the prevention of harm in the open must await more information. The shelter of a tree may be more dangerous than stopping in the open, or just the opposite. Men would not care to carry chain armour, and sit in a pond of water if handy—though these would give almost perfect protection. The armour, not the pond, would be at hand at the moment of danger.

The conclusion to which a careful consideration of the subject leads the enquirer, is that almost certain protection can be obtained for every building, but that no such protection can be suggested in the open. Is it not worth while then to enact that all buildings "shall be adequately protected?" A further question is, Is the existing danger great enough to make legislative interference necessary? Those who have experienced in their own homes the results of a thunderstorm will say that it is; others, perhaps, are not so well qualified to pronounce an opinion.

THE VACUUM BRAKE.

THE vacuum brake has fallen upon evil days. Testimony to its worthlessness accumulates with remarkable rapidity. Closely following on Major Marindin's report on the Penistone accident, comes another of considerable interest. In the Penistone accident the brake went on and immediately came off again. In an accident which occurred in Nottingham station on the Great Northern Railway on the 19th of July, it refused to go on at all when it was wanted. In this case, the 3 p.m. passenger train from Newark to Nottingham—consisting of engine and tender, one third-class and two composite carriages, a third-class brake carriage, one composite, and one third-class carriage, and a rear brake van—when entering the new arrival line at Nottingham at 3.49 p.m., overran the proper stopping place, and came violently into collision with the buffer stops. The engine ran up the stops, which were destroyed, and came to a stand at the edge of the retaining wall of a canal, knocking down about thirty yards of the wall. The carriages did not leave the rails, but three passengers were injured. Major Marindin, reporting on the event, says:—"This collision with buffer stops was due to a failure of the vacuum brake with which the train was fitted. There is abundant evidence that the driver stopped his train, according to rule, at the down home signals, 709 yards from the buffer-stops; that, having started again and run with steam on for about 200 yards, he shut off steam, and let his train run forward into the station at a speed of about 10 miles an hour at the outside; that he tried his vacuum brake when about 500 yards from the buffer-stops, and put it on with full power at a distance of about 100 yards from the buffer-stops. I do not think he was sufficiently prompt in taking other steps to stop his train when he found that his vacuum brake was not acting, and he was running too fast to stop by the use of the hand brakes only; but no doubt he was rather confused at the unexpected failure of the brake, which had been working properly all through the journey. There is no evidence whatever to show why the brake failed, and it is stated that no pipes or sacks were disconnected or burst, and that the brake was found to act well when tried after the accident. I can only surmise that in some way the flap of the release valve must have been open, and that consequently the opening of the ejector failed to create a vacuum. There have been previous cases of accidents arising from this cause. It would be far better to forbid the use of this continuous brake at all for the purpose of stopping at a terminal station, than to run the risk of its failing; and, as drivers are enjoined to enter terminal stations at such a speed as to be able to stop by means of the hand brakes only, they had better be told to use the hand brakes only for stopping, and to resort to the continuous brake only when they find that the train is not being pulled up properly by the hand brake." In this instance it has been impossible to make a scapegoat of the driver. It is quite well known that trains fitted with the vacuum brake constantly overrun platforms. When this does not happen at a terminal station, no harm may be done, and nothing is heard of the matter by anyone outside the official circle. The driver is fined half-a-crown, and there is an end of the thing. At terminal stations the case is different, and the results are too serious to admit of being hushed up. It has been argued that by fitting the vacuum brake with a tell-tale, all the advantages of automaticity would be secured. If an automatic brake is out of order, it goes on and stops the train, thus giving warning that it is defective. The tell-tale is intended to do the same thing another way, and inform the driver if anything is wrong. The Great Northern train in Nottingham station has, it will be seen, a tell-tale, which just served to deceive the driver. He said in his evidence, which was amply corroborated, "We left Newark a little late, and we had to stop at Radcliffe and Colwick. I used the brake to stop with on both these occasions, and it acted properly. I stopped also at the home signal at Nottingham, according to rule. I stopped with the vacuum brake, and it acted properly there. I stopped dead just for a moment; the signal was off. I started again immediately, putting on steam, which I kept on for about 200 yards. There is a slight fall into the station, but I generally keep steam on for about 200 yards. When I shut steam off, I was running about ten miles an hour. When about 20 yards further, I tried the vacuum, and the tell-tale came all right. I let the train run further, nearly as far as the end of the arcade, until I wanted the brake to stop, when I found I had no power. I said to my mate, 'Hold on all you can, as I can't get the brake on.' I held the ejector open for some seconds, and finding I could get no power, I let go the ejector, reversed the engine and opened the regulator. But then I was at the stops, and I struck them when running about four miles an hour. . . . After standing for about fifteen minutes after the collision, I tried the vacuum, keeping the ejector on for full half-a-minute, and I succeeded in getting 10in. of vacuum." We do not think it is necessary to add a word of comment. The facts speak for themselves.

WAGES IN THE IRON TRADE.

IRONMASTERS in the several districts wherein ironworkers' wages are determined by the arrangements come to between the two sections of the Iron Trade Wages Board of South Staffordshire, may now enter upon negotiations with the assurance that for another two months at least no alteration will be made in the rate of wages now ruling. The rating is upon the basis of 7s. 3d. per ton for puddling. At such a figure the scale was fixed until the 23rd of last month by the arbitrator of the Board, notwithstanding that in the district dominated by the Northern Arbitration Board the rate was 6s. 9d. The 6d. difference is quite regular. Ten years back the employers on the Staffordshire Board admitted that to that extent their ironworkers were worse off than the northern ironworkers, who were paid extras unusual in the South. But the northern wages because of a further drop are now 6s. 6d. When, therefore, the 23rd ult. came, the southern employers sought the removal of the disadvantage in which the reduction of the 3d. per ton placed them. Before the arbitration came on, the northern masters, still suffering from continued reductions in the prices realised for finished iron, gave notice for a further drop in wages. In both districts the men met their masters face to face. They sought a rise of wages. This was the position when, on Monday last, the Staffordshire Board appeared before their arbitrator in Birmingham. The further notice of the employers in the North, while it had strengthened the case of the South, had yet somewhat altered it. If there should soon be another drop in the North, it were well that there should rather be one drop of 6d. than two of 3d. So they told the arbitrator that they were prepared to continue to pay the present scale, till the most recent notice affecting the northern trade has been arbitrated, and they volunteered that the consideration of their own notice should be deferred for two months. Their determination removes all excuse for the accusation by the men that between the masters in the two districts the game of battledore and shuttlecock is kept up to the disadvantage of labour. Labour was never more considerately treated by capital, and seldom has the working of industrial arbitration and conciliation been seen to greater advantage.

MINING ACCIDENTS IN CLEVELAND.

A VERY useful work is being done by the Miners' Association in Cleveland—the recording and tabulation of accidents in mines, both fatal and non-fatal. The Association has published a record of the accidents for the first six months of the present year. In that time, there were three fatal accidents—against seventeen in the first half of the past year. Of minor accidents there were 435—an increase of forty-five on the numbers for the corresponding half-year. These accidents took place at twenty-four distinct mines. Of the three fatal accidents, one was caused by a fall of ironstone, and two to men "caught with stone whilst barring"—using the crow bar. Of the minor or non-fatal accidents, the numbers vary from one in a mine in the six months to as high as 112; but in the latter case it is the largest and most productive mine, as well as the oldest. These minor accidents include many that are far from serious, some of the injured men returning to work after eight or ten days' absence, whilst in other cases the accident caused absence from work for more than as many weeks. It is noticeable, too, that where the cause of the accident is given, "fall of stone" is that which is the most frequently assigned; whilst a "fall of balk," or timber, is also a cause of many accidents. It is only by the careful tabulation of the causes and the nature of the accidents that there can be precautions taken against their recurrence. In the cases of fatal accident there is an enquiry that is full and ample; but there has not hitherto been so great care taken in regard to the "minor" accidents, and the recording and analysis of these should be of value in the future. If all the miners' associations would follow the same plan, and if they would impress upon their members the cautions which some of the teachings of these records suggest, there might be a not inconsiderable fall in the number of accidents recorded in the future. It is evident, too, that the work could be better done by an organisation than by the efforts of isolated mine-owners, and thus it is best left in the hands of the men.

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STEPS TOWARDS A KINETIC THEORY OF MATTER.

By Professor Sir WILLIAM THOMSON.*

THE now well-known kinetic theory of gases is a step so important in the way of explaining seemingly static properties of matter by motion, that it is scarcely possible to help anticipating in idea the arrival at a complete theory of matter, in which all its properties will be seen to be merely attributes of motion. If we are to look for the origin of this idea, we must go back to Democritus, Epicurus, and Lucretius. We may then, I believe, without missing a single step, skip 1800 years. Early last century we find in Malebranche's "Recherche de la Verité," the statement that "La dureté de corps" depends on "petits tourbillons." These words, imbedded in a hopeless mass of unintelligible statements of the physical, metaphysical, and theological philosophies of the day, and unsupported by any explanation, elucidation, or illustration throughout the rest of the three volumes, and only marred by any other single sentence or word to be found in the great book, still do express a distinct conception, which forms a most remarkable step towards the kinetic theory of matter. A little later we have Daniel Bernoulli's promulgation of what we now accept as a surest article of scientific faith—the kinetic theory of gases. He, so far as I know, thought only of the Boyle's and Marriot's law of the "spring of air," as Boyle called it, without reference to change of temperature, or the augmentation of its pressure if not allowed to expand for elevation of temperature—a phenomenon which perhaps he scarcely knew, still less the elevation of temperature produced by compression, and the lowering of temperature by dilatation, and the consequent necessity of waiting for a fraction of a second or a few seconds of time—with apparatus of ordinary experimental magnitude—to see a subsidence from a larger change of pressure, down to the amount of change that verifies Boyle's law. The consideration of these phenomena forty years ago by Joule, in connection with Bernoulli's original conception, formed the foundation of the kinetic theory of gases as we now have it. But what a splendid and useful building has been placed on this foundation by Clausius and Maxwell, and what a beautiful ornament we see on the top of it in the radiometer of Crookes, securely attached to it by the happy discovery of Tait and Dewar, that the length of the free path of the residual molecules of air in a good modern vacuum may amount to several inches. Clausius' and Maxwell's explanations of the diffusion of gases, and of thermal conduction in gases, their charmingly intelligible conclusions that in gases the diffusion of heat is just a little more rapid than the diffusion of molecules, because of the interchange of energy in collisions between molecules, while the chief transference of heat is by actual transport of the molecules themselves, and Maxwell's explanation of the viscosity of gases, with the absolute numerical relations which the work of those two great discoverers found among the three properties of diffusion, thermal conduction, and viscosity, have annexed to the domain of science a vast and ever-growing province.

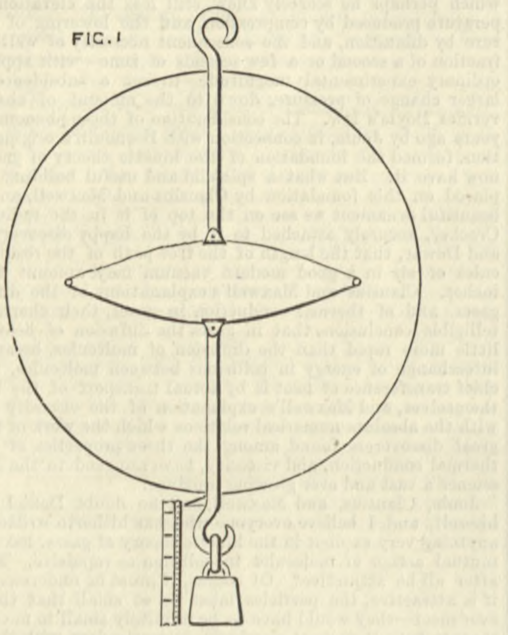
Joule, Clausius, and Maxwell, and no doubt Daniel Bernoulli himself, and I believe everyone who has hitherto written or done anything very explicit in the kinetic theory of gases, has taken the mutual action of molecules in collision as repulsive. May it not after all be attractive? Of course, it must be understood that, if it is attractive, the particles must be so small that they hardly ever meet—they would have to be infinitely small to never meet—that, in fact, they meet so seldom, in comparison with the number of times their courses are turned through large angles by attraction, that the influence of these purely attractive collisions is preponderant over that of the comparatively very rare impacts from actual contact. Thus, after all, the train of speculation suggested by Davy's "Repulsive Motion" does not allow us to escape from the idea of true repulsion, does not do more than let us say it is of no consequence, nor even say this with truth, because, if there are impacts at all, the nature of the force during the impact and the effects of the mutual impacts, however rare, cannot be evaded in any attempt to realise a conception of the kinetic theory of gases. And, in fact, unless we are satisfied to imagine the atoms of a gas as mathematical points endowed with inertia, and, as according to Boscovich, endowed with forces of mutual positive and negative attraction, varying according to some definite function of the distance, we cannot avoid the question of impacts, and of vibrations and rotations of the molecules resulting from impacts, and we must look distinctly on each molecule as being either a little elastic solid or a configuration of motion in a continuous all-pervading liquid. I do not myself see how we can ever permanently rest anywhere short of this last view; but it would be a very pleasant temporary resting place on the way to it if we could, as it were, make a mechanical model of a gas out of little pieces of round, perfectly elastic, solid matter, flying about through the space occupied by the gas, and colliding with one another and against the sides of the containing vessel. This is, in fact, all we have of the kinetic theory of gases up to the present time, and this has done for us, in the hands of Clausius and Maxwell, the great thing which constitute our first step towards a molecular theory of matter. Of course, from it we should have to go on to find an explanation of the elasticity and all the other properties of the molecules themselves—a subject vastly more complex and difficult than the gaseous properties, for the explanation of which we assume the elastic molecule; but without any explanation of the properties of the molecule itself, with merely the assumption that the molecule has the requisite properties, we might rest happy for a while in the contemplation of the kinetic theory of gases, and its explanation of the gaseous properties, which is not only stupendously important as a step towards a more thoroughgoing theory of matter, but is undoubtedly the expression of a perfectly intelligible and definite set of facts in nature. But alas for our mechanical model consisting of the cloud of little elastic solids flying about amongst one another! Though each particle have absolutely perfect elasticity, the end must be pretty much the same as if it were but imperfectly elastic. The average effect of repeated and repeated mutual collisions must be to gradually convert all the translational energy into energy of shriller and shriller vibrations of the molecule. It seems certain that each collision must have something more of energy in vibrations of very finely divided nodal parts than there was of energy in such vibrations before the impact. The more minute this nodal subdivision, the less must be the tendency to give up part of the vibrational energy into the shape of translational energy in the course of a collision, and I think it is rigorously demonstrable that the whole translational energy must ultimately become transformed into vibrational energy of higher and higher nodal subdivisions if each molecule is a continuous elastic solid. Let us, then, leave the kinetic theory of gases for a time with this difficulty unsolved, in the hope that we, or others after us, may return to it armed with more knowledge of the properties of matter, and with sharper mathematical weapons to cut through the barrier which at present hides from us any view of the molecule itself, and of the effects other than mere change of translational motion which it experiences in collision. To explain the elasticity of a gas was the primary object of the kinetic theory of gases. This object is only attainable by the assumption of an elasticity more complex in character, and more difficult of explanation, than the elasticity of gases—the elasticity of a solid. Thus, even if the fatal fault in the theory, to which I have alluded, did not exist, and if we could be perfectly satisfied with the kinetic theory of gases founded on the collisions of elastic solid molecules, there would still be beyond it a grander theory which need not be considered a chimerical object of scientific ambition—to explain the elasticity of solids.

If we could make out of matter devoid of elasticity a combined system of relatively moving parts which, in virtue of motion, has the essential characteristics of an elastic body, this would surely be, if not positively a step in the kinetic theory of matter, at least a finger-post pointing a way which we may hope will lead to a

* British Association: Abstract of President's address, Section A.

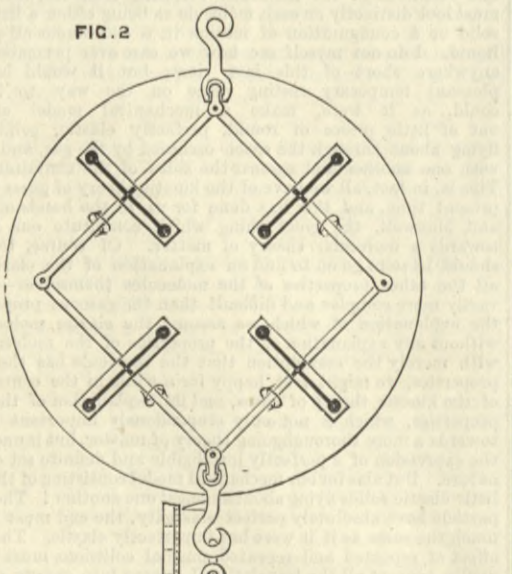
kinetic theory of matter. Now this, as I have already shown, we can do in several ways. In the case of the last of the communications referred to, of which only the title has hitherto been published, I showed that, from the mathematical investigation of a gyrostically dominated combination contained in the passage of Thomson and Tait's "Natural Philosophy" referred to, it follows that any ideal system of material particles, acting on one another mutually through massless connecting springs, may be perfectly imitated in a model consisting of rigid links jointed together, and having rapidly rotating fly-wheels pivotted on some or on all of the links. The imitation is not confined to cases of equilibrium. It holds also for vibration produced by disturbing the system infinitesimally from a position of stable equilibrium and leaving it to itself. Thus we may make a gyrostatic system such that it is in equilibrium under the influence of certain positive forces applied to different points of this system; all the forces being precisely the same as, and the points of application similarly situated to, those of the stable system with springs. Then, provided proper masses—that is to say, proper amounts and distributions of inertia—be attributed to the links, we may remove the external forces from each system, and the consequent vibration of the points of application of the forces will be identical. Or we may act upon the systems of material points and springs with any given forces for any given time, and leave it to itself, and do the same thing for the gyrostatic system; the consequent motion will be the same in the two cases. If in the one case the springs are made more and more stiff, and in the other case the

FIG. 1



angular velocities of the fly-wheels are made greater and greater, the periods of the vibrational constituents of the motion will become shorter and shorter, and the amplitudes smaller and smaller, and the motions will approach more and more nearly those of two perfectly rigid groups of material points, moving through space and rotating according to the well-known mode of rotation of a rigid body having unequal moments of inertia about its three principal axes. In one case the ideal nearly rigid connection between the particles is produced by massless exceedingly stiff springs; in the other case it is produced by the exceedingly rapid rotation of the fly-wheels in a system which, when the fly-wheels are deprived of their rotation, is perfectly limp. The drawings—Figs. 1 and 2—before you illustrate two such material systems.* The directions of rotation of the fly-wheels in the gyrostatic system—Fig. 2—are indicated by directional

FIG. 2



ellipses, which show in perspective the direction of rotation of the fly-wheel of each gyrostat. The gyrostatic system—Fig. 2—might have been constituted of two gyrostatic members, but four are shown for symmetry. The inclosing circle represents in each case in section an inclosing spherical shell to prevent the interior from being seen. In the inside of one there are fly-wheels, in the inside of the other a massless spring. The projecting hooked rods seem as if they are connected by a spring in each case. If we hang any one of the systems up by the hook of one of its projecting rods, and hang a weight to the hook of the other projecting rod, the weight, when first put on, will oscillate up and down, and will go on doing so for ever if the system be absolutely unfrictional. If we check the vibration by hand, the weight will hang down at rest, the pin drawn out to a certain degree; and the distance drawn out will be simply proportional to the weight hung on, as in an ordinary spring balance. Here, then, out of matter possessing rigidity, but absolutely devoid of elasticity, we have made a perfect model of a spring in the form of a spring balance. Connect millions of millions of particles by pairs of rods such as these of this spring balance, and we have a group of particles constituting an elastic solid; exactly fulfilling the mathematical ideal worked out by Navier, Poisson, and Cauchy, and many other mathematicians who, following their example, have endeavoured to found a theory of the elasticity of solids on mutual attraction and repulsion between a group of material particles. All that can possibly be done by this theory, with its assumption of forces acting according to any assumed law of relation to distance, is done by the gyrostatic system. But the gyrostatic system does, besides, what the system of naturally acting material particles cannot do; it constitutes an elastic solid which can have the Faraday magneto-optic rotation of the plane of polarisation of light; supposing the application of our solid to be a model of the luminiferous ether for illustrating the undulatory theory of light. The gyrostatic model spring balance is arranged to have zero moment of momentum as a whole, and therefore to contribute nothing to the Faraday rotation; with this arrangement the model illustrates the luminiferous ether in a field unaffected by magnetic force. But now let there be a different rotational velocity imparted to the jointed square round the axis of the two projecting hooked rods, such as to give a resultant moment of momentum round any given line through the centre of inertia of the system, and let pairs of the hooked rods in the model thus altered, which is no longer a model of a mere spring balance, be applied as connections between millions of pairs of particles as before, with the lines of resultant moment of momentum all similarly directed. We now have a model elastic solid which will have the property that the direction of vibration in waves of rectilinear vibrations propogated through it shall turn round the line of propagation of the waves, just as Faraday's observation proves to be done by the line of vibration of light in a dense medium between the poles of a powerful magnet. The case of wave front perpendicular to the lines of resultant moment of momentum—that is to say, the direction of propagation being parallel to these lines—corresponds, in our mechanical model, to the case of light travelling in the direction of the lines of force in a magnetic field.

Imagine a solid bored through with a hole, and placed in our ideal perfect liquid. For a moment let the hole be stopped by a diaphragm, and let an impulsive pressure be applied for an instant uniformly over the whole membrane, and then instantly let the membrane be dissolved into liquid. This action originates a motion of the liquid relatively to the solid, of a kind to which I have given the name of "irrotational circulation," which remains absolutely constant, however the solid be moved through the liquid. Now, imagine the whole liquid to be enclosed in an infinitely large, rigid, containing vessel, and in the liquid, at an infinite distance from any part of the containing vessel, let two perforated solids, with irrotational circulation through each, be placed at rest near one another. The resultant fluid motion due to the two circulations will give rise to fluid pressure on the two bodies, which, if unbalanced, will cause them to move. The force systems—force and torques, or pairs of forces—required to prevent them from moving will be mutual and opposite, and will be the same as, but opposite in direction to, the mutual force systems required to hold at rest two electro-magnets fulfilling the following specification. The two electro-magnets are to be of the same size and shape as the two bodies, and to be placed in the same relative positions, and to consist of infinitely thin layers of electric currents in the surfaces of solids possessing extreme diamagnetic quality—in other words, infinitely small permeability. The distribution of electric current on each body may be any whatever which fulfils the condition that the total current across any closed line drawn on the surface once through the aperture is equal to a $\frac{1}{4}\pi$ of the circulation through the aperture in the hydro-kinetic analogue. It might be imagined that the action at a distance thus provided for by fluid motion could serve as a foundation for a theory of the equilibrium, and the vibrations, of elastic solids, and the transmission of waves like those of light through an extended quasi-elastic solid medium. But unfortunately for this idea, the equilibrium is essentially unstable, both in the case of magnets, and, notwithstanding the fact that the forces are oppositely directed, in the hydro-kinetic analogue also, when the several movable bodies—two or any greater number—are so placed relatively as to be in equilibrium. If, however, we connect the perforated bodies with circulation through them in the hydro-kinetic system, by jointed rigid connecting links, we may arrange for configurations of stable equilibrium. Thus without fly-wheels, but with fluid circulations through apertures, we may make a model spring balance, or a model luminiferous ether, either without or with the rotational quality corresponding to that of the true luminiferous ether in the magnetic fluid; in short, do all by the perforated solids with circulations through them that we saw we could do by means of linked gyrostats. But something that we cannot do by linked gyrostats we can do by the perforated bodies with fluid circulation: we can make a model gas. The mutual action at a distance, repulsive or attractive according to the mutual aspect of the two bodies when passing within collisional distance of one another, suffices to produce the change of direction of motion in collision, which essentially constitutes the foundation of the kinetic theory of gases, and which, as we have seen before, may as well be due to attraction as to repulsion, so far as we know from any investigation hitherto made in this theory.

There remains, however, as we have seen before, the difficulty of providing for the case of actual impacts between the solids, which must be done by giving them massless spring buffers, or, which amounts to the same thing, attributing to them repulsive forces sufficiently powerful at very short distances to absolutely prevent impacts between solid and solid; unless we adopt the equally repugnant idea of infinitely small perforated solids, with infinitely great fluid circulations through them. Were it not for this fundamental difficulty, the hydro-kinetic model gas would be exceedingly interesting; and, though we could scarcely adopt it as conceivably a true representation of what gases really are, it might still have some importance as a model configuration of solid and liquid matter, by which without elasticity the elasticity of a true gas might be represented. But lastly, since the hydro-kinetic model gas with perforated solids and fluid circulations through them fails because of the impacts between the solids, let us annul the solids and leave the liquid performing irrotational circulation round vacancy, in the place of the solid cores which we have hitherto supposed; or let us annul the rigidity of the solid cores of the rings and give them molecular rotation according to Helmholtz's theory of vortex motion. For stability the molecular rotation must be such as to give the same velocity at the boundary of the rotational fluid core as that of the irrotationally circulating liquid in contact with it, because, as I have proved, frictional slip between two portions of liquid in contact is inconsistent with stability. There is a further condition, upon which I cannot enter into detail just now, but which may be understood in a general way when I say that it is a condition of either uniform or of increasing molecular rotation from the surface inwards, analogous to the condition that the density of a liquid, resting for example under the influence of gravity, must either be uniform or must be greater below than above for stability of equilibrium. All that I have said in favour of the model vortex gas composed of perforated solids with fluid circulations through them holds without modification for the purely hydro-kinetic model, composed of either Helmholtz cored vortex-rings or of coreless vortices, and we are now troubled with no such difficulty as that of the impacts between solids. Whether, however, when the vortex theory of gases is thoroughly worked out, it will or will not be found to fail in a manner analogous to the failure which I have already pointed out in connection with the kinetic theory of gases composed of a little elastic solid molecules, I cannot at present undertake to speak with certainty. It seems to me most probable that the vortex theory cannot fail in any such way, because all I have been able to find out hitherto regarding the vibration of vortices, whether cored or coreless, does not seem to imply the liability of translational or impulsive energies of the individual vortices becoming lost in energy of smaller and smaller vibrations. As a step towards kinetic theory of matter it is certainly most interesting to remark that in the quasi-elasticity, elasticity looking like that of an india-rubber band, which we see in a vibrating smoke ring launched from an elliptic aperture, or in two smoke rings which were circular, but which have become deformed from circularity by mutual collision, we have in reality a virtual elasticity in matter devoid of elasticity, and even devoid of rigidity, the virtual elasticity being due to motion, and generated by the generation of motion.

* In Fig. 1 the two hooked rods seen projecting from the sphere are connected by an elastic coach spring. In Fig. 2 the hooked rods are connected one to each of two opposite corners of a four-sided jointed frame, each member of which carries a gyrostat, so that the axis of rotation of the fly-wheel is in the axis of the member of the frame which bears it. Each of the hooked rods in Fig. 2 is connected to the framework through a swivel joint, so that the whole gyrostatic framework may be rotated about the axis of the hooked rods in order to annu the moment of momentum of the framework about this ax sdue to rotation of the fly-wheels in the gyrostat.

LOCOMOTIVE RUNNING SHED, TAFF VALE RAILWAY, CARDIFF.*

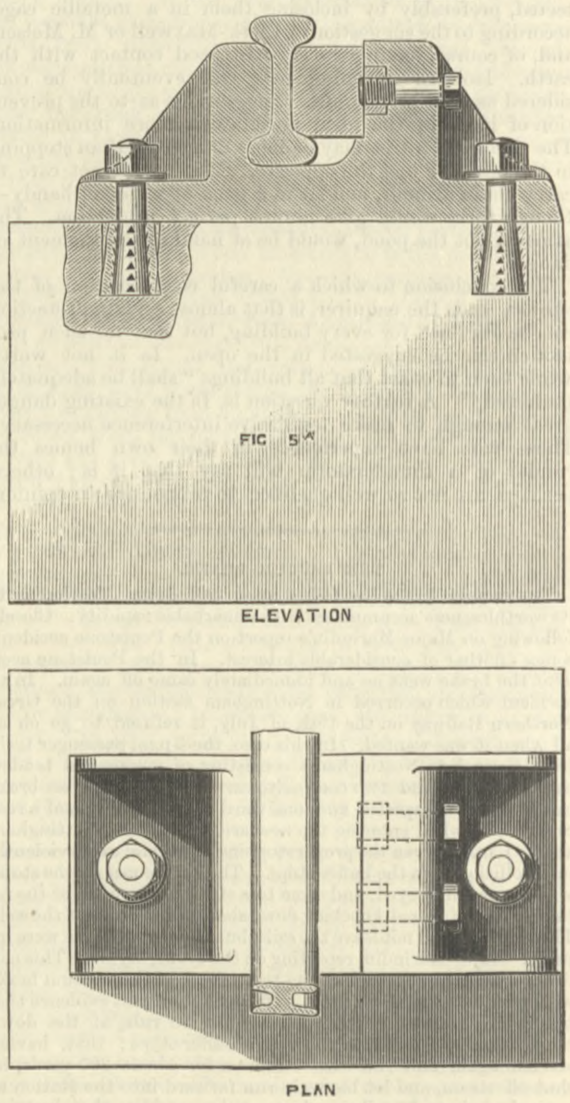
By Mr. C. H. Riches.

The large increase during the past few years in the traffic of the Taff Vale Railway made it necessary to remove the Cardiff engine shed from the Cardiff terminus to Cathays. The arrangements of the new shed, with its adjacent yard and appurtenances, are shown in the accompanying drawings, Figs. 1 and 2.

Main shed.—The main shed is built to accommodate sixty large tender engines, and is 383ft. long inside the walls, Fig. 1. It comprises two spans of 67ft. each, divided by a centre wall, which is supported by elliptic arches, resting upon brick pillars, Fig. 2. There are five roads under each span, making ten in all. Midway in the length of the shed is placed a steam traverser, 40ft. long, which works at the floor level right across both spans of the shed, so as to remove engines from any one of the ten roads. The pits are numbered from No. 1, on the eastern side of the shed, up to No. 10, on the western side. The same numbers hold good for the corresponding lines of road throughout the entire length of the shed—that is to say, both north and south of the traverser; and the length of the shed is divided into six divisions or tiers of berths. Commencing from the ten pairs of outlet doors at the north end, the first berth is lettered A; consequently, the ten engines against the doors will be in berths 1 A to 10 A. The next tier of berths is lettered B; and so on to F, the last at the south end, which is invariably used for "day-in" engines. This plan of berthing the engines of each "booked train" enables the men to find their engines at once when they come on duty, and obviates delay, which otherwise would inevitably arise in so large a shed.

Engine pits.—The main pits are 3ft. 6in. deep, and extend throughout the entire length of the shed, excepting under the traverser. In all the pits there are drains at intervals of 46ft. 10in., each of which is trapped with a syphon box; underneath the box is a sump, 2ft. square and 3ft. deep, for the purpose of catching

CHAIR FOR TURNTABLE RACE



PLAN

any refuse; and the drain pipes lead away at a height of 2ft. from the bottom of the sump. In every alternate space between the pits there is a water main, with hydrants at every 37ft. 6in. These are covered with cast iron frames, having a small lifting flap for the insertion of the stand pipe, which keeps the hose clear of the floor; and when not in use, the whole falls flush with the floor. All the hydrants have screwed plugs, and are of course duplicates of one another, as shown half full size in Fig. 3. Between all the roads the floor of the shed is pitched with firebrick set on edge. At the berths at the south end, called the "day-in" tier, pieces of hard wood are let into the pitching alongside each road, for placing lifting jacks upon; and along the wall at the south end of the shed, adjoining these berths, are the fitters' benches.

Workshops and offices.—Across the south end, and covered by continuations of the same roofs, are placed the workshops and offices, Fig. 1. The coppersmiths' shop, G, entered through the end wall at the south-west corner, is 19ft. 6in. wide and 19ft. 3in. high to the eaves. Adjoining this come the boiler shop, H, and smiths' shop, also entered from the main shed, near the longitudinal centre wall; these two shops together occupy the end of the western span. In the eastern span, and having also an entrance from the shed, comes the machine shop, K, in the corner of which is placed the chief foreman's office, I; then the passage for the workmen's entrance, J, and finally a tier of timekeepers' offices. The southern extension of the main roof is 30ft., and consequently all these shops have an equal width, as shown in the plan, Fig. 1. The offices on the eastern side of the entrance passage are two in number; the one, L, nearest the shed being for the train-booking timekeeper, and the other, M, for those taking enginemen's "trips" and shedmen's tickets. Adjoining the latter, but covered by a lean-to roof, is a trainmen's waiting-room, N, where the men remain to give their

* Paper read before the Institution of Mechanical Engineers, at Car

LOCOMOTIVE RUNNING AND REPAIR SHOPS, TAFF VALE RAILWAY, CARDIFF.

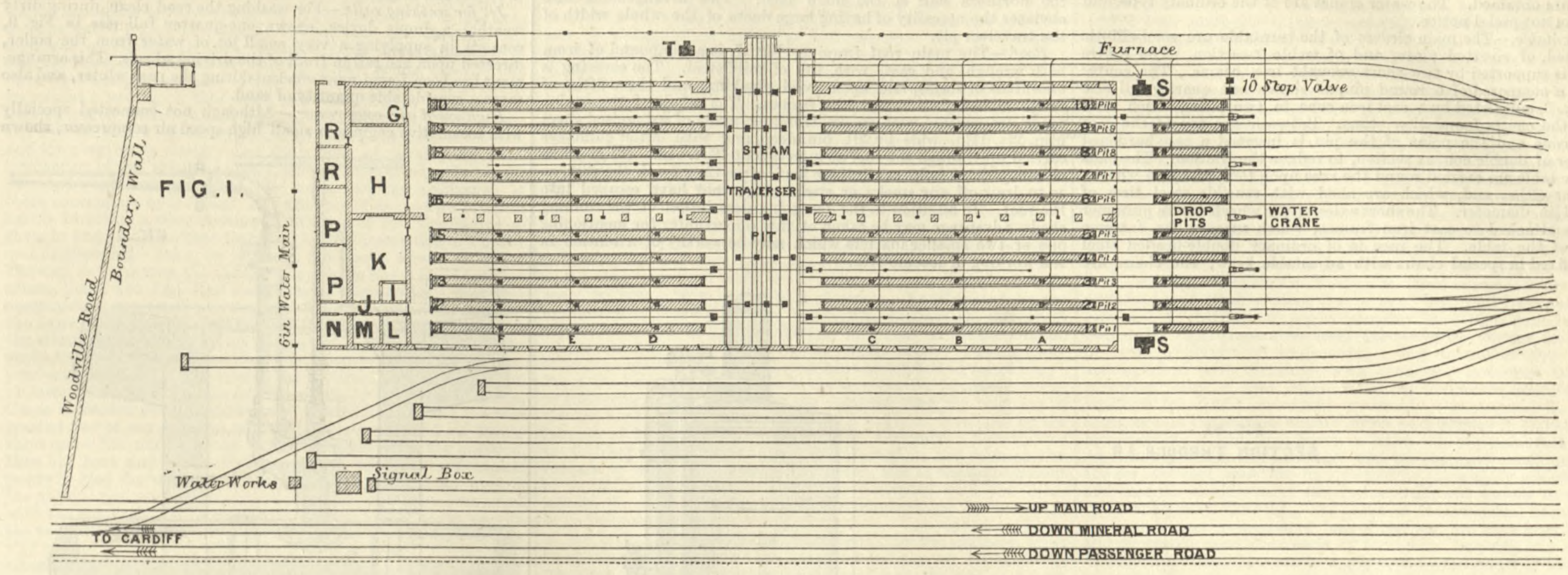
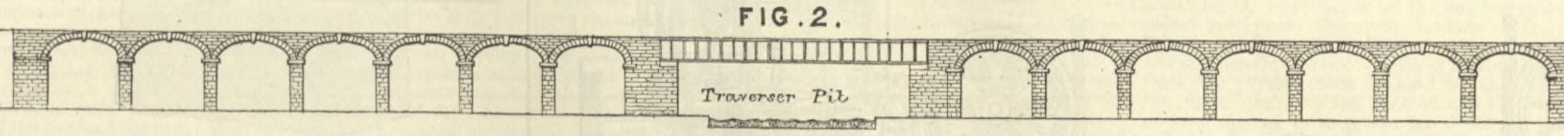
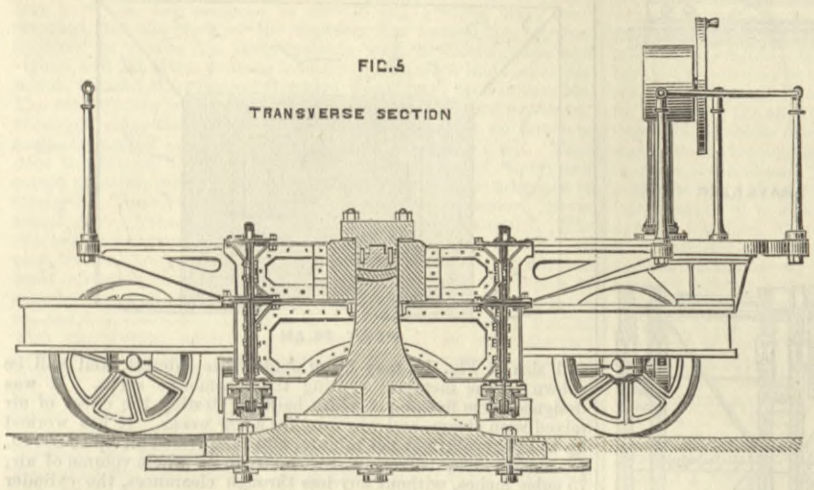
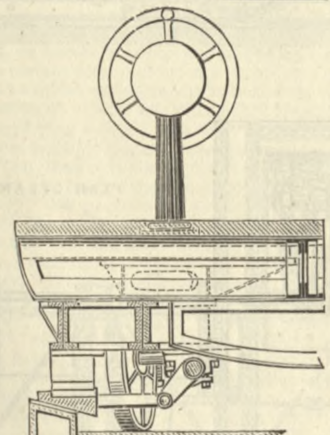
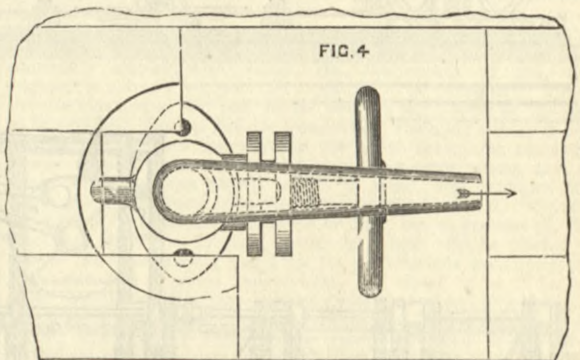


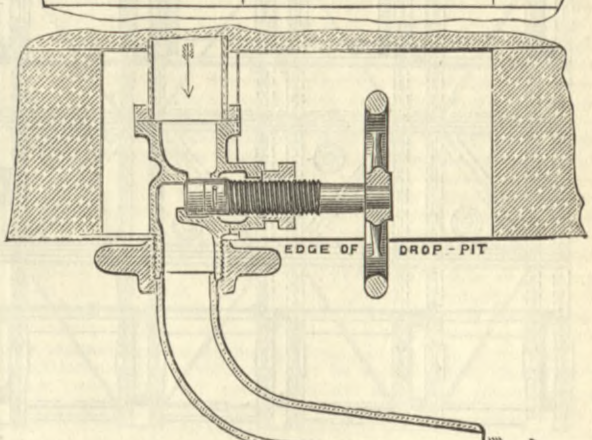
FIG.2.

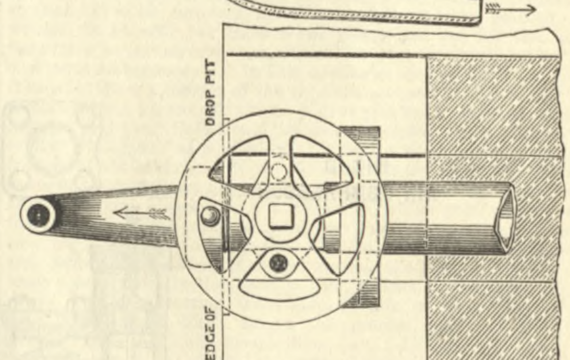


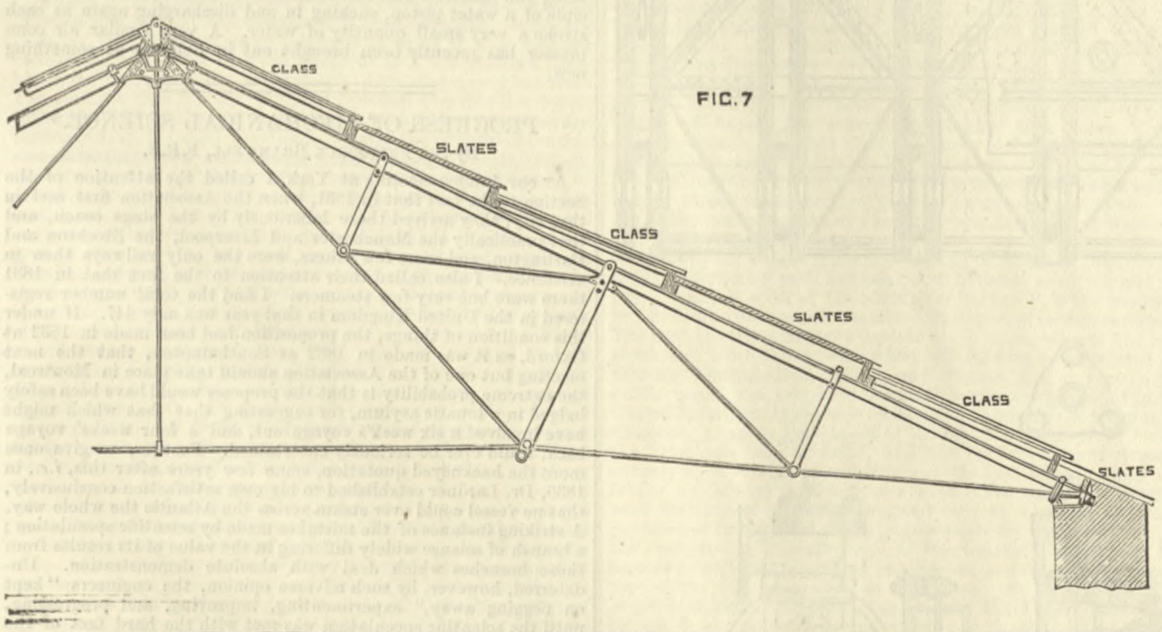


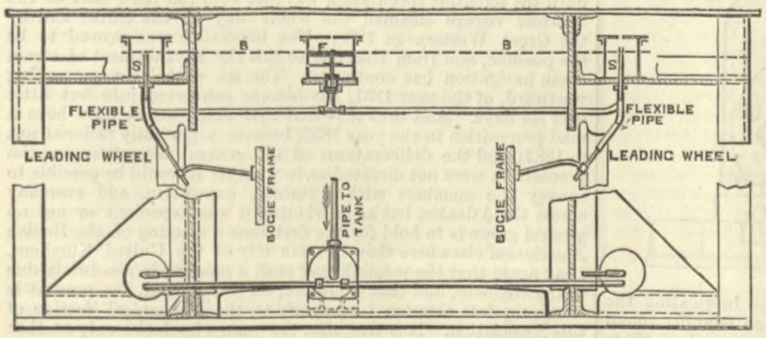


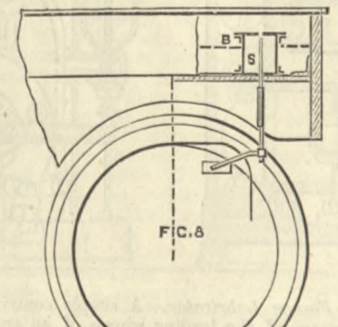


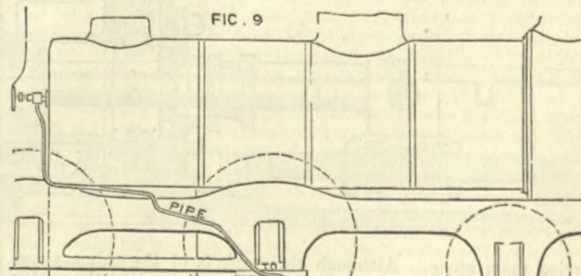












"trips" off, and await orders for trains. The lean-to roof extends across the whole south end of the shed, and under it are placed two long mess-rooms, P, of 30ft. length and 14ft. 6in. width, and also the stationary engine and boiler-houses, R, Fig. 1. The lighting of the shed is by gas, but it is intended to light the yard and approaches by electricity.

Drop pits.—Outside the shed at the northern or outlet end the ten roads lead to separate drop pits, each of which has a large syphon drain, fitted with similar sumps to those in the shed; and with water jets so arranged as to enable the men, when dropping fire, to set them at any angle, as shown full size in Fig. 4, and throw the water into the ash pan without the use of flexible hose. Adjoining the drop pits are erected two double-fire furnaces, for lighting the engines; and there is also a third by the doors of the traverser. On the further side of the drop pits are five water cranes, placed between alternate pits, and each capable of supplying two roads.

Yard.—Passing out into the yard, there are cross-over roads with compound shunts, so arranged as to lead the engines out from any of the ten shed roads to the six main running lines that lead from the yard, or to the main coal stage roads. There are three junctions to get from the yard to the main line. The coal stage has a double platform, with a road for the wagons in the centre, and a road on the outside of either platform for the engines. The platforms are 133ft. 3in. long, and each is fitted with three coal cranes and nine tumbler buckets for working.

Sand drying.—Between the coal cranes are placed tanks for containing dried sand, and in close proximity to the coal stage there is a sand-drying kiln. This has three furnaces, and the flues are so arranged as to heat 406 square feet of drying platform, which is made of fire-brick. The sand is first thrown in through doors in the front of the kiln, ranged above the stoke-plates, and is there received upon an inclined iron slide, the bottom end of which rests upon the front edge of the kiln; any excess of moisture in the sand runs down the slide and is at once converted into steam. The sand from the slide is cast and spread out upon the kilns, and in process of drying is gradually worked by hand across to the delivery side, where, when dry, it is cast upon a sloping screen, and the fine sand passing through is taken to the tanks upon the coal stage, the rough refuse being thrown out.

Water supply.—The water used at this shed is pumped up from a well by means of a Tangye "special" pump, which delivers it into a cast iron tank, supported by wrought iron girders that rest upon a stone building. The bottom of the tank is 25ft. above the ground. The well is 53ft. depth, of which 7ft. is subsoil, 9ft. gravel, and 37ft. marl. From this depth about 7000 gallons per hour are obtained. The water cranes are of the ordinary type, and require no special notice.

Turntable.—The main girders of the turntable are semi-elliptic inverted, of rivetted plate, and of treble T-section. The centre piece is supported by two short wrought iron beams. The centre pivot is composed of a round pin, as shown one quarter full size in Fig. 5, supported by a cast iron cone in two parts, which rests upon the centre foundation stone. Between the top of the cast iron cone and the point of the pin is inserted a case-hardened washer of double convex section, to reduce the friction. The ends of the table are carried round the race upon four cast iron wheels, two at either end, which are shod with crucible steel tires of 2ft. 11⅝in. diameter. The short axles of the wheels run in plummer blocks attached to cast iron frames, which support the extreme ends of the table. The race is of ordinary double-headed steel rails, fixed in special chairs with adjustable keys; the chairs are carried upon stone. Although this table is of the ordinary construction, it works so well without any cog gearing that the author thought the mention of it might be of interest.

Traverser.—The main frames of the traverser, Fig. 6, are composed of eighteen pairs of double-headed steel rails, laid transversely, and joined together by angle iron and wrought iron plate both diagonally and transversely, with cast iron distance pieces intervening, the whole rivetted together both top and bottom, thus forming a broad shallow box girder, upon which are laid the the bridge rails that carry the locomotive. This box girder is formed for a width of 9ft. 9in.; but the double-headed rails are made to extend a distance of 3ft. 10in. beyond on either side; and to these are attached the cast iron bearing blocks, which carry the axles of the traverser wheels. On the western side these rails are still further extended, so as to form a platform, upon which are carried the boiler and engines that work the machine. Upon the same side the axles of the bearing wheels are prolonged, so as to attach to them cog-wheels, into which gear the main pinions of the driving engines, Fig. 6. The driving engines are a pair of 8in. cylinders, with 12in. stroke; they have a suitable vertical boiler. In working across the shed, the traverser runs into the western side recess, Fig. 1, which enables engines to be taken out of the building without passing through the northern half of the main shed. This arrangement also obviates the necessity of having large doors of the whole width of the traverser pit.

Roof.—The main roof framing, Fig. 7, is a compound of iron, both wrought and cast, with ties of mild steel. The covering is two-fifths of slates, laid upon wood planking, and three-fifths of rough ribbed glass in cast iron frames. The whole of the engine roads are covered with smoke trunking, made of galvanised sheet iron, 2ft. 11in. wide by 3ft. 5in. deep, and with outlet chimneys carried up through the roof at intervals of 35ft. 8in. All of these chimneys have holes cut in them just before they reach the roof, so as to draw off any smoke or steam which may have escaped into the roof. In addition to the foregoing description of the running sheds, advantage may be taken of this opportunity for mentioning one or two smaller matters which may be worthy of attention in the working of locomotives.

FIG. 6A
SECTION THROUGH AB

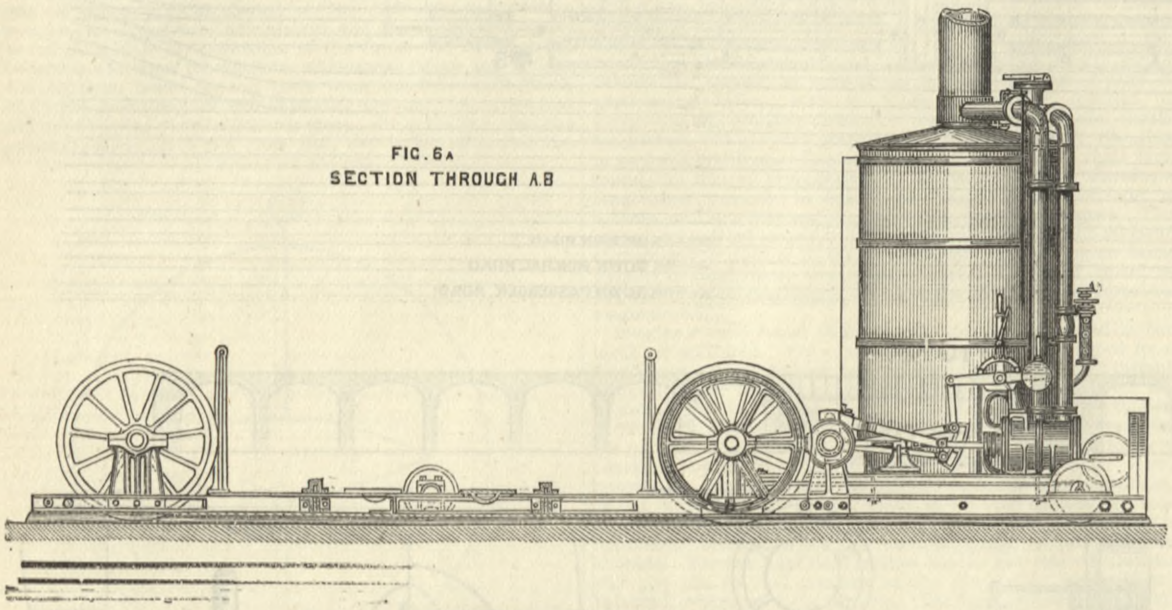


FIG. 6
PLAN STEAM TRAVERSER

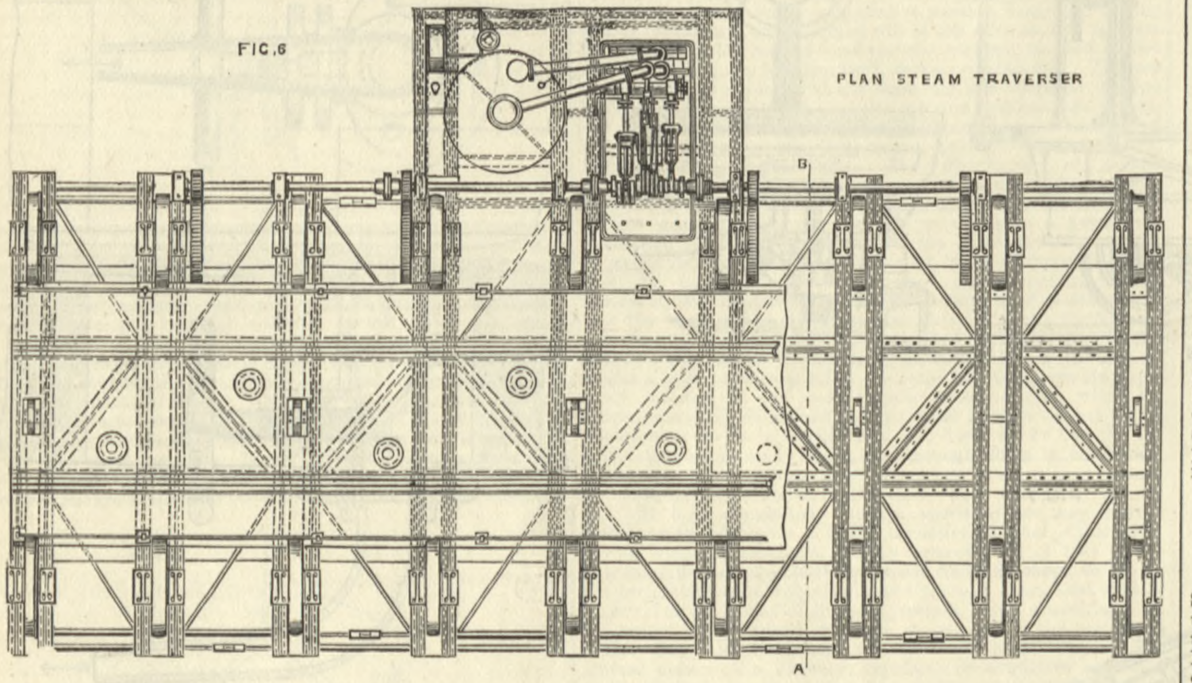
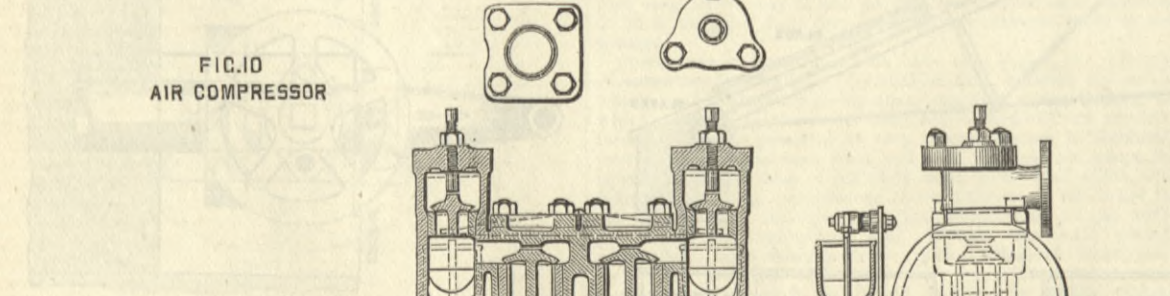


FIG. 10
AIR COMPRESSOR

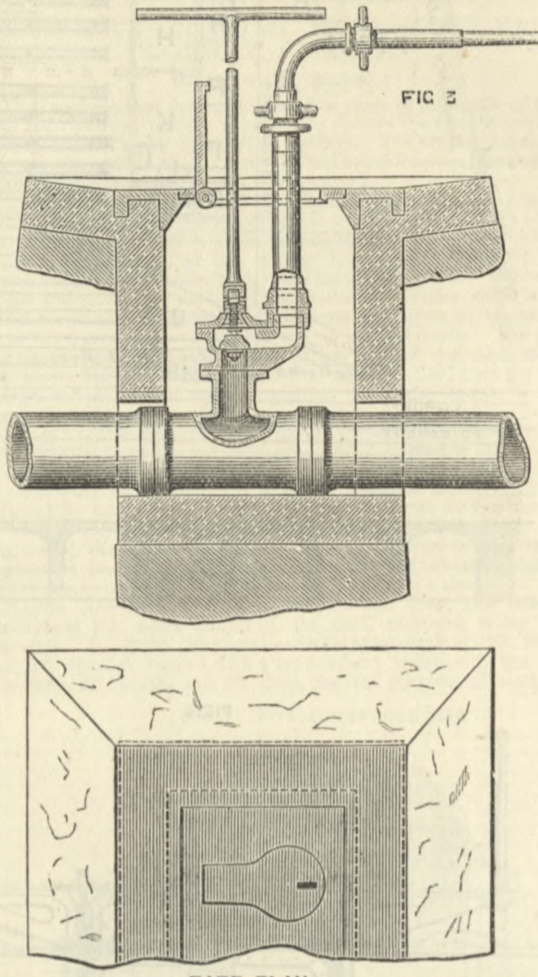


Flange Lubricator.—A simple contrivance for lubricating the flanges of the leading wheels of an engine when running round curves is shown half full size in Fig. 8. It is composed of three small vessels, one placed on either side, and the third in the centre of the leading end of the engine, under the foot-plate. The middle vessel is a closed tank, which is connected with both the others by means of a ⅜in. copper pipe. It is also connected with the tender or feed-water tank by another pipe, on which is arranged a small inlet valve I, worked by a float F in the vessel; and this float admits water up to a certain level B only. In each of the two side vessels is fixed a small syphon S, the top of which stands at a certain height above the ordinary water level B, so that no water will flow out through the syphon unless the water level is raised above its top. From the syphon a pipe passes down to deliver the overflowing water on the flange of the leading wheel. To put the apparatus into working order, water is poured into all three vessels until it rises to a height B, at which the float F closes the inlet valve I. When the engine is running round a curve, the centrifugal force causes the water to flow towards the outside of the curve, where it rises in the vessel at that side, and flows over the top of the syphon, and down to the flange. This continues till the engine leaves the curve; when the water will resume a uniform level in all three vessels, and the float F will drop and admit a supply to bring the level up to its normal height.

Jet for washing rails.—For washing the road clean during dirty weather, a simple device, shown one-quarter full size in Fig. 9, consists in supplying a very small jet of water from the boiler, directed upon the rail in front of the driving wheels. This arrangement has been found most efficient during the past winter, and also saves a considerable quantity of sand.

High-speed air compressor.—Although not connected specially with locomotive engines, a small high-speed air compressor, shown

FIG. 9



PART PLAN

full size in Fig. 10, may be of some little interest, and will be shown to the members visiting the locomotive shops. It was designed some five or six years back for testing the effect of air mixed with steam, and was used for a few weeks. It has worked up to 120 revolutions per minute, and compressed air up to 250 lb. per square inch, delivering at each stroke its whole volume of air, 75 cubic inches, without any loss through clearances, the cylinder being 4in. diameter and 6in. stroke. It is constructed on the principle of a water piston, sucking in and discharging again at each stroke a very small quantity of water. A very similar air compressor has recently been brought out in Belgium as something new.

PROGRESS OF MECHANICAL SCIENCE.*

By SIR FREDERICK BRAMWELL, F.R.S.

AT our Jubilee meeting at York, I called the attention of the Section to the fact that in 1831, when the Association first met in that city, they arrived there laboriously by the stage coach, and that practically the Manchester and Liverpool, the Stockton and Darlington, and some few others, were the only railways then in existence. I also called their attention to the fact that in 1831 there were but very few steamers. I find the total number registered in the United Kingdom in that year was only 447. If under this condition of things, the proposition had been made in 1832 at Oxford, as it was made in 1882 at Southampton, that the next meeting but one of the Association should take place in Montreal, the extreme probability is that the proposer would have been safely lodged in a lunatic asylum, for suggesting that that which might have involved a six week's voyage out, and a four weeks' voyage back, could ever be seriously entertained. Further, to give once more the hackneyed quotation, some few years after this, *i.e.*, in 1836, Dr. Lardner established to his own satisfaction conclusively, that no vessel could ever steam across the Atlantic the whole way. A striking instance of the mistakes made by scientific speculation; a branch of science widely differing in the value of its results from those branches which deal with absolute demonstration. Undeterred, however, by such adverse opinion, the engineers "kept on pegging away," experimenting, improving, and progressing, until the scientific speculation was met with the hard fact of the Atlantic voyage steamed the whole way by the Sirius and by the Great Western in 1838. The impossible was proved to be the possible, and from that day to this the advancement of steam ocean navigation has continued. The six weeks' voyage, sailing westward, of the year 1831, has become converted into but little over six days. And thus it is that that which would have been a mad proposition in the year 1832, became a perfectly rational one in 1882; and the deliberations of the general committee on the proposition were not directed as to whether it would be possible to convey the members with certainty, expedition, and economy across the Atlantic, but as to whether it was expedient or not on general grounds to hold for the first time a meeting of the British Association elsewhere than in some city of the United Kingdom. I say again that the possibility of such a meeting is absolutely due to the engineer, and that therefore, on this ground, the present is an appropriate occasion to magnify G, the Mechanical Section of this Association. It is true that the man who looks only at that which is on the surface may say, "You arrogate too much to yourselves. You ignore—to which I say Heaven forbid!—the skill and daring of your sailors. You ignore commercial enterprise. You ignore the development of iron and steel manufacture, which have enabled you to build the steamers of the present day. You ignore the increased output of the best steam coal in the world, and you attribute the whole result to the engineer." Such an objector would be in the condition of that man who, in answer to George Stephenson's question, "What is causing that railway train to move?" said, "Why, I suppose the coal that is burning in the locomotive;" and who was met by that grand and comprehensive answer, that it was the "Sun," for the coals were a consequence, and not a first cause. Similarly I venture to say that the mechanical engineer may lay claim to be the central source which has

* Presidential address, Mechanical Section. British Association at Montreal.

vivified and given rise to the improvements in the manufacture of iron and steel, in the construction of engines, and in the development of our collieries. There are those I know who object that Section G deals too little with pure science, too much with its applications. It may be, as the members of Section G might retort, that it is possible to attend so much to pure science as to get into the unchecked region of scientific speculation, and that had the members of Section G been debarred from the application of science, the speculation of Dr. Lardner might to the present day have been accepted as fact. I have quoted it before, but it has so important a bearing on this point, and comes from a man of such high authority, that I cannot refrain from once more giving you Dr. Tyndall's views on this question. "The knowledge of nature, and the progressive mastery over the powers of nature, imply the interaction of two things—namely, thought conceived and thought executed; the conceptions of the brain, and the realisation of those conceptions by the hand. The history of the human intellect hardly furnishes a more striking illustration of this interaction of thought and fact than that furnished by the Association of Physics and Engineering. Take, for instance, the case of steam. Without knowing its properties, the thought of applying steam could not have arisen, hence the first step was physical examination. But that examination suggested practice, and the steam engine at last saw the light; thus experimental physics was the seedling from which the steam engine sprang. But the matter did not end here. The positions of debtor and creditor were soon reversed, for the stupendous operations of the steam engine forced men of thoughtful philosophic minds to inquire into the origin of the power of steam. Guess succeeded guess, inspiration succeeded inspiration; the ever present fact of our railways, and our power looms, and our steamships gave the mind no rest until it had answered the question, How are heat and steam, its instruments, related to mechanical power? Had the works of the engineer not preceded the work of the natural philosopher, this question would never have been asked with the emphasis, nor pursued with the vigour, nor answered with the success which have attended it. It was the intellectual activity excited by the work which the civil engineers of England had accomplished that gave to philosophy the theory of the conservation of energy, including the dynamical theory of heat. . . . The engineering genius of the future is certain to derive from this theory strength and guidance. Thus necessarily has thought originated fact, and fact originated thought. In the development of science these two powers are coequal; each in turn ceasing to be a consequence, and becoming a creative cause. The Atlantic cable also had its small beginnings in the laboratory of the physical inquirer. Here, as before, experimental physics led the way to engineering facts of astounding magnitude and skill. But here also the positions of debtor and creditor have been reversed, for the work of the engineer has caused the physical inquirer to pursue his investigations with a thoroughness and vigour, and has given to those investigations a scope and magnitude which, without the practical stimulus, would have been impossible. The consequence is that the practical realisation of sending electric messages along the bottom of the Atlantic has been an immense augmentation of our knowledge regarding electricity itself. Thus does the human intelligence oscillate between sound theory and sound practice, gaining by every contact with each an accession of strength. These two things are the soul and body of science. Sever sound theory from sound practice, and both die of atrophy. The one becomes a ghost and the other becomes a corpse." I think all men, even although they be followers of science in its purest and most abstract form, must agree that these words are words of sound sense, well worthy of being borne in mind and of being acted on, and will, therefore, concur in the propriety of Section G dealing with engineering subjects generally as well as with abstract mechanical science. Once admitting this, I may ask—certain what the answer must be—whether there is any body of men who more appreciate and make greater use of the applications of pure science than do the members of this Section. Surely every one must agree that we engineers are those who make the greatest practical use not only of the science of mechanics but of the researches and discoveries of the members of the other Sections of this Association.

Section A: Mathematical and Physical Science.—The connection between this Section and Section G is most intimate. With any ordinary man I should have referred, in proof of this intimate connection, to the fact that the president of A this year is a member of the Council of the Institution of Civil Engineers; but when I remind you that it is Sir William Thomson who fills this double office, you will see that no deduction such as I have hinted at can be drawn from his dual functions, because the remarkable extent and versatility of his attainments qualify him for so many offices, that the mere fact of his holding some one double position is no certain evidence of the intimate connection between the two. But setting aside this fact of the occupancy of the chair of A by a civil engineer, let us remember that the accomplished engineer of the present day must be one well grounded in thermal science, in electrical science, and for some branches of the profession in the sciences relating to the production of light, in optical science and in acoustics; while, in the other branches, meteorological science, photometrical science, and tidal laws are all important. Without a knowledge of thermal laws, the engineer engaged in the construction of heat motors, whether they be the steam engine, the gas engine, or the hot air engine, or engines depending upon the expansion and contraction under changes of temperature of fluids or of solids, will find himself groping in the dark; he will not even understand the value of his own experiments, and therefore will be unable to deduce laws from them; and if he make any progress at all, it will not guide him with certainty to further development, and it may be that he will waste time and money in the endeavour to obtain results which a knowledge of thermal science would have shown him were impossible. Furnished, however, with this knowledge, the engineer starting with the mechanical equivalent of heat, knowing the utmost that is to be attained, and starting with the knowledge of the calorific effect of different fuels, is enabled to compare the results that he obtains with the maximum, and to ascertain how far the one falls short of the other. He sees even at the present day that the difference is deplorably large, but he further sees in the case of the steam engine that which the pure scientist would not so readily appreciate, and that is how a great part of this loss is due to the inability of materials to resist temperature and pressure beyond certain comparatively low limits; and he thus perceives that unless some hitherto wholly unsuspected, and apparently impossible, improvement in these respects should be made, practically speaking, the maximum of useful effect must be far below that which pure science would say was possible. Nevertheless, he knows that within the practical limits great improvements can be made; he can draw up a debtor-and-creditor account, as Dr. Russell and myself have done, and as has been done by Mr. William Anderson, the engineer, in the admirable lecture he gave at the Institution of Civil Engineers in December last, "On the Generation of Steam and the Thermo-dynamic Principles Involved." Furnished with such an account, the engineer is able to say, in the language of commerce, I am debtor to the fuel for so many heat units; how, on the credit side of my account, do I discharge that debt? Usefully I have done so much work, converted that much heat into energy. Uselessly I have raised the air needed for combustion from the temperature of the atmosphere to that of the gases escaping by the chimney; and he sets himself to consider whether some portion of the heat cannot be abstracted from these gases and be transmitted to the incoming air. As was first pointed out by Mr. Anderson, he will have to say a portion of the heat has been converted into energy in displacing the atmosphere, and that, so far as the gaseous products of the coal are concerned, must, I fear, be put up with. He will say, I have allowed more air than was needed for combustion to pass through the fuel, and I did it to prevent another source of loss—the waste which occurs when the combustion is imperfect; and he will begin to direct his attention to the use of gaseous or of liquid fuel, or of solid fuel reduced to fine dust, as by Crampton's process, as in these conditions the supply may be made continuous and uniform, and the introduction of air may be easily regulated with the greatest nicety. He will say, I am obliged to put among my credits—loss of heat by convection and radiation, loss by carrying particles of water over with the steam, loss by condensation within the cylinder, loss by strangulation in valves and passages, loss by excessive friction or by leakage; and he will as steadily apply himself to the extinction or the diminution of all such causes of loss, as a prudent Chancellor of the Exchequer would watch and cut down every unproductive and unnecessary expenditure. It is due to the guidance of such considerations as these that the scientific engineer has been enabled to bring down the consumption of fuel in the steam engine, even in marine engines such as those which propelled the ship that brought us here, to less than one-half of that which it was but a few years back. It is true that the daily consumption may not have been reduced, that it may be even greater, but if so it arises from this, that the travelling public will have high speed, and at present the engineer, in his capacity of naval architect, has not seen how—notwithstanding the great improvements that have been made in the forms of vessels—to obtain high speed without a large expenditure of power. I anticipate from the application of thermal science to practical engineering, that great results are before us in those heat motors, such as the gas engine, where the heat is developed in the engine itself. Passing away from heat motors, and considering heat as applied to metallurgy: From the time of the hot blast to the regenerative furnace, it is due to the application of science by the engineer that the economy of the hot blast was originated, and that it has been developed by the labours of Lowthian Bell, Cowper, and Cochrane. Equally due to this application are the results obtained in the regenerative furnace, in the dust furnace of Crampton, and in the employment of liquid fuel, and also in operations connected with the rarer metals, the oxygen furnace and the atmospheric gas furnace, and, in its incipient stage, the electrical furnace. To a right knowledge of the laws of heat, and to their application by the engineer, must be attributed the success that has attended the air refrigerating machines, by the aid of which fresh meat is at the end of a long voyage delivered in a perfect condition; and to this application we owe the economic distillation of sea water by repeated ebullitions and condensations at successively decreasing temperatures, thus converting the brine that caused the Ancient Mariner to exclaim, "Water, water everywhere, nor any drop to drink," into the purest of potable waters, and thereby rendering the sailor independent of fresh water storage. With respect to the application by the engineer of electrical science, it is within the present generation that electricity has passed from the state of a somewhat neglected scientific abstraction into practical use:—First, by the establishment of the land telegraph, then by the development into the submarine cable, by means of which any one of us visitors here in Canada may be in instant communication with his own country, and may be so without a selfish exclusive occupation of the cable, for once more the application of science has solved that apparently impossible problem of employing a single wire to be at one and the same time the transmitter of multiple electric messages, and messages in opposite directions. Then, thanks to the application of Faraday's great discovery of induced electricity, there has been, during the last quarter of a century, the progressive development of the dynamo machine, whereby the energy of ordinary motors, such as steam engines, is converted into electrical energy, competent to deposit metals, to—as has already been said—fuse them, to light not only isolated buildings, but extensive areas of towns and cities, and to transmit power to a distance, whether for manufacturing purposes or for the railway or tramcar; and thus the miracle is peformed of converting a waterfall into a source of light, as at Sir William Armstrong's house, or into the origin of power for a railway, as at the Giant's Causeway. To the application of electrical science is due the self-exciting of the dynamos and the construction of secondary batteries, enabling a development of electricity to be continued for many hours. In the United Kingdom, general electric lighting, that is to say, the lighting of large sections of a town from a central station, has been stopped by the most unwise, because most unjust, conditions imposed by the Government General Electric Lighting Act of 1882. A new and meritorious industry, which should have been granted the same privileges as are accorded to other industrial undertakings needing parliamentary powers, was subjected to this most unjust condition: that at the end of twenty-one years the public authority of the town or place lighted should have the option of buying the undertaking for the then value of the mere materials, and that if the authority did not choose to purchase—for it was not bound to buy—at every subsequent five-year period this option should re-arise; that is to say, that a new undertaking, which would require years for its general acceptance—for the public is slow to take up a novelty—was, after the experimental and non-paying stage had been passed, to be practically forthwith taken away for a mere fraction of the capital that had been outlaid if the undertaking paid, but was not to be taken away if it did not pay. Such, in spite of the teaching of Section F, is the condition to which our Government has arrived in respect of economic science. The next electrical matter I have to touch upon, that of the telephone and microphone, with which will for ever be associated the names of Graham-Bell, Edison, and Hughes, has, as regards the public use of the telephone, been all but similarly treated in the United Kingdom. It has been declared to be within the telegraphic monopoly given by Parliament to the Post-office nine years before the telephone was invented, and the power to use it depends entirely upon the grace and favour of the Post-office, a grace and favour not always accorded; and even when accorded, coupled with limitations as to distance, and coupled with a condition of payment of 10 per cent. of the gross receipts by the companies to the Post-office as a royalty; and all this because Government has become a trader in electrical intelligence, and fears the competition of the telephone with its telegraphs. No one in the ship-loving countries of England, Canada, and the United States can refrain from feeling the warmest interest in all connected with navigation, and we know how frequently, alas! the prosperous voyage across the wide and fathomless ocean ends in shipwreck and disaster when the wished-for shore is approached, and when the sea is comparatively shallow. Except for the chance of collision, there is, in a staunch ship, little danger in the open ocean, but on nearing the shore, not only is the liability to collision increased, but shoals and sunken rocks render navigation perilous, and it is on the excellence of the lighthouses and lightships, that—coupled with soundings—the sailor relies. These structures and appliances are confided to the engineer, and to be efficient they require him to be able to apply the teachings of Section A in optical science, and in the case of fogs, or as regards buoys at night time, the science of sound. I parenthetically alluded to soundings as one—indeed, a principal one—of the safeguards of ships when approaching shore. It is important in these days of high speeds that these should be made with ease and without the necessity of stopping the ship, or even of diminishing its velocity. Sir William Thomson, by the application of the science of pneumatics, has enabled this to be done. Again, most important is it that the compass, midst all the difficulties attendant upon its being situated on an iron or steel structure, should be trustworthy. And here Sir William has applied the science of magnetism in his improved compass to the practical purposes of navigation. To go to another important branch of engineering—water supply. The engineer dealing with a district to be fed from the surface will find himself very deficient if he have not the power of applying the science of meteorology to the work that he has in hand; he must know, not the average rainfall, for that is of but little use to him, but the maximum, and most important of all, the minimum rainfall over a consecutive period of years: the maximum so that he may provide sufficient channels and by-washes for floods; the minimum so as to provide sufficient storage. He must know what are the losses by evaporation, what are the chances of frost interfering with his filters and with his distributive plant. Coming to the mathematical side of Section A—whether we consider the naval architect preparing his design of a vessel to cleave the waves with the least resistance at the highest speed, or whether we consider the unparalleled series of experiments of that most able Associate of Naval Architects, the late William Froude, carried out as they were by means of models which were admirable in their material, their mode of manufacture with absolute accuracy to the desired shape, and their mode of traction and of record, we must see that both architect and experimenter should be able to apply mathematical science to their work, and that it is in the highest degree desirable that they should possess, as Froude did, those most excellent gifts, science and practical knowledge. Again, the mathematical side of Section A has to be applied by engineers when considering the strength and proportion of boilers, ships, bridges, girders, viaducts, retaining walls, and in short the whole of the work with which an engineer is entrusted. Notable instances of great bridges will occur to all our minds, especially meeting as we are in this Continent of grand streams, Eads' St. Louis Bridge, Roebling's Niagara Bridge, and his and his sons' East River Bridge, Gzowski's International Bridge, and going back to our own land, Fowler and Baker's Bridge over the Forth.

Passing from Section A to Section B, there is evidently so much overlapping of these sections that a good deal that I have said in reference to Section A might properly have been reserved for Section B. The preparation from the ore of the various metals is in truth a branch of engineering; but to enable this to be accomplished with certainty, with economy, involving the not throwing away of that which is called the waste product, but which is frequently a valuable material, it is essential that the engineer and the chemist should either be combined in one and the same person, or should go hand in hand. In the manufacture of pig iron it is absolutely necessary that the chemical constituents of the ore, the fuel, and the flux should be thoroughly understood, and that the excellence of the process followed should be tested by an analysis of the slag. For want of this chemical knowledge thousands upon thousands of tons of bad pig iron have been made, and thousands upon thousands of tons were formerly left in the issuing slag. Similar remarks apply to the production of lead and of copper from the ores, and still more do they apply to that great metallurgical manufacure of the last few years—"steel." In the outset steel was distrusted because of the uncertainty of its behaviour, but the application of chemical science now enables the manufacturer to produce with precision the material required to fulfil the physical tests imposed by the engineer. Reverting to the water engineer, the chemist and the microscopist have their sciences applied to ascertain the purity of the intended source, and as in the case of Clark's beautiful process, by the application of chemistry, water, owing its hardness to that common cause, carbonate of lime, is rendered as soft as the water from the mountain lake. Taking that other branch of engineering commonly coupled with water, viz., the supply of gas, the engineer is helpless without the application of chemistry. From the examination of the coal to be used, to the testing of the gas to be supplied, there is not one stage where chemical science is not necessary. The consumer requires gas which shall be as nearly as possible a pure hydrocarbon of high illuminating power, and it might well have been that a person to whom was delivered the crude gas as it issued from the retort would have said, "Certain things may be separated out more or less, but to practise on the wholesale scale the delicate operations which will be needed to cleanse the illuminating gas from its multifarious accompanying impurities is a hopeless undertaking, and must be so if for no other reason than this—the excessive cost that would be entailed." But what are the facts? Although I for one do not like to sit in a room where gas is burnt, unless special provision is made for taking away the products of combustion, the engineer of the present day, thanks to the application of chemical science, delivers gas to the consumer in a state of comparative purity—although it may have been made from impure coal—which but a few years ago would have been deemed impossible; and so far as this improvement from being attended with extra cost, that the residual products not now uncommonly all but pay the whole cost of the coal, and in some rare instances even leave a slight profit to go towards the charge for labour. Again, it is by the application of chemical science in the dynamite and the gun-cotton of the present day that the engineer is enabled to prepare submarine foundations, to blast away shoals, and to drive tunnels through rock of a character that cannot be dealt with by mere cutting-machines. Equally to the application of chemistry is it due that there are hopes, by the employment of lime cartridges, of breaking down coal without that risk of igniting fire-damp which is attendant upon the use of gunpowder. I need hardly observe that much more might most pertinently be said on the way in which the engineer applies chemical science. In fact, those ways are so multifarious, that a volume might be written upon them, but I must pass on and ask you to consider how the engineer applies geological science, the science treated by Section C. I have already spoken of the engineer supplying towns by water collected from the surface; even he, however, must have a knowledge of geology, for without it he will not know what places are apt for the huge reservoirs he constructs, nor where he can in safety make his enormous embankments. In this continent of vast lakes one feels it must excite a sensation of the ridiculous when a "Welsh lake" is spoken of, but I must ask you to believe you are in Lilliput, and to imagine that the "Bala Pond" of eleven hundred acres in extent is really "Bala lake," as it is called. Within a few miles of that, our friends at the other end of the Atlantic steam ferry, the inhabitants of Liverpool, are now constructing under the engineering and advice of Mr. Hawksley, a waterworks which will involve the formation, I believe one may safely say the re-formation, of a lake, practically the same area as that of Bala, of some 80ft. in depth, and containing between the overflow and the point of lowest discharge nearly twelve thousand million gallons. This lake will be made by the throwing from side to side of the valley of a solid stone bank, 100ft. above the ground, 140ft. above the deepest part of the foundations, and 113ft. thick at its thickest part. Contrasted with Lake Superior this new lake will be small, a thing demanding a microscope even, but the bursting of the wall would liberate a body of water sufficient to carry death and ruin throughout a considerable district. It is, therefore, in the highest degree important that whether he be constructing the solid stone wall, or the more common earthen embankment with a puddle trench, the engineer should so apply geological science as to ensure the safety of his work. But in those cases where the waterworks engineer has to derive the supply from underground sources the application of this science is still more necessary; he must know whether he is likely to find a water-bearing stratification at all—if so, where it receives the rain from heaven, and the extent of the area which receives it; in what direction the water travels through it, what is the varying height of water in the different parts of the stratification giving the "head" to produce that travel; how far this height is likely to be affected by the pumping of the desired quantity; whether, if near the outflow into the sea, the pumping is likely to reverse the direction of the current, and to bring back brackish water, and whether the rocks are of such a character as to be liable to yield a water impregnated with iron or with lime, and whether these water-bearing rocks are accessible from the surface without the execution of costly and laborious work in passing through overlying stratifications of an unfit or it may be even of a dangerous character. It need hardly be said that the engineer when engaged in metalliferous mining, or in the extraction of coal or of petroleum, unless he applies the science of Section C, is but a haphazard explorer whose work is more likely to end in disaster than in success. Again, the engineer when laying out a railway, has to consider the geological features of the country in determining the angles of his cuttings, and to determine where it becomes more economical to tunnel than to cut. Indeed, without the application of that science to engineering there are some enterprises on the feasibility of which the engineer would not be able to pronounce an opinion—a notable instance, the Channel Tunnel. The engineers, of whom I am one, said there is a material, the compact non-water-bearing grey chalk, which we have at a convenient depth on the English side and is of all materials the most suitable; if that exist the whole way across, success is certain. Then came geological science, and that told the engineer that in France the same material existed; that it existed in the same position in relation to other stratifications as it existed in England; that the line of outcrop of the gault lying below it had been checked across; and that taken together, these indication enabled a confident opinion to be expressed that it was all but certain this grey chalk stratification did prevail from side to side. The engineer believed it, an intelligent section of the public believed it, and came forward with their money; large sums were expended in England and in France on the faith of the repeated declaration of the English Government—of both sides of politics—that so long as the nation was not called on to contribute towards the cost of the work, it would hail with satisfaction the improved means of communication between England and the Continent; the experimental works were carried on from both sides with the happiest results, and then, when success appeared certain, the whole work was stopped by the incredible suggestion that in the event of a war the soldiers of England, and the science of England, could not defend a couple of rat-holes, holes 14ft. in diameter and 20 miles long, situated far below the surface of the sea, having a rapid dip from the shore to a low point, gradually rising from there to the centre of the length of the tunnel, so that the English end could be flooded with sea-water in twenty-five minutes up to the soffit of the arch at the dip; and in consequence of this incredible and most-to-be-ashamed-of scare it is due that one of the finest instances of civil engineering work in connection with the science of geology, and as I believe one of the most useful works that has ever been proposed, has been put a stop to. To come to Section D, the botanical side of it is interesting to the engineer as instructing him in the locality and quality of the various woods that he occasionally uses in his work. With regard to that most important part of the work of D which relates to "germs" and their influence upon health, the engineer deals with it thus far: he bears in mind that the water supply must be pure, and that the building must be ventilated, and that excreta must be removed without causing contamination; thus the water-works engineer, the warming and ventilating engineer, the sewage engineer can—and do—all of them profit by the labours of Section D, and can by their works assist in giving practical value to the pure science of that Section.

Section E, *Geography*.—Probably in these days, when our kingdom at home and the old countries near us are all but full of the works of the engineer, there are few who take a greater interest in geography than he does, and I am quite sure there are none who make a more useful application of geographical knowledge for the benefit of mankind at large than does the engineer. Almost at the outset of this address I claimed to magnify Section G, on the ground that without the aid of its members we should not have had that practical lesson in geography which we have received by our visit here, a lesson that no doubt will be continued and amplified by many of us before we return to our homes. Whether it be by the ocean steamer or by the railway train, the enterprising geographical explorer is carried to or through countries which now, thanks to the engineer, are well known and settled, up to the beginning of the unknown and not settled; and thus his labours are lightened, he consumes his energies only upon his true work, brings back his report, which is, as I have said, studied by the engineer, with a view to still further development, and thus turn by turn the geographer and the engineer carry civilisation over the face of the world. Now to come to Section F, which treats of Economic Science. The matters with which this section deals—birth-rate, death-rate, the increase or the diminution of populations, the development of particular industries in different localities, the varying rates of wages, the extent and nature of taxation, the cost of production, the cost of transport, the statistics of railway and marine disasters, the consumption of fuel, and many matters which come within the purview of F, are of importance to the engineer. Guided by the information given him by the labours of this section, he comes to the conclusion that a work having a particular object in view should or should not be undertaken. With the information derived from the past he judges of the future; he sees what provision should be made for prospective increase of population or of industries; he sees the chances of the commercial success of an undertaking or of its failure, and he advises accordingly. I do not propose to say anything about Section H, for I have dealt with it as being still included within D. I trust I have now established the proposition with which I set out, viz., that not only is Section G the section of Mechanical Science, but it is emphatically the section of all others that applies in engineering to the uses of man the several sciences appertaining to the other sections: an application most important in the progress of the world, and an application not to be lightly regarded, even by the strictest votaries of pure science, for it would be in vain to hope that pure science would continue to be pursued if from time to time its discoveries were not brought into practical use.

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

(*From our own Correspondent.*)

THE pig iron market displays most activity, and it was in this branch that yesterday—Wednesday—in Wolverhampton, and to-day—Thursday—in Birmingham, that most business was done. Good sales were made in numerous instances, and altogether this department displays more animation than for months past. As last week, so also this, consumers were desirous of securing forward supplies, and some vendors of part-mines, made in other districts than Staffordshire, stated that they could have sold 7000 or even 10,000 tons to-day if they had been prepared to accept purchasers' offers as to price and date of delivery. Sellers wished an advance upon former prices. A few Northampton and Derbyshire brands of pigs were quoted up 2s. a ton, while one or two brands were not to be bought at any price, the makers having determined to stand off the market until a sensible advance can be established. Northampton pigs were quoted 41s. to 42s., and Derbyshires were 41s. to 42s. 6d. delivered to stations. Vendors would not sell more than four months ahead, and there is every probability of further heavy sales in the ensuing few weeks.

Hematites showed more business than recently, and prices were stiffer. Barrow forge was quoted 56s. delivered, and Blaenavon hematites 55s. More than before, the Blaenavon Company is pushing its special cold-blast pigs in this district, and lots are going off for best foundry and roll making purposes, as well as mixtures for A 1 finished iron making. The prices quoted were:—No. 1 foundry, £6 10s. per ton; No. 2, £6 7s. 6d.; No. 3, £6 5s.; No. 4, £6 2s. 6d.; and No. 5, £6. In the smelting of these pigs the company utilises its bed of charcoal coal.

Native pig makers are not experiencing so much briskness as characterises the trade of the foreign pig vendors, and prices remain as last week. In South Staffordshire the total make of forge iron was about 68,000 tons, and in Shropshire 14,704 tons. At the end of June in this district perhaps 46,211 tons of pig iron were held in stock by the makers, and 15,937 tons in East Worcestershire, a total of 66,148 tons against 55,600 tons on the 31st December last. In Shropshire the iron in stock at the end of June showed a reduction of nearly 7000 tons on the preceding six months, due in great measure to the execution of contracts from stock, some of the furnaces having been blown out.

The new rates for the carriage of pigs into this district from Cleveland and South Wales, to which I referred last week, are not likely to prove much more of a relief to consumers than the reduction a month ago in the rates from Midland pig-making centres into Staffordshire. Instead of delivering, as before, to public wharves, the railway companies have enacted strict station to station rates, so that the consumers have to fetch their own pigs away at a cost varying according to the distance of the works from the stations of from 3d. to 1s. per ton. Such terms will certainly not content the traders in this district.

The finished iron market wears a steadier appearance on the week as to prices consequent upon the settlement mentioned further on of the wages question. Buyers can now see that there is likely to be no further ease in prices, certainly this side quarter day, and their confidence should be strengthened that there will be no more favourable opportunity than the present for buying. It is now expected that foreign merchants' indents will increase. At present these are very restricted in all but one or two special branches.

The thin sheet makers continue as busy as ever. Canadian, colonial, and continental requirements are all pressing, and it is difficult to know which orders to execute first. "Severn" singles are quoted to actual consumers at £11; Baldwin Wilden B., £12; B. B., £13; and B. B. B., £14. To merchants prices are a little less. The demand for tin-plates is fairly active, and stocks are much smaller than lately.

Plates and sheets for bridge and girder, roofing, and galvanising purposes are going off for local consumption, the last-named in particular for increased quantities. An advance of 25s. per ton in galvanised sheets established during the past fortnight in the Sydney market will be matter for much satisfaction if it should be maintained. No. 26 gauge, a good brand, is now quoted in Sydney at £21 15s. Considerable quantities of best sheets are just now being taken by the British Government for dockyard use.

Hoops and strips are in slightly better request, but the bar mills are irregularly employed. The New British Iron Company issued on Monday revised price lists, showing several reductions in their extras. The prices of bars are as follows:—Best Corngreaves, £6 10s.; Lion, £7 10s.; best Lion, £9; best best scrap Lion, £10; best best best Lion, £11; best charcoal, £11 10s.; best Corngreaves plating, £7; Lion plating, £8; best Lion plating, £9 10s.; best Lion turning, £11; best Lion rivet, £9; best best Lion rivet, £10; best Lion chain, £9; best best Lion chain, £10; best Corngreaves horseshoe, £6 10s.; and Lion horseshoe, £7 10s.

Steel in all forms was in abundant supply to-day, and there was brisk competition between the vendors of Bessemer for the orders offering, whether in the shape of blooms and billets, thin bars, plates, sheets, or what not. The Blaenavon Company offered tin bars, billets, and blooms at £5 15s. per ton delivered, and plating bars at £6 5s.

The Iron Trade Wages' Board assembled on Monday in the Council House, Birmingham, to show cause before Mr. Alderman Avery, the arbitrator, why, on one part, the employers should get a reduction in wages; and, on the other part, why the operatives should get a rise. The masters' claim was based upon the disadvantage which they suffer in the market from the ironmasters of the North of England being called upon to pay 9d. less per ton in wages than themselves. Admitting, however, that two-thirds of that difference is covered by the northern ironworkers receiving extras which are not paid to the ironworkers in the south, the difference is practically 3d. Though the southern masters are not wholly unprepared to maintain that by the general abandonment of extras in the North, they in the South are prejudiced to the full extent of the 9d., nevertheless they consented to allow their claim to remain in abeyance till the 3rd of November, when the Board will reassemble to consider it and the men's strategical counter claim.

The only new feature in the strike of colliers is the fact that the Strike Committee have resolved "That those colliers at work at the old rate of wages demand a proportionate increase of wages when their employers advance the price of coal." The men appear determined to carry on the strike, and are indulging in the hope that now the cold weather is approaching the masters will find it to their advantage to give the old rate.

The best export markets for hardwares at the present is India, but New Zealand is also expressing her wants freely. Notwithstanding the agricultural losses in New South Wales, the Sydney market wears a brighter appearance, and more orders are coming forward. The Cape trade shows little settled revival, and this is a matter of much unsatisfactory significance to the cart and wagon spring and axle makers of Wednesbury. With Bombay and Calcutta, however, these manufacturers are doing fairly well. Certain of the Mediterranean and other European countries are good customers just now for miscellaneous hardwares. Complaints of a scarcity of orders from North America are made by the vice and anvil manufacturers of Dudley.

A new crucible furnace, known as Hodgkin's patent, has been adopted by Messrs. Disturnal and Co., spring and axle manufacturers, Wednesbury, for casting the axle boxes and other portions of their manufactures, and it has also been tried by a few other makers of the district. The direct object of the furnace is to make the crucibles—whether plumbago or clay—last longer, and it has the subsidiary advantages of effecting a saving in coke, shortening the length of the several heats, and somewhat improving the metal. Users have obtained as many as sixty-five heats out of a plumbago pot, and as many as twenty-five heats out of a common clay pot. The patentee is himself a Wednesbury man, and the sole right of constructing is now in the hands of Messrs. Disturnal.

Major Tulloch, on behalf of the Local Government Board, has this week held an inquiry at Redditch respecting the application of the Local Board of that place to borrow £5000 for sewage works, road improvements, public baths, and steam roller. After proceeding for some time, the inspector advised the Board to quickly prepare a plan of the streets, showing what had been done out of the last loan, what streets were perfect, and what was proposed to be done with the loan which is now required. Until this plan was ready, no further notice would be taken of the application.

The Walsall Corporation have accepted the tender of Mr. A. Lynes, of that town, to erect sewage farm buildings at a cost of £2989.

A conference of Cannock Chase coalmasters' and miners' delegates was held in Birmingham this—Thursday—afternoon, when the latter asked for an advance of wages. The demand was strongly resisted, and the meeting was ultimately adjourned for three weeks.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester.—The condition of the iron trade in this district is no worse. If there is any change, it may perhaps be regarded as rather in the direction of improvement, in so far that prices appear not only to have touched the limit beyond which makers are not prepared to meet buyers with further concessions, but that in some cases there is disinclination to enter into further engagements at the lowest prices that have recently been taken. Of course this does not represent any actually realised improvement, but it may possibly indicate the turning point that may lead to a better trade being done. In pig iron there is no really increased weight of business coming forward, but with the present restricted production of both local and district brands, makers are in the position that with only a very small business doing they are not actually compelled to press sales, and prices have got to so low a point that they prefer to work on from hand to mouth with the few orders that buyers have to give out, rather than attempt to force a larger trade at unremunerative rates. In the manufactured iron trade there is a fair weight of orders in the market to be got at low prices, and one of the largest finished-iron works in Lancashire, Messrs. Pearson and Knowles, is being kept going at the full output of 2000 tons per week; but the turn over of business practically leaves no profit to the producer. It is, of course, quite possible that there may be still before the trade an extended period of depression, and buyers evidently do not as yet see any probable improvement in the immediate future; but prices seem to have reached the lowest point that they are at all likely to touch, and under present conditions it would require very little to bring about an upward movement in the market.

At Manchester on Tuesday there was again a very dull market, with prices unchanged. The Lancashire pig iron makers are still open to take 41s. to 42s., less 2½ per cent., for forge and foundry qualities, delivered equal to Manchester, and on the basis of these figures they are doing a small business. District brands are also to be got at about the same price. Some of the makers, however, are now holding out for 1s. to 2s. per ton above these figures, but they are practically out of the market, and although 41s. to 42s. is now the very minimum at which orders could be placed, very little business is practicable where more than this is asked. Outside brands, such as Scotch and Middlesbrough, maintain their price; but the margin between these and the local and district brands is so great that competition, so far as ordinary trade here is concerned, is practically out of the question.

For hematite there is really little or no inquiry, and where there is any business to be done prices are cut extremely low, good foundry brands delivered here being obtainable at about 53s. 6d. to 54s. per ton, less 2½ per cent.

In the manufactured iron trade there appears to be rather more inquiry stirring, and there seems to be a larger demand coming forward from the Colonies, especially Canada; but there is so much competition in the market that orders are only got at the very lowest possible prices. For good qualities of Lancashire and North Staffordshire bars, delivered into the Manchester district, £5 12s. 6d. remains the average price, with common brands to be got at £5 10s., hoops at about £6 2s. 6d., local-made sheets at £7 2s. 6d. to £7 5s., and good Staffordshire qualities at £7 10s. per ton.

In the wire trade there is more doing, and the works in the Warrington district are fully employed. The recent reduction in wages has enabled manufacturers to compete more successfully for the colonial trade, which was previously passing almost entirely into the hands of the German makers; and although they are not able to command anything like remunerative prices, a fair weight of orders has been got, and in special made wire for fencing purposes a moderately large trade is being done.

The secretary of the Steam Engine Makers' Society, in the report for the past month just issued, states that the society is not able to show any improvement, and regretted to record that the unemployed list showed an increase over those recently issued. The cause for this was, however, not far to trace, as the heaviest records were made by branches where marine engines were the principal trade of the district. In other localities not much change presented itself, as the generality of the stationary engine, mill-wright, and tool shops were fairly employed, and locomotive builders also appeared to have an abundance of orders. The locomotive departments of railway companies were, however, as a rule, slack, and in some instances even on short time, so that they could only conclude that the orders at private firms were being made for foreign countries, notwithstanding the lectures they sometimes received about foreign competition. They had, however, pleasure in saying that although trade was far worse than they cared to see it, there were no disputes pending at the present time that in any way affected their members to a serious extent. Although their unemployed list was less satisfactory this month, they were sanguine enough to expect that there would soon be a revival in their favour, and it was quite possible their next report might bear proof of this. The impression seemed to be gaining ground that the depression had spent itself, and the excellence of the harvest, coupled with other causes, might lead to a brisk trade for some time to come. It was reported from the Clyde that a fair amount of orders for new ships had been given out, whilst similar rumours were circulated on the Tyne and the Wear. New orders were also being placed in the stationary engine shops, and the opinion as to business generally was that we should have a far better winter than was anticipated a few months back. In the Lancashire district, where employment generally is reported as steady, the society have only about 1½ per cent. of their members in receipt of out-of-work support, but for the whole of the branches throughout the country the average is 2½ per cent.

A couple of powerful machine tools, specially constructed for ordnance work, have been made by Messrs. Hulse and Co., of Manchester, for the gun factories at Elswick. One of these is a special machine for trepanning and for boring out steel ingots up to 40in. diameter, and to a length of about 25ft. The machine is double-ended, and the ingots are bored through from each end simultaneously. The boring bars are propelled by large steel screws, and the ingot is held and rotated by a large hollow central head-stock, and supported by suitable stays, by which the weight bearing upon the head-stock is greatly reduced. The machine is 70ft. in length over all, and massive in construction, weighing about 50 tons; it is fitted with powerful spur gearing, with very great strap power, and to ensure a perfectly true axial line through the rotating work, the utmost accuracy of construction has been absolutely necessary throughout. The second machine is an exceptionally large lathe, weighing about 80 tons. This machine is 54ft. in length, has a spindle of the best crucible cast steel, and double slide rests; very powerful gearing is provided to enable the machine to remove half a ton of metal per hour with two tools; it has a 40in. centre, and will take in work 5ft. 6in. diameter. One special feature is that the guide screw is fitted with propeller-like thrust bearings, so as to withstand an exceptional end pressure.

Preliminary surveys and estimates have been made by Mr. E. Leader Williams, C.E., in connection with suggestive alternative schemes for the Manchester Ship Canal, the result of which is that the proposal for cutting a canal from Garston through the solid is found to be impracticable owing to the great depth and expense of the cutting which would be necessary; and although nothing definite has yet been decided upon, it seems probable that the construction of a channel along either the southern or the northern shore of the estuary of the Mersey will be recommended for adoption.

The coal trade is beginning to show a little more animation and the pits are getting into better work, but business generally is still only dull, and most of the collieries are not running more than four days a week. It is chiefly for house fire coals that any increased inquiries are coming forward, other descriptions of fuel for iron making and steam purposes still meeting with only a dull sale with supplies plentiful in the market. For round coals prices are hardening a little where sellers have been taking under list rates, and at the pit mouth quoted prices now average more nearly 9s. for best coals, 7s. for seconds, and 5s. 6d. to 6s. for common round coals. Engine classes of fuel are without improvement, and do not more than maintain about 4s. 6d. to 5s. for burgy, 4s. to 4s. 3d. for best slack, and 3s. 3d. to 3s. 6d. for common qualities at the pit mouth.

For shipment there is a good demand, and in some cases prices have been slightly advanced, 7s. 3d. to 7s. 6d. being now the minimum for good qualities of Lancashire steam coal delivered at the high level, Liverpool, or the Garston Docks.

There is some possibility of a dispute with the colliers in the Oldham district. Notices have been given to the men to terminate present contracts with the view of a reduction in wages, the precise amount of which has not yet been determined upon, and the men express a strong determination to resist should any reduction be attempted.

The Preston Town Council, after a long and excited discussion at a special meeting held on Wednesday, resolved to accept the tender of Mr. Walker, of Great George-street, Westminster, for the construction of dock works at a cost of £439,359, and for the diversion and deepening of one portion of the river at a cost of £17,000 in connection with the proposed development of the Ribble navigation.

Barrow.—There is a rather better tone in the hematite pig iron market this week, and the number of orders which have lately been booked are in excess of the business which has fallen into the hands of makers for some weeks past. An improved inquiry for iron has set in, not only on home, but on continental account, and it is just within the bounds of probability that during the next week or two there will be a fair business doing on shipping account, as the season is not far from closing. But it will not be until next spring that any practical change for the better can be expected. In the meantime, however, there seems reason to believe that makers will be able to maintain the present output of iron. Stocks, however, remain very large, and it is noticeable that while they are not increasing, the deliveries of iron taking place at present are not reducing stocks, although it has been expected that this would be the case. Steel makers are indifferently employed in all departments. Shipbuilders are expecting one or two good orders, for which the arrangements are almost fully completed.

The Dalton Local Board have determined to light the streets of Askam with electricity. Askam, it will be remembered, is the *locale* of the works of the Furness Iron and Steel Company.

Very large banks of iron ore have accumulated at the iron mines in the district. The Furness Railway Company has adopted the vacuum brake on some of its express trains.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

A QUIET tone and sparse attendance were the most noticeable features of the iron market held at Middlesbrough on Tuesday last. Makers' price for No. 3 is still nominally 37s. per ton f.o.b., but there are scarcely any sales at this or any other price. Merchants offer at 36s. 3d. Forge iron may be had at 34s., and sales have even been made at as low a figure as 33s. 9d. The position, as far as the smelters combination goes, is one of unstable equilibrium, and no one would be surprised to see it collapse any day. Meanwhile there is really very little being done; and how all the merchants and brokers who seem to be in the trade get a living, is a complete mystery.

The manufactured iron trade remains steady and without any new characteristic. Plates for ships are £5 per ton, and for girders and general purposes, £5 2s. 6d. There is more demand for the latter than for the former purpose. What little shipbuilding is being done is mainly at foreign shipyards, where labour is cheaper than in England. Test iron is more sought after than ordinary quality, and when sold is usually subjected to a very rigid inspection. Steel makers are still slack, and the prices obtainable by them unremunerative.

At the ensuing meeting of the Iron and Steel Institute at Chester, there will probably be some severe sparring between the advocates of the basic and those of the Siemens process. The gauntlet will be thrown down by Mr. Arthur Cooper, of the North-Eastern Steel Works, Middlesbrough.

A meeting was held on the 30th ult., at Scarborough, of the shareholders of the Scarborough and Whitby Railway Company, whose line is now under construction. The directors stated that an agreement had been made with the North-Eastern Railway Company to work the new line for 50 per cent. of the gross receipts. This would appear to be a very fair and reasonable bargain, and in accordance with the interests of both parties. It is quite out of the question to suppose that a short railway, such as that between Scarborough and Whitby, could long exist, without being absorbed by its more powerful neighbour and rival.

The exports of pig and manufactured iron and steel during the month of August have now been published. Of pig iron 71,815 tons were sent away during the month, and of manufactured iron and steel, 31,186 tons; total, 103,001 tons. The pig iron exports were just two tons less than those of the previous month. Comparing the first eight months of 1884 with the same period of 1883, we have 607,648 in the first case, and 623,917 in the second.

During the month of August, 274,200 tons have been dredged from the bottom of the river Tees, at a cost of £4005. The depth of the river is steadily increasing, and it may now be considered a harbour of refuge accessible to vessels of very large size. At the fifth buoy light, two or three miles west of the Tees mouth, a first-class ironclad might lie afloat, even at low water. The South Gare breakwater is nearly completed, and in about a month will be entirely so. The Tees Conservancy Commissioners have been discussing what kind of light should be exhibited from it. They first proposed a red and white flashing light, but the Elder Brethren of Trinity House refused their sanction. They say that experience has proved that a red light has but little penetrating power, and they recommend a flashing light of three seconds' duration, repeated every ten seconds. This suggestion was finally adopted, and the requisite two months' notice to mariners is about to be given.

At the Gateshead locomotive building and repairing shops belonging to the North-Eastern Railway Company a notice was posted up a short time since to the effect that from the 1st of September sixty working hours per week would be expected, instead of the fifty-four hours which was agreed to several years ago, after the prolonged agitation known as the "nine hours' movement." The workmen employed at the Gateshead shops seem to have been considerably excited by the above notice, which they regarded as an attack upon the much cherished system they supposed was now permanently established. Consequently, they met in conclave at various centres throughout the locality, and resolutions were passed to resist to the utmost the threatened innovation. In consequence of this opposition, the notice has been temporarily withdrawn, but what the final outcome will be is not yet known.

The secretary of the Iron Manufacturers' Association has given notice to the secretary of the Ironworkers' Union that from and after September 27th next ensuing the employers will require relief to the extent of a general reduction of ironworkers' wages of 5 per cent. on standard rates. Of this 5 per cent., one-half became due on the 1st of August, according to Mr. Waterhouse's bi-monthly ascertainment, and reckoning the proportion of wages to ascertained selling prices to be 1/6 above shillings for pounds. The other half of the proposed reduction is also claimed, as it certainly will become due under the next bi-monthly ascertainment. The 5 per cent. which has usually also been claimed in consideration of the absence of a time bargain, has been temporarily foregone by the employers on the present occasion, in view of the low level which wages rates have reached. Immediately on receiving the above notice, Mr. E. Trow, the ironworkers' secretary, wrote out a claim for a 5 per cent. advance. He gives no reason for his claim, and it is generally regarded only as a counterblast, in the hope that if the matter comes to a reference, the arbitrator may be induced to split the difference and leave the rates unaltered. The meeting of the Standing Committee will be held on Monday next, the 8th inst., to consider the whole question.

At six of the large reversing plate mills, belonging to members of the Iron Manufacturers' Association, notice was given to the rollers on Saturday last of a considerable reduction of wages rates, which nevertheless will leave them from 10s. to 20s. per day clear. A fortnight has been given to each roller for consideration and decision, whether he will agree, refer to the Standing Committee, or leave his employment. In case, as is expected, the middle course be generally selected, then if the Standing Committee fails to come to a decision, the new rates will be decided by Mr. David Dale, the standing referee. Should the men prove disloyal to the board on this question, it is thought the Employers' Association is now strong enough to enforce the lower rates.

The county of Durham appears to have taken the lead of all other counties in the yield of lead during 1883. Of dressed lead ore it produced 7696 tons; of lead in the ore, 5797 tons; of silver in the ore, 40,360 oz., whilst £62,839 was the total value of ore at the mines collectively. The first item includes the following figures, viz.:—Teesdale Mines, worked by the London Lead Company, 3365 tons; Green Hurth, 1049 tons; and W. B. Beaumont's mines, 1721 tons. The Arkengarthdale Mines—North Yorkshire—produced 1879 tons, and the Greenside Mines—Helvelyn—1100 tons of dressed lead ore.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

DR. WEBSTER, the United States Consul at Sheffield, has recently forwarded a report to the State Department at Washington, which, on its reproduction in full in this country, will excite general interest among steel manufacturers and users. Dr. Webster refers especially to the increasing sale of Bessemer steel as "cast" steel without any means of distinguishing it from crucible cast steel. "It is an open secret," he says, "that thousands of tons of Bessemer are sold annually as 'cast' steel for the home or foreign markets." "One of Sheffield's best makers, whose steel bears a good name in the United States," continues Dr. Webster, "says he has recently charged his manager to be careful henceforth to label all his steel so as to distinguish between Bessemer cast steel and crucible cast, he applying the word cast to both of them. This indicates how commonly Bessemer has come to be called cast steel. It is, in a sense, cast steel, since it is run into moulds; and yet, as is well-known, the term as thus applied is deceptive, cast steel being understood to be crucible steel." Of course, as Dr. Webster points out, there is a wide range of profit secured by those who buy what they know to be Bessemer at a low price, and sell the same material either without specific description or as cast steel at a very high price. He instances a case where a steel manufacturer boasted that he bought steel at £10 a ton and sold it at £50. What have our steel manufacturers to say in reply to this charge? It cannot refer to several leading firms at all, for they have no Bessemer plant on their premises. To give names would be invidious, but in the Sheffield district, apart from the firms to which I allude scorning to deceive their customers by palming off Bessemer as crucible cast steel, the principal firms who make steel their chief speciality adhere to the original method of making crucible steel, and therefore remain untouched by the allegations in Dr. Webster's report.

Messrs. Wm. Jessop and Sons, Brightside Steel Works, have been awarded the diploma of honour at the International Exhibition now being held at the Crystal Palace, London, for their exhibit of steel castings for marine purposes. This is a speciality to which Mr. F. J. Hall, the manager, has given great attention, and the success of the firm is most gratifying. A diploma of honour is the highest possible award.

Some important evidence was given at the adjourned inquiry into the deaths of the four persons killed by the explosion of a boiler at Messrs. Wm. Cooke and Co.'s Tinsley Steel, Iron, and Wire Works, near Sheffield. Mr. R. H. Longridge, managing director of the Engine, Boiler, and Employers' Liability Insurance Company, Manchester, made an examination of the boiler at the request of the coroner. Mr. Longridge drew up a report, in which he minutely explained the character and position of the boiler, and the manner in which it was worked. His chief conclusion was that the explosion was caused by corrosion of the plates in the outward part of the shell, in consequence of leakage at the seams. The plates being thus so much reduced in thickness, rendered the boiler quite unfit for the pressure at which it usually worked. What the actual pressure was at the time of the explosion was uncertain, there being no pressure gauge attached to the boiler. Mr. John Poole, the head repairer at Messrs. Cooke's, said that he had had forty years' experience of boilers, and when asked to state the cause of the explosion, the worthy old gentleman gravely stated that it was because the boiler had given way "at the weakest part!" The inquiry has been adjourned till the 5th inst.

The committee of the Wombwell Miners' Union and Mr. Thomas Burt, M.P., are at issue. The committee are deeply dissatisfied with the conclusions arrived at after the inquiry into the causes of the explosion at Wharncliffe Carlton Colliery, and they drew up a report "embodying serious allegations with regard to the management and mode of procedure at the inquest." This report was forwarded to the Home-office, and as no notice was taken of it, they communicated with Mr. Burt, but had waited in vain for him to take action. The committee express regret that Mr. Burt did not, from his place in the House of Commons, question the Home Secretary upon the matter. Mr. Burt has replied, stating that he had done what he could in the matter. The secretary to the Union has replied, saying that they think there was a dereliction of duty on the part of Mr. Burt, as a mining representative, in not pressing such a question as they had raised upon the attention of the Home Secretary, and a want of respect to them in not explaining his reasons for not doing so. To this letter Mr. Burt has not replied.

The first Thursday in September this year sees no Cutlers' Feast. The new master, Mr. J. E. Bingham, is in America, and will not return till October. This will throw the feast fully a month later than usual. On the usual day, however—Thursday, the 4th September—the company will meet in their accustomed manner and go through all the formalities with the exception of swearing in the new master, which will be postponed till his return. It will be like the play of "Hamlet" with the prince left out, but it is unavoidable.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

IN the pig iron market business has again been quiet. Warrants have fluctuated very little, but upon the whole are weaker, the turnover this week having been comparatively poor. The shipments of Scotch pigs are still below the mark, those of the past week having been 9539 tons against 9320 in the week, and 15,683 in the corresponding week of 1883. For the better qualities of makers' iron, there is a good demand both for home use and export, but there is rather less inquiry for g.m.b., the quotations of which are about 6d. lower. Since last report a furnace has been damped down at Ardeer Ironworks, leaving ninety-four in blast compared with 114 at this date last year. The stock of pig iron in Messrs. Connal and Co.'s stores is reduced by about 120 tons. The past week's imports of Cleveland pig iron were 4150 tons, and the aggregate to date are 166,255, being a total decrease of 8018 tons as contrasted with those of 1883.

Business was done in the warrant market on Friday at 41s. 4d. to 41s. 3½d. and 41s. 5½d. one month. On Monday, transactions were recorded at 41s. 3d. to 41s. 4d. cash, and 41s. 5d. to 41s. 6d. one month. At Tuesday's market the quotations were 41s. 4½d. to 41s. 5d. and 41s. 4½d. cash. Business was done on Wednesday at 41s. 5d. to 41s. 7½d. cash, while to-day—Thursday—transactions took place at 41s. 8d. to 41s. 5½d. cash.

There is little change in the pig iron quotations, which are as follows:—Gartsherrie, f.o.b. at Glasgow, per ton, No. 1, 53s.; No. 3, 50s. 3d.; Coltness, 60s. and 51s. 6d.; Langloan, 55s. and 51s. 6d.; Summerlee, 52s. 6d. and 47s. 3d.; Calder, 52s. and 48s. 3d.; Carnbroe, 50s. and 46s. 6d.; Clyde, 48s. and 45s.; Monkland, 43s. 6d. and 40s. 6d.; Quarter, 42s. and 40s. 3d.; Govan, at Broomielaw, 42s. 9d. and 40s. 6d.; Shotts, at Leith, 51s. 6d. and 51s.; Carron, at Grangemouth, 48s. (specially selected, 52s. 6d.), and 47s. 6d.; Kinneil, at Bo'ness, 44s. and 43s.; Glengarnock, at Ardrossan, 49s. 6d. and 43s.; Eglinton, 44s. and 40s. 9d.; Dalmellington, 47s. and 43s.

In the foundries and general engineering works there is a large amount of work being done; but the past week's exports of iron and steel goods were smaller than usual, and in value to about £14,000. At some of the malleable works in Lanarkshire there is ample employment upon contracts recently obtained, but others are slack, and the prices are for all articles at about the lowest.

The operative ironmoulders of the Mushet Ironworks at Dalkeith and Granton have, after a protracted strike, returned to work at a reduction of 5 per cent. on their former rates of pay.

The coal trade has been somewhat quieter in certain districts, and merchants have accepted a few pence less money per ton for good orders. But the shipments of the past week are, as a whole, not unsatisfactory. At Glasgow 24,181 tons were shipped, 1845 at Greenock, 1920 at Irvine, 8243 at Troon, 9204 at Ayr, 5441 at Leith, 5423 at Bo'ness, and 12,482 at Grangemouth. The demand for shipment in Fifeshire is reported to have been good in the course of August, with the exports over the average. Prices f.o.b. at Burntisland range from 6s. 9d. to 7s. 3d. a ton.

Replying to a demand from the miners for an advance of wages, the coalmasters of Larkhall and Cambuslang state that the price of coals, which has not been so low for about thirty years, will not afford an increase of pay at present.

The first general meeting of the Boson Oil Company has been held in Edinburgh. Mr. W. Holmes, who presided, intimated that good progress had been made with the erection of the works, and it was expected that ere long they would be able to produce 200 tons of crude oil per day.

During the past month twenty-one vessels, with an aggregate tonnage of 25,123, were launched from the Clyde shipyards, against twenty-five vessels of 34,003 tons in the same month of 1883. In the eight months 167 vessels, of an aggregate tonnage of 189,865, were put in the water, as compared with 191 vessels and 259,820 tons in the corresponding period of last year. The new contracts received are not sufficient to fill the places of the vessels launched, and the prospects of the trade are not encouraging.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

I HAD a glance at the iron and steel works last week from Dowlais to Ebbw Vale, and it was not an encouraging one. Trade is unmistakeably flat, and if the tin works were not brisk, it would be much worse. As it is, there is a moderately good make going on of steel bar, which sells at £5 12s. 6d., and so leaves little, if any, margin to the maker. Yet it helps to keep the works going, and is thus of benefit. As for steel rails, the make is very sparse, and as heavy contracts are unusual for the autumnal and winter season, prospects are gloomy.

Managers of steel works, the property of limited companies, are placed in awkward positions. In the transformation of obsolete plant, so as to keep pace with the age, large disbursements are imperative; and when no trade is to be done, and no returns are forthcoming, the temper of shareholders is not a sweet one. I am afraid that the bed of most managers at present is not one of roses.

The continuance of Mr. Evans as manager of Rhymney Steel Works is in jeopardy, if not by this time ended. Rumour assigns it to a disagreement between the chairman and himself; but from whatever cause, the loss to Rhymney will be a calamitous one. When the Mechanical Engineers visited the works a few weeks ago, the opinion was strongly expressed that they had never seen a more perfect plant; everything was in finest order, and, given a flow of trade, no works could grapple with it better. Mr. Evans has given the fullest measure of time and ability to the work, and the upshot is that Rhymney will not reap the results as it should, and some other works will derive the benefit of his skill and experience. He was offered a substantial income some time ago to go to Barrow, but elected to remain at Rhymney. "He had advised large outlays, and would not leave." I should like, in the interests of shareholders, a special meeting called, and a thorough investigation made.

It may suit the interests of men who are embarking in fresh enterprise, and require public confidence and capital, to buoy up the community with the impression that the coal trade is as buoyant as ever. A visit to Cardiff Docks and the offices would tell a different tale. The coal trade is not brisk, and the number of offices closing at early hours shows this. The principal collieries, those holding Peninsular and Oriental contracts, and others, keep up an average amount of activity, but, generally speaking, there is little animation in the trade, and the demand upon the collieries has not for weeks been of that vigorous kind which once characterised it. One hears of no peremptory requests, of no demurrage, and congestion is for the time out of use.

The freight market is very depressed, and low figures are current for many of the foreign ports, Malta and elsewhere.

Taking the three leading ports, Cardiff, Swansea, and Newport, I think that the last has shown the greatest liveliness of late. Figures show this in comparing, say, Cardiff and Swansea, for though Cardiff sent away 125,000 tons, and Swansea 40,000, yet Cardiff shows a decrease of 25,000 tons per week, and Swansea 10,000 tons increase.

Small steam does not maintain its firmness, and stocks I see are beginning to accumulate. House coal may soon be expected to advance in quantity, if not in price. At present No. 2 sells for 8s. 6d., and No. 3 for 9s. 3d.

I am glad to hear that Mr. Evans, who is now working Tyla Cock, has won the Aberghorki vein at that place, and largely increased the workable area. This vein is one of the best house coals in the valley. Harris's Deep Navigation is doing better, and an average of 4000 tons weekly are turned out. This, however, is not in proportion to the area and appliances, not to mention the capital of half a million sunk in the colliery. The capacity of the place, had the roof been good, would be nearer 12,000 tons per week.

The dispute at Mardy has been amicably settled; that at Gelli and Tynebodw continues, though Mr. Thomas, the manager, has given his consent to arbitration. At a meeting of the Colliers' Association, Rhondda, it was agreed this week to help towards the support of the men on strike.

Tin-plates, best charcoal, are quoted at 19s. 3d.; ordinary cokes rule at about 16s.; last week they were 15s. 9d.

The Ystalyfera Ironworks have been started by a new company, principally Swansea men; capital, £100,000. In the hopeful condition of the tin-plate trade prospects are good, and the company will start well.

The patent fuel trade is active; iron ore a trifle better.

The "mile" of the Great Western system continues to stop the opening of the Newport, Caerphilly, and Treforest line. Sir George Elliott should have arranged this earlier.

SOUTH KENSINGTON MUSEUM.—Visitors during the week ending Aug. 30th, 1884:—On Monday, Tuesday, and Saturday, free, from 10 a.m. to 10 p.m., Museum, 13,439; mercantile marine, Indian section, and other collections, 5111. On Wednesday, Thursday, and Friday, admission 6d., from 10 a.m. to 6 p.m., Museum, 1479; mercantile marine, Indian section, and other collections, 310. Total, 20,339. Average of corresponding week in former years, 20,868. Total from the opening of the Museum, 23,320,336.

THE ACCIDENT ON THE HIGHGATE CABLE TRAMWAY.—On Monday General Hutchinson, on behalf of the Board of Trade, held an inquiry into the cause of the accident which happened on the 13th ult. Josiah Barker, driver, said: On the day of the accident his car worked well enough up to the last journey. On reaching the depôt, he stopped as usual to drop the cable, and then gravitated about thirty yards to where it should be taken up again, but he was unable to take up the cable again. He was under the impression that the slipper brake was attached all right, but he discovered afterwards that it was not. Presently, finding the speed of the car and dummy increasing, he told the conductor to go into the car and apply the slipper brake. The conductor in trying to do so fell, and he then sent a workman who was in the dummy to do it, but he in getting off fell also. Witness kept to his post, applying the wheel and foot brakes, until the smash, when he was thrown off. He had once previously missed the cable, and came down all right, but he had the use of the slipper brakes. All the dummies are now to be fitted with the slipper brake. The Board of Trade report has yet to appear.

THE PATENT JOURNAL.

Condensed from the Journal of the Commissioners of Patents.

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

Applications for Letters Patent.

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

26th August, 1884.

11,619. SELF-REGULATING FEED for MILLS, E. S. Beaven.—(*W. Andrews and A. W. Beaven, New Zealand.*)
11,620. WATER CRANES, &c., W. H. Baraclough, Birmingham.
11,621. FRAME for CONTAINING NAME and ADDRESS of PERSONS upon SATCHELS, &c., W. H. S. Aubin, Bloxwich.
11,622. RENDERING ASEPTIC the AIR ENTERING VESSELS HOLDING MILK, &c., D. C. McVail, Glasgow.
11,623. ALBUMS, J. Tirebuck, Liverpool.
11,624. SCREW SPANNERS and WRENCHES, E. Barnes, Birmingham.
11,625. BREECH-LOADING SMALL-ARMS, W. Bentley, Birmingham.
11,626. STOPPERING BOTTLES, H. Finch, Hollinwood.
11,627. HYDRAULIC MOTOR, A. M. Clark.—(*A. J. and H. Schlaadt and G. S. Barton, New Zealand.*)
11,628. COPPERATED BLUE for PREVENTING CONTAGIOUS DISEASES, B. Hammond, Guildford.
11,629. MUSICAL INSTRUMENTS, J. G. Wilson.—(*V. Siedal, Klingenthal.*)
11,630. MULES and TWINERS, J. Moorhouse, London.
11,631. BOTTLE STOPPERS, C. E. Gibson and G. Hood, Birmingham.
11,632. WEAVING, W. Ireland, J. E. Thurman, and P. Mortimer, Manchester.
11,633. STEAM and HOT-WATER BOILERS, G. H. Lloyd, Birmingham.
11,634. ATTACHING WIRE to CHAIN MATTRESSES, &c., I. Chorlton and G. L. Scott, Manchester.
11,635. DYNAMO-ELECTRIC MACHINES, &c., T. Parker, London.
11,636. STRAW PLAIT MILL, J. J. Groom, London.
11,637. BAG FILTERS, E. Perrett, London.
11,638. PROPULSION of SHIPS, J. Buchanan, Glasgow.—*29th July*, 1884.
11,639. LUBRICANTS, J. Hopkinson, London.
11,640. TRAP for PIPES, J. Jameson, London.
11,641. TREATMENT of SEWAGE, E. J. Levison and J. W. Slater, London.
11,642. BOTTLES, H. Codd, London.
11,643. NEWSPAPERS, G. E. Skliros, London.
11,644. OPERATING RAILWAY SIGNALS, J. Coleman and I. Henson, London.
11,645. INJECTORS, A. Budenberg.—(*Schaffer and Budenberg, Buckau-Magdeburg.*)
11,646. RADIAL WIRE ROPE, &c., J. Leitch, London.
11,647. STOPPERING BOTTLES, T. P. Pashby, London.
11,648. DRIVING GEAR for BICYCLES, &c., W. B. Downey, Hendon.
11,649. CLUTCHES, W. H. C. Stanford, London.
11,650. FURNACES, W. R. Jones, London.
11,651. BOILERS for TREATING WOOD PULP, &c., D. O. Francke, London.
11,652. STUDS, C. D. Abel.—(*W. Bourke, United States, and R. A. Kipling, Paris.*)
11,653. ELECTRIC BATTERIES, C. D. Abel.—(*E. J. N. Onimus, Paris.*)
11,654. ORGANS, T. Casson, London.
11,655. BOILING with SULPHITES, A. Mitscherlich, London.
11,656. SAIL GROMMETS, A. H. Reed.—(*W. W. Wilcox, United States.*)
11,657. SAFETY COUPLING for RAILWAY CARRIAGES, H. J. Haddan.—(*C. A. Dupuis, Villiers aux Chênes, and A. Jeanmaire, Tremilly.*)
11,658. MANHOLES, &c., J. Robbins, London.
11,659. PAVEMENTS or FLOORINGS, H. H. Lake.—(*K. Kühn, St. Johann-on-the-Saar.*)
11,660. COATING WOOD, &c., with PAINT or COMPOSITION, H. H. Lake.—(*L. Brown, United States.*)
11,661. PURIFYING WATER, H. H. Lake.—(*G. H. Nott, United States.*)
11,662. FENCES, B. Scarles, London.
11,663. RIVETTED JOINTS, J. A. Rowe, London.
11,664. WORKING CRANES, &c., S. Butler, London.
11,665. STENCH TRAPS, J. Atterton, London.
11,666. FIRE-PROOF DOORS, J. Edwards and A. Rogers, London.
11,667. ROLLING MILLS, H. H. Lake.—(*C. Gardner, United States.*)
11,668. METALLIC LATHING, B. Scarles, London.
11,669. FLEXING CHAIN PROPELLERS, J. M. Rosse, London.
11,670. PRODUCING STEREOTYPE MATRICES, O. Mergenthaler, London.
11,671. MANUFACTURING TAGS in SERIES, A. J. Boult.—(*E. W. Dennison, United States.*)
11,672. DIFFERENTIAL PULLEY BLOCKS, T. H. Ward, London.
11,673. CARTRIDGES for ORDNANCE and SMALL-ARMS, D. F. Downing, Woolwich.

27th August, 1884.

11,674. SPRING MATTRESSES, G. Hurdle, Southampton.
11,675. RELEASING the SHUTTLE in WEAVING LOOMS, J. C. Stafford and G. Heap, Manchester.
11,676. PROPULSION of SHIPS or VESSELS, A. MacLaine, Belfast.
11,677. PICKING the ENDS of SILK, E. Rushton and D. Walmsley, Manchester.
11,678. SAFETY STIRRUP, C. K. Gibbons, Newcastle-on-Tyne.
11,679. MECHANICALLY COOLING AIR, J. J. Coleman, Glasgow.
11,680. FILLING and EMPTYING BATHS, W. R. Maguire, Dublin.
11,681. FEEDING TROUGH for POULTRY, E. R. Baller, Birchfield.
11,682. TAPS for CONTROLLING the FLOW of GAS, S. H. Wright, London.
11,683. HIGH-PRESSURE TAPS, T. Osborne, London.
11,684. PREPARING and SPINNING COTTON, J. Dodd, Manchester.
11,685. CARTRIDGES, H. S. Maxim, London.—*26th May*, 1884.
11,686. MATCHES, S. Pitt.—(*J. H. Mitchell, U.S.*)
11,687. CLEANING the SIDES and BOTTOMS of SHIPS AFLOAT, A. D. Spiers, Glasgow.
11,688. EARTH PLATES for FENCING STANDARDS, W. Bayliss, London.
11,689. WIRE FENCING, P. S. Brown, Glasgow.
11,690. WIRE FENCING, P. S. Brown, Glasgow.
11,691. ADJUSTING CANDLES in CANDLESTICKS, E. C. Burch.
11,692. CHAMFERING, &c., BARREL STAVES, F. Myers, London.
11,693. TRAM-CARS and other ROAD VEHICLES, P. Zerfass, London.
11,694. SPINNING COTTON, T. Robinson, London.
11,695. GRINDING GRAIN and PREPARING FLOUR, W. Hardy, jun., London.
11,696. PROTRACTOR, P. S. Marks, London.
11,697. FASTENING WIRE to FENCING STANDARDS, J. Lees, London.
11,698. TRANSPARENT SCALES and PROTRACTORS, H. E. Thomas and J. C. Shrader, London.
11,699. PRESERVING FISH in GUTS, J. A. Meylers, London.
11,700. REGULATING DRAUGHT in STOVES, C. D. Abel.—(*C. de Choubersky, Paris.*)
11,701. EXTRACTING GOLD and SILVER from ORES, H. M. Whitehead, London.
11,702. ROAD CARRIAGES, H. J. Haddan.—(*J. Vidal-Bonnafous, Carcassonne.*)
11,703. SECURING TILES, &c., to WALLS and other like SURFACES, J. N. Peake, London.
11,704. RAILWAY POINTS, W. A. Barlow.—(*L. Lutz, Göppingen.*)
11,705. ALLOYS of COPPER and ZINC, J. W. Woore, London.
11,706. WARPERS' and WEAVERS' BEAMS, J. W. Holmes, London.
11,707. SHUTTLE BOX, J. W. Holmes, London.
11,708. POWER-LOOM SHUTTLE GUARDS, J. W. Holmes, London.
11,709. ELECTRIC CLOCK, T. Calliphronas, London.
11,710. SPECTACLES, A. J. Boult.—(*B. Frank, Eisepach.*)
11,711. AMMONIA, A. Feldmann, London.
11,712. AUTOMATIC BRAKES, J. Alston, London.
11,713. SCREWED STOPPERS for BOTTLES, H. W. Caton and A. R. Stocker, London.
11,714. SPRING-PROPELLED CARRIAGES, E. Edwards.—(*A., W., and E. Schwickert, Hoechst.*)
11,715. ELECTRICAL SIGNALLING, W. R. Lake.—(*The Equitable Electric Company, Incorporated, U.S.*)

28th August, 1884.

11,716. FIRE HOSE, F. Reddaway, Manchester.
11,717. HAND and STEAM STEERING GEAR, J. H. Smiles, Stockton-on-Tees.
11,718. VENTILATORS, R. Stanley, Nuneaton.
11,719. CRICKET WICKETS, J. Southall, Worcester.
11,720. MECHANISM for the PROPULSION of TRICYCLES, F. J. Harrison, London.
11,721. NAME, &c., PLATES, H. Franklin and B. W. Hornblower, Birmingham.
11,722. WOODWORKING MACHINERY, &c., J. Hamilton, Derby.
11,723. SPRING MATTRESSES, J. Clark, Birmingham.
11,724. DRIVING ONE of a PAIR of ROLLS from the OTHER, J. W. Bretherick, Liverpool.
11,725. STEAM BOILERS, J. McG. McCulloch, Liverpool.
11,726. FILTERING WATER, &c., J. P. Jackson, Liverpool.
11,727. BALL VALVE, H. Trott, London.
11,728. COFFEE MACHINES, L. Hamel, London.
11,729. SPRING MATTRESS, J. K. Wilder, Glasgow.
11,730. SHOT GUNS, W. Ford, London.
11,731. PRESSING ROLLERS, A. F. Link.—(*P. Rochatte, La Petite Raon, and C. Baur, père, Sulz.*)
11,732. PACKING, &c., MATERIAL, B. Rhodes, London.
11,733. LAYING UNDERGROUND CONDUCTING WIRES, B. P. Stockman, London.
11,734. PREVENTING COLLISIONS at SEA, C. C. P. Fitzgerald, Greenwich.
11,735. COMPOUND for EXTINGUISHING FIRE, H. Gardner.—(*R. A. Saalfield, U.S.*)
11,736. PLATES for SECONDARY BATTERIES, W. Wilkinson, Deptford.
11,737. GALVANIC CHAINS or BELTS, H. J. Haddan.—(*W. Donnerstag, Stettin.*)
11,738. STORAGE BATTERIES, H. Edmunds, jun., London.
11,739. CHEEKBIT MARTINGAL for HORSES, Baron E. de S. de Cortenberg, London.
11,740. SPECTACLES, T. Baird, London.
11,741. COLLARS for SHIRTS, &c., J. S. Weingott, London.
11,742. FRICTION CLUTCHES, J. H. Hamilton, London.
11,743. METAL TUBES, A. Latch, London.
11,744. MAST-HEAD SHEAVES, &c., E. F. Jones and J. Peterkin, London.
11,745. JOINTS for the PLATES of SAFES, &c., A. D. Bryce-Douglas, London.
11,746. THREADS, A. Mitscherlich, London.
11,747. ELECTRIC SIGNALLING LETTER-BOX, &c., W. J. Baker, London.

29th August, 1884.

11,748. PREVENTING PUTREFACTIVE CHANGE in HUMAN BODIES, T. Bayley, Birmingham.
11,749. CARRIAGE SPRING, C. Windover, Huntingdon.
11,750. GAS ENGINES, G. C. Douglas, Dundee.
11,751. TAMBOUR FRAME for LACE WORKERS, M. A. Turner, London.
11,752. CIRCULAR KNITTING MACHINES, W. Rothwell, London.
11,753. SPINNING and DOUBLING COTTON, &c., C. W. Lyon and W. Fearn, Manchester.
11,754. CUTTING FIREWOOD, H. Sanders, London.
11,755. WIRE FENCING, P. S. Brown, Glasgow.
11,756. BOTTLES, J. Armstrong, London.
11,757. CUTTING BOOK EDGES, H. J. Haddan.—(*Dietz and Listing, Leipzig.*)
11,758. CLOCKWORK ESCAPEMENT, H. J. Haddan.—(*F. Béal, fils aîné, La Chaise-Dieu.*)
11,759. BOTTOM PLATE for RAG ENGINES, T. Biggin and G. Elliott, London.
11,760. MANIFOLD WRITING APPARATUS, A. P. Hodgson, London.
11,761. CARD for MOUNTING TRANSPARENCIES, E. V. Emery, London.
11,762. VELOCIPEDES, O. Ber, London.
11,763. WEAVING CARPETS, &c., E. Crossley and H. N. Mellor, London.
11,764. FIRE-GUARDS, &c., H. E. Clark, London.
11,765. HOSIERY, J. H. Woodward, London.
11,766. THROTTLE VALVES, H. J. Pearson, London.
11,767. TIME SIGNAL, R. Howson, London.
11,768. SHIRTS, R. Young, London.
11,769. SPEED INDICATORS, F. A. Field, London.
11,770. VARIABLE BLAST NOZZLE, W. Wilkinson, London.
11,771. APPARATUS for GROWING PLANTS, &c., A. Booty, London.
11,772. SAND MOULDS, J. Y. Johnson.—(*E. Körting, Hanover.*)
11,773. PUNCHING the EYES in PICKS, &c., J. B. Jackson, London.
11,774. BATS for PLAYING LAWN TENNIS, J. C. Rogers, London.
11,775. PURIFYING BICARBONATE of SODA, H. Gaskell, jun., London.
11,776. WHEELS, F. H. Lloyd, London.
11,777. HALL, &c., LAMPS, C. W. Torr, London.—*8th August*, 1884.
11,778. STEAM TRAPS, J. French, J. Hayes, and T. H. Hodge, London.
11,779. SCISSORS and SHEARS, E. Nunan, London.
11,780. DISPOSING of REFUSE ORGANIC MATTERS, T. Hawksley, Brighton.

30th August, 1884.

11,781. FLUES, &c., of STEAM BOILERS, S. Webster, Liverpool.
11,782. AUTOMATIC WHITEWASHER, J. Hall, Sheffield.
11,783. SPINNING, &c., FIBRES, R. Curtis and J. Wain, Manchester.
11,784. PARCEL-BOX, J. Malcolm and J. Simpson, Glasgow.
11,785. RING and TRAVELLER APPARATUS, W. H. Bramall, J. Wolstenholme, and W. Napier, Manchester.
11,786. GALVANIC BATTERIES, B. A. Slade.—(*C. E. O'Keenan, Paris.*)
11,787. HAYMAKING MACHINES, H. Bamford, Birmingham.
11,788. STARTING TRAMWAY-CARS, &c., E. T. Ponting, London.
11,789. SELF-ACTING HYDRO-PNEUMATIC ENGINE, S. P. Chease and E. F. Boehm, Liverpool.
11,790. PIKE for SLAUGHTERING CATTLE, J. A. Milbourne, Manchester.
11,791. RETAINING GLASSES at an ANGLE, W. H. H. Morgan, London.
11,792. MACHINE for MINING CLAY, J. H. Key, Newton Abbot.
11,793. MAKING WOVEN FABRICS, T. Rigg, London.
11,794. LOOMS, J. Gath, London.
11,795. MEANS for DRIVING POTTERS' WHEELS, J. A. Keetch, Bristol.
11,796. STONE-BREAKING &c., MACHINERY, G. Lowry, London.
11,797. BURNERS of TABLE, &c., LAMPS, W. B. Woolley, London.
11,798. CHAIRS, J. Allen, Leeds.
11,799. DRIVING GEAR for BICYCLES, W. T. Cave, Birmingham.
11,800. BARREL DOOR BOLTS, J. Banks, London.
11,801. TELESCOPE KEYLESS WATCH WINDER, J. Brecknell, London.
11,802. FEED-WATER PURIFIERS, W. E. Gedge.—(*The California Feed-water Purifying Co., U.S.*)
11,803. WASHING TROUGHS for PHOTOGRAPHIC NEGATIVES, F. Bishop, London.
11,804. REEDS for ORGANS, &c., H. Smith, London.
11,805. PHOSPHATES, P. M. Justice.—(*S. G. Thomas, Paris.*)
11,806. DRIVING SPINNING MULES, L. and G. Baxter, L. Rushworth, and H. Clough, London.
11,807. PAPER COP TUBES, A. Knox, London.
11,808. GUNPOWDER, R. W. S. Griffith, London.
11,809. SEPARATING DIAMONDS, GOLD, from EARTHY MATTERS, C. J. Ball, London.
11,810. BARS or CHAINS of SLEEVE LINKS, E. Dobell, London.
11,811. RAILWAYS, R. G. and F. A. Fairlee, and R. H. Hepburn, London.
11,812. CHAINS for TRANSMITTING MOTIVE POWER, J. I. Warman, London.
11,813. MATERIAL for STAMPING PADS, F. H. Markgraf, London.
11,814. LAVATORY APPARATUS for SCHOOLS, &c., H. R. Butson, London.
11,815. RAISING, &c., GEAR for MULTIPLE PLOUGHS, C. D. Abel.—(*F. W. Grahmann and W. Allé, Riga.*)
11,816. PAPER BOLT, A. Mitscherlich, London.
11,817. MORTISE BOLT, E. J. Lines, London.
11,818. MOTION of SHUTTLES of LOOMS, H. J. Haddan.—(*N. Drucbert, Fourmies.*)
11,819. AUTOMATIC SHIP MOTOR, E. J. W. Clayton, London.
11,820. BOOTS, &c., A. C. Wilczynski, London.
11,821. PENCIL SHARPENER, B. S. Cohen, London.
11,822. PREVENTING RATTLING of CARRIAGE SASHES, G. D. Peters, London.
11,823. GAS REGULATORS, &c., J. and W. Goodson, London.
11,824. DYEING TEXTILE MATERIALS, W. R. Lake.—(*C. Corron, St. Etienne.*)

1st September, 1884.

11,825. INHALATION of VAPOURS, F. D. Delf, Dewsbury.
11,826. FLASK with DRINKING GLASS, P. Thornton and E. Fleming, Barnsley.
11,827. TREATING ORES for SULPHIDE of ANTIMONY, J. Simpson and E. W. Parnell, Liverpool.
11,828. TREATING ORES for SULPHIDE of ANTIMONY, E. W. Parnell and J. Simpson, Liverpool.
11,829. SLIDING SEAT for BOATS, J. C. Green, Portsmouth.
11,830. DIP REGULATOR, J. R. Heath, Stoke-on-Trent.
11,831. SAFETY-VALVES, &c., J. McKellar, Belfast.
11,832. VALVE-COCKS, J. McKellar, Belfast.
11,833. INHALATION APPARATUS, R. Garbett, Birmingham.
11,834. TREATING "HOOSE," &c., in ANIMALS, R. Garbett and T. Simpson, Birmingham.
11,835. PRESERVING FLORAL SPECIMENS, J. Saward, London.
11,836. SEAT for VELOCIPEDES, W. Barnwell, Birmingham.
11,837. GAS ENGINES, W. Clark.—(*G. M. Hopkins, U.S.*)
11,838. SPINNING and DOUBLING COTTON, &c., R. Tatham, Manchester.
11,839. CIGARETTE-MAKING MACHINE, B. Salmon and M. Gluckstein, London.
11,840. SOLIDIFYING URINE, W. W. Daw, Chadwell Heath.
11,841. CONVEYANCE of TELEGRAPHIC WIRES, H. H. Martyn, London.
11,842. SHIRTS, W. P. O'Neill, London.
11,843. WORKING TELEPHONIC EXCHANGES, L. J. Crossley, J. F. Harrison, and W. Emmott, London.
11,844. PIPES and CIGAR-HOLDERS, &c., S. S. Allin, London.
11,845. TOY FIGURES, W. R. Lake.—(*E. A. Cooper and F. Sibley, U.S.*)
11,846. PURIFYING MIDDLINGS, W. R. Lake.—(*The Knickerbocker Company, U.S.*)
11,847. BOLTING or SEPARATING APPARATUS for use in FLOUR-MILLS, W. R. Lake.—(*The Knickerbocker Company, U.S.*)
11,848. BOLTING or SEPARATING APPARATUS for use in FLOUR-MILLS, W. R. Lake.—(*The Knickerbocker Company, U.S.*)
11,849. FOLDING FIRE LIGHTERS, S. Lloyd, London.
11,850. TOBACCO-PIPES and CIGAR-HOLDERS, W. R. Lake.—(*H. Kemperling, Vienna.*)
11,851. MARINE STEAM BOILERS, C. D. Abel.—(*J. F. Belleville, Paris.*)
11,852. WATCHES, R. Squire, London.
11,853. SECONDARY BATTERIES, E. G. Dornbusch, London.
11,854. KEYBOARD MUSICAL INSTRUMENTS, E. B. Purdon, London.
11,855. DECORATION of GLASS, A. Laurence, London.
11,856. PLOUGHS, H. J. Haddan.—(*A. Cosson, Villemuzard.*)
11,857. BUCKLES, F. J. Candy, London.
11,858. INCOMBUSTIBLE COMPOUNDS, W. R. Lake.—(*La Société Vve. Wendt et Hérard, Nancy.*)
11,859. MACHINES for BEVELLING GLASS, W. R. Lake.—(*N. Vogley, Lyons.*)

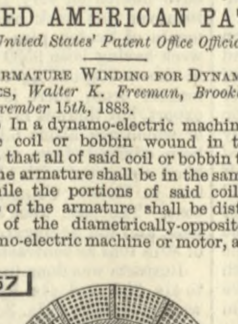
SELECTED AMERICAN PATENTS.

From the United States' Patent Office Official Gazette.

302,557. ARMATURE WINDING FOR DYNAMO-ELECTRIC MACHINES, *Walter K. Freeman, Brooklyn, N.Y.—Filed November 15th, 1883.*

Claim.—(1) In a dynamo-electric machine or motor, an armature coil or bobbin wound in the manner described, so that all of said coil or bobbin that is upon one side of the armature shall be in the same armature division, while the portions of said coil upon the opposite side of the armature shall be distributed on either side of the diametrically-opposite division. (2) In a dynamo-electric machine or motor, a cylindrical

302557

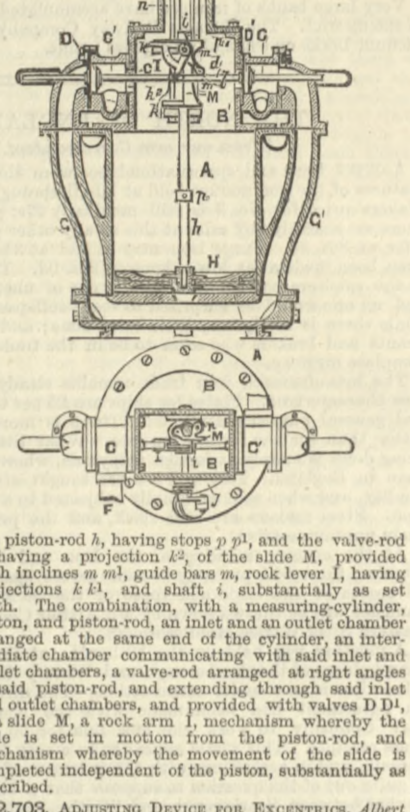


armature wound with a set of coils or bobbins disposed in the manner described, with the half of each coil that lies upon one side of the armature laid in the same armature division, while the remaining half that lies upon the opposite side of the armature is laid in two equal portions in division to either side of the diametrically-opposite division.

302,561. LIQUID METER, *Roger W. Graves, Buffalo, N.Y.—Filed September 28th, 1883.*

Claim.—The combination, with a measuring-cylinder A, piston H, and piston-rod h, of the valve chambers C C^1, arranged at the same end of the cylinder, intermediate chamber B^1, communicating with the cylinder and said valve chambers, ports G G^1, extending from said valve chambers to the opposite end of the cylinder, valve rod d, arranged at right angles to the piston-rod, valves D D^1, secured to said valve-rod, and mechanism whereby the valve-rod is actuated from the piston-rod, substantially as set forth. The combination, with the cylinder A, piston H, and piston-rod h, valve chambers C C^1, arranged at the same end of the cylinder, intermediate chamber B^1, communicating with the cylinder and said valve chambers, valve-rod d, arranged at right-angles to the piston-rod, and extending through said valve chambers, and provided with valves D D^1, of the rock arm I and slide M, and mechanism whereby an intermittent reciprocating movement is imparted to the slide from the piston-rod, substantially as described. The combination, with the piston-rod h, having stops p p^1, and the valve-rod d, having a projection k^2, of the slide M, provided with inclines m m^1, rock arm I, having projection k k^1, and arm l, substantially as set forth. The combination, with

302561

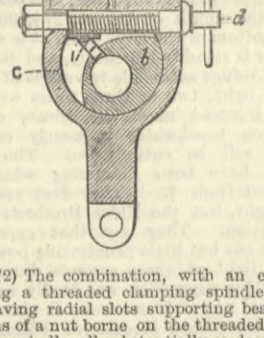


the piston-rod h, having stops p p^1, and the valve-rod d, having a projection k^2, of the slide M, provided with inclines m m^1, guide bars m, rock lever I, having projections k k^1, and shaft i, substantially as set forth. The combination, with a measuring-cylinder, piston, and piston-rod, an inlet and an outlet chamber arranged at the same end of the cylinder, an intermediate chamber communicating with said inlet and outlet chambers, a valve-rod arranged at right angles to said piston-rod, and extending through said inlet and outlet chambers, and provided with valves D D^1, of a slide M, a rock arm I, mechanism whereby the slide is set in motion from the piston-rod, and mechanism whereby the movement of the slide is completed independent of the piston, substantially as described.

302,703. ADJUSTING DEVICE FOR EXCENTRICS, *Albert T. Booth, Meriden, Conn.—Filed April 20th, 1883.*

Claim.—(1) In combination, an excentric strap c, bearing in a socket at the end of its arms the rotary screw-threaded spindle d, a nut g, with connected bearers i, excentric b, with peripheral mortise and radial slots, and the crank pin a, all substantially as

302703



described. (2) The combination, with an excentric strap bearing a threaded clamping spindle, of an excentric having radial slots supporting bearers for the trunnions of a nut borne on the threaded shaft of the clamping spindle, all substantially as described.

CONTENTS.

IT is expected that the electric light in the tower at Hallett's Point, Hell Gate, will be in operation before the close of the present month.