ELASTIC EXTENSION: A SPECIES OF MOTION.

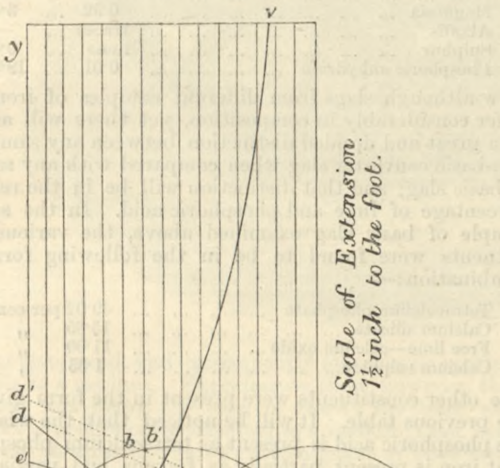
By ROBERT HUDSON GRAHAM.

(1) *Classification.*—For a long time past the subject of elasticity, in the particular form of experiments upon the strength of metallic wire, bars, or plates, has engaged the time and attention of a number of scientific men, who have repeatedly put on record the behaviour of different brands of iron and steel under gradually increased loads. So far, however, and in defiance of an inexhaustible supply of neat autographic diagrams, there exists no reasonable or satisfactory theory of the distinctive and characteristic features which these diagrams display. And yet the mere mechanical reproduction of a curve, with the added comment that it rises here and falls there, that the limit of elasticity is remarkably high, and that the specimen finally broke under a registered tension of so many tons per square inch, with a certain specific extension, does not carry us very far towards a complete solution of the problem. Nevertheless, such information is extremely valuable as a check upon speculative deductions made outside the laboratory. The fragmentary history of experimental tests has revealed to us phenomena such as the increase of the rate of extension with the rate of load, the intensified acceleration of fracture in the post-elastic stages of the experiment, and many other signs, all tending to show that elasticity is a special, although very odd and peculiar, form of motion, and therefore that elastic extension is subject to the same laws of velocity and acceleration that govern movement under more visible and tangible conditions.

(2) *The velocity of extension.*—Consider the curve $o\,v$, Fig. 1, which represents a test made by Professor Kennedy, of University College, London, described in the "Proceedings" of the Institution of Mechanical Engineers, April, 1881.

It is unnecessary to examine the test prior to the limit of elasticity, because from zero up to that limit the extension is nearly uniform, and therefore proportional to the load; or, in other words, the locus of extension is a straight line, the tangent of whose inclination to the axis of x is constant and equal to $\frac{d\,y}{d\,x}$, the uniform velocity of motion. But beyond the limit of elasticity the situation rapidly changes, the strain speed is greatly accelerated, and the locus of extension is no longer a straight line, but a pronounced curve.

Fig. 1



In order, therefore, to study the nature of this post-elastic curve, take the origin of co-ordinates at o, the limit of elasticity; let equal divisions of the axis of x correspond to equal additions of load in equal times, extensions being measured parallel to the axis of y, and let $o\,l = 2\,r$ be termed the *range* of the test, extending from the limit of elasticity to the limit where the ordinate becomes infinite and tangent to the curve. Then observe the following construction, which will be justified in the course of the paper. Upon the range $o\,l$ as diameter describe the semicircle shown in the figure. Produce any ordinate $a\,c$ of the curve to meet the circumference of the range circle in b; set off the length $o\,k = 3\,r$, or thrice the radius of the range circle, and from k draw the secant $k\,b$, intersecting the axis of ordinates in d, from which draw a normal $d\,x$ to the tangent to the curve at the chosen element $c\,c^1$. Let this normal meet the axis of abscissæ in a point x. Then by similar triangles we have, since equal $d\,x$ correspond to equal $d\,t$,

$$\frac{d\,y}{d\,t} = \frac{o\,x}{o\,d} \quad . \quad . \quad . \quad . \quad (1)$$

From x draw $x\,e$ parallel to $d\,k$, and join $k\,e$. Repeat the same operation for the succeeding element of the curve, corresponding to the ordinate $a^1\,c^1$, and so on for other curve elements, when it will be found that all pairs of lines of the kind $a\,c$ and $e\,k$ meet in a point upon the extension curve. Hence

$$\frac{o\,x}{o\,k} = \frac{o\,e}{o\,d}$$

or

$$o\,x = \frac{o\,k \cdot o\,e}{o\,d}.$$

Wherefore, substituting for $o\,x$ in equation (1)

$$\frac{d\,y}{d\,t} = \frac{o\,k \cdot o\,e}{o\,d^2}. \quad . \quad . \quad . \quad . \quad (2)$$

This equation enables us to calculate the velocity of extension at any instant of time. For example, suppose t to be represented by $o\,a$ or five time-units; erect the perpendicular $a\,c$, intersecting the curve and range circle in c and b respectively, and project these two points from the fixed focus k upon the axis of ordinates in e and d respectively; then the velocity

$$\frac{d\,y}{d\,t} = \frac{o\,k\,.\,o\,e}{o\,d^2} = \frac{22{\cdot}5 \times 4{\cdot}5}{81} = 1{\cdot}25,$$

all quantities being expressed in terms of the scalar unit $d\,t$, of which there are 15·5 to the scalar inch, so that in inches

$$\frac{d\,y}{d\,t} = 0{\cdot}08\text{in.} \quad . \quad . \quad . \quad . \quad . \quad (3)$$

But this expression for the velocity can be reduced to a much simpler and more convenient form; for rebat $o\,d$ upon $o\,x$, making $o\,z = o\,d$; join $e\,z$, perpendicular to which draw $z\,h$, insecting the line $o\,y$ produced in h, then obviously

$$o\,h = \frac{\overline{o\,d}^2}{o\,e},$$

and by substitution in equation (2),

$$\frac{d\,y}{d\,t} = \frac{o\,k}{o\,h} = \frac{k}{h} \quad . \quad . \quad . \quad . \quad . \quad (4)$$

(3) *Elastic acceleration.*—Differentiating the value of the velocity of extension, as given in equation (4), in order to obtain the elastic acceleration at any instant, we have

$$\frac{d^2\,y}{d\,t^2} = \frac{-k}{h^2} \cdot \frac{d\,h}{d\,t} \quad . \quad . \quad . \quad . \quad . \quad (5)$$

where, as shown in the figure, $\frac{d\,h}{d\,t} = h_5\,h_6$, for $t = 5$.

This graphic expression for the acceleration at any instant can be further reduced by joining $k\,h_5$, and setting of a line $h_5\,x_5$ perpendicularly to $k\,h_5$, intersecting the axis of x produced in x_5, then obviously, if $o\,x_5 = x_5$,

$$\frac{d^2\,y}{d\,t^2} = \frac{-h_5\,h_6}{x_5} \quad . \quad . \quad . \quad . \quad . \quad (6)$$

For example, when $t = 5 = o\,a$, we have $h_5 = 19$, $d\,h = h_5\,h_6 = 3{\cdot}5$.

$$\frac{d^2\,y}{d\,t^2}\left[\begin{array}{l} = 0{\cdot}218, \text{ in terms of } d\,t \\ = 0{\cdot}014067\text{in.}\end{array}\right.$$

In order to put a right interpretation upon this expression for the elastic acceleration at any instant of time, let us assume that the influence of the weight and inertia of the specimen is, for all practical purposes, *nil*; and that the tension is uniform along the whole length of the test-piece, or that the elemental extension $d\,y$ is the same for all elemental lengths $d\,x$. Let y^1 be the extension in the length l due to the instantaneous tension, which, of course, varies from instant to instant; then the corresponding specific extension per unit of length will be $\frac{y^1}{l}$; and if $\varpi =$ the sectional area, E the coefficient of elasticity, the total tension at the time t is $E\,\varpi\,\frac{y^1}{l}$.

Now, if the load added per unit of time be represented by $\frac{d\,p}{d\,t}$, the actual load upon the specimen is equal to $t\,.\,\frac{d\,p}{d\,t}$, and the resistance to acceleration of the mass $\frac{t}{g}\cdot\frac{d\,p}{d\,t}$ of this load will be $\frac{t}{g}\cdot\frac{d\,p}{d\,t}\cdot\frac{d^2\,y}{d\,x^2}$. The moving force $t\,\frac{d\,p}{d\,t}$ has to overcome this resistance *plus* the tensional resistance to extension, which has just been expressed in the form $E\,\varpi\cdot\frac{y^1}{l}$; hence we have the equation—

$$\frac{t}{g}\,.\,\frac{dp}{d\,t}\,.\,\frac{d^2\,y}{d\,x^2} + E\,\varpi\,.\,\frac{y^1}{l} = t\,\frac{dp}{d\,t},$$

$$\text{or,} \quad \frac{d^2\,y}{d\,t^2} = g - \frac{g}{t\,\frac{d\,p}{d\,t}}\,.\,E\,\varpi\,\frac{y^1}{l} \quad . \quad . \quad (7)$$

In order to improve the form of this equation, let us represent the extension due to the static load $t\,\frac{dp}{d\,t}$ by y_o; so that

$$y_o = t\,\frac{d\,p}{d\,t}\,.\,\frac{l}{E\,\varpi}.$$

Substituting in equation (7),

$$\frac{d^2\,y}{d\,t^2} = -\,g\left(\frac{y^1 - y_o}{y_o}\right) = \frac{-g\,z}{y_o} \quad . \quad . \quad (8)$$

where z is the difference between the elastic extension y^1 and the static extension y_o, both taken at the same phase of the test.

Thus, then, according to equation (8), we have the relation

$$\frac{\text{elastic acceleration}}{\text{gravity acceleration}} = \frac{\text{elastic} - \text{static extension}}{\text{static extension}}$$

Now, it will be observed that the static extension $y_o = \beta\,t$, where $\beta = \frac{l}{E\,\varpi}\,.\,\frac{dp}{d\,t}$, a constant; wherefore, taking $d\,t$ as the scalar unit, we find from a comparison of equations (5) and (8) that

$$\frac{d^2\,y}{d\,t^2} = \frac{-\,g\,z}{\beta\,t} = \frac{-\,o\,k\,.\,d\,h}{h^2},$$

which equation furnishes the difference z between the elastic and static extension, or what may be termed the *elastic excess*, in the convenient form

$$z = \frac{o\,k\,.\,d\,h}{h^2}\,.\,\frac{\beta\,t}{g} = \frac{c\,.\,t\,d\,h}{h^2} \quad . \quad . \quad (9)$$

where $c = \frac{\beta}{g}\,.\,o\,k$, a constant. But according to the drawing, $d\,h$ varies approximately as h; therefore we conclude from (9) that z varies directly as the time and inversely as h. In this value of z, β and g are expressed in inches and z in terms of $d\,t$. Having calculated the value of z, we have $y^1 = y_o + z$, and the actual value of the tension is $E\,\varpi\,.\,\frac{y^1}{l}$. To exemplify the use of these forms, let us work out the example represented in the figure, in which $\frac{d\,p}{d\,t} = 2000$ lb., $l = 10$in., $t = 5$, and $E = 29{,}000{,}000$. This value of E is not furnished by Professor Kennedy, but cannot be much in error. With these data and the graphic results of the figure combined, we find—

log. β	$\bar{4}{\cdot}83863$, a constant	
log. $\beta\,.\,o\,k$	$\bar{2}{\cdot}19081$,	„
„ $\frac{\beta\,.\,o\,k}{g}$	$\bar{5}{\cdot}60648$,	„
„ z_5	$\bar{6}{\cdot}29202$, in terms of $d\,t$	
„ y_0	$\bar{2}{\cdot}72793$, for 5 secs. and in $d\,t$	
„ $\frac{z_5}{y_0}$	$\bar{5}{\cdot}56409$	

The ordinary theory of elasticity being based upon the assumption that the actual tensional resistance is $E\,\varpi\,\frac{y_o}{z}$, instead of $E\,\varpi\,\frac{y^1}{z}$, would lead us to very erroneous conclusions; not only because it takes no account of the loss of tension by reason of contraction of the sectional area, whilst the test-piece increases in length; but also because it neglects the loss through the gradual debasement of the metal, which becomes more and more plastic as the time of fracture draws nearer.

(4) *The curve of extension.*—In order to find the equation to the elastic curve $o\,v$, it is only necessary to integrate equation (4); thus, in

$$\frac{d\,y}{d\,t} = \frac{k}{h}$$

substituting for h its value $\frac{\overline{o\,z}^2}{o\,e} = \frac{\overline{o\,d}^2}{o\,e}$, we find

$$\frac{d\,y}{d\,t} = \frac{o\,k \cdot o\,e}{\overline{o\,d}^2};$$

where, according to the drawing,

$$\frac{o\,e}{o\,d} = \frac{y}{a\,b},\ \frac{o\,k}{o\,d} = \frac{a\,k}{a\,b},$$

and $\quad o\,k = 3r;\ a\,k = (3r - t);\ \overline{a\,b}^2 = t\,(2r - t).$

After substitution of these values in the above form for $\frac{d\,y}{d\,t}$, we obtain $\frac{d\,y}{d\,t} = \frac{(3r - t)}{t\,(2r - t)}$

$$\text{or} \quad \frac{1}{y}\,\frac{d\,y}{d\,t} = \frac{1}{\sqrt{\frac{t^3}{2r - t}}}\,.\,\frac{d}{d\,t}\left(\sqrt{\frac{t^3}{2r - t}}\right).$$

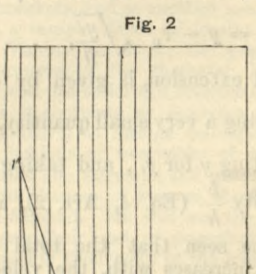
Integrating this equation,

$$\log.\,y = \log.\,\sqrt{\frac{t^3}{2r - t}}$$

$$\text{and} \quad y = \sqrt{\frac{t^3}{2r - t}}. \quad . \quad . \quad . \quad . \quad (10)$$

This cissoidal curve can also be directly derived from the geometrical relations of the figure. It correctly represents the extension curve in the special case under review, the difference between the ordinates, as given by Professor Kennedy and as reduced from equation (10), being so slight as scarcely to be visible upon the scale. The coincidence is still more marked in the example represented in Fig. 2, which, stripped of the geometric staging, is the exact reproduction of the curve traced by Professor Unwin for aluminium bronze. (THE ENGINEER, January

Fig. 2



14th, 1887.) It will be seen that this quality of bronze has a very short post-elastic range owing to the great steepness of its curve and the plastic nature of the material.

The curve, Fig. 1, which we venture to call the envelope of velocity and acceleration, is similar in character to the original extension curve. It is, in more explicit terms, the curve envelope of the tangent lines drawn from points z to points h.

(5) *The rate of load addition.*—Let the normal extension, or the total extension less that due to vibratory effect of the load at the time t, be termed y_t, and let y be the variable extension during the period of vibration which necessarily succeeds every increment of load; then

$$y - y_t = z^1$$

will be the increase or diminution of y_t at any phase of the vibration.

Now, we may safely assume, as already proved for the analogous case of elastic acceleration, (§ 3), that

$$\frac{\text{vibratory acceleration}}{\text{gravity acceleration}} = \frac{y - y_t}{y_t} = \frac{z^1}{y_t};$$

whence

$$\text{vibratory acceleration} = \frac{z^1}{y_t} \cdot g;$$

or, counting time from the origin of vibration,

$$\frac{d^2 z^1}{d t^2} = \frac{-z^1}{y_t} g$$

and

$$\frac{d^2 z^1}{d t^2} + \frac{z^1}{y_t} g = o.$$

Integrating this equation by known methods,

$$z^1 = \text{A} \cos. t \sqrt{\frac{g}{y_t}} + \text{B} \sin. t \sqrt{\frac{g}{y_t}}, \quad (11)$$

in which A and B are arbitrary constants to be determined by the conditions of the problem. Thus, when $t = o$, $z^1 = o$, and therefore $\text{A} = o$. Moreover, the normal extension y_t for a given phase t of the experiment is constant, and continues so during the whole period of vibration at that phase, which may be assumed to reach a maximum before the next increment of load begins to take effect; for, inasmuch as the increase of load is continuous, it is impossible for the vibration to go back or to sink below the normal extension y_t. We shall therefore take this maximum value of z^1 as the increase of extension arising from the vibratory effect of the load.

Differentiating Equation (11), in order to find the velocity

$$\frac{d z^1}{d t} = \frac{d}{d t}\left(y - y_t \right) = v =$$

$$\frac{d y}{d t} = -\text{A} \sqrt{\frac{g}{y_t}} \cdot \sin. t \sqrt{\frac{g}{y_t}} + \text{B} \sqrt{\frac{g}{y_t}} \cos. t \sqrt{\frac{g}{y_t}};$$

but, when $t = o$, $\frac{d y}{d t} = v_o$; therefore A being zero, we have

$$v_o = \text{B} \sqrt{\frac{g}{y_t}}; \quad \text{B} = v_o \sqrt{\frac{y_t}{g}};$$

whereby Equation (11) takes the simpler form—

$$z^1 = v_o \sqrt{\frac{y_t}{g}} \cdot \sin. t \sqrt{\frac{g}{y_t}} \quad . \ . \ . \ . \ . \ (12)$$

This value of z^1 attains a positive maximum for $t \sqrt{\frac{g}{y_t}} = \frac{\pi}{2}$, or $t = \frac{\pi}{2} \sqrt{\frac{y_t}{g}}$; a negative maximum for $t = \frac{3}{2} \pi \sqrt{\frac{y_t}{g}}$; and returns to zero for $t = 2\pi \sqrt{\frac{y_t}{g}}$, which, therefore, would be the period of vibration were it possible to complete it.

Making $t = \frac{\pi}{2} \sqrt{\frac{y_t}{g}}$ in equation (12), we obtain the positive maximum value

$$z_m = v_0 \sqrt{\frac{y_t}{g}};$$

whence

$$y = y_t + z_m = y_t + v_0 \sqrt{\frac{y_t}{g}}$$

and

$$y_t = y - v_0 \sqrt{\frac{y_t}{g}}, \quad . \ . \ . \quad (13)$$

where y, the total extension, is given by equation (10); and $v_0 \sqrt{\frac{y_t}{g}}$, being a very small quantity, may be calculated by substituting y for y_t, and taking the factor v_0 equal to the velocity $\frac{k}{h}$ (Eq. 4, Art. 2), at the time t.

Thus it will be seen that the total extension depends upon, and increases with, the velocity of extension v_o at any phase of the experiment. The increment of extension produced by the vibration of the load and expressed by $v_o \sqrt{\frac{y_t}{g}}$ is always a very small quantity, even in the vicinity of the point of rupture. For example, in the phase $t = 6$ of the case under review, we have $y_t = a^1 c^1 = \frac{1}{3}$ of an inch, $v_o = 0{\cdot}094$in.; and, therefore, $z_m = \frac{27}{10000}$ in. Again, if in the fracture-phase $y_t = 3$in. and $v_o = 1{\cdot}88$in., which are extreme values, z_m only rises to about 0·166 of an inch.

But, although the value of z_m is so small relatively to y_t, it nevertheless serves to explain a peculiar feature of wire experiments—namely, that the extension-curve becomes visibly steeper for quicker rates $\frac{d p}{d t}$ of load-addition, and that the increase in steepness is more visible and pronounced in the later stages of the test—perfectly in accord with what might be anticipated from the form of the function z_m, which varies directly as the velocity v_o and the square root of the normal extension y_t. Now, if the rate $\frac{d p}{d t}$ be increased, it stands to reason that the velocity of extension v_o at any particular phase is likewise increased. In order, however, to illustrate this almost self-evident statement, take a simple hypothetical case in which

$$\frac{d^2 y}{d t^2} = \beta$$

and therefore—

$$\frac{d y}{d t} = \beta\, t, \quad y = \frac{\beta}{2} \cdot t^2.$$

Now, if the rate be varied, the extension y, corresponding to any given load, will, apart from all question of vibration, remain constant. Thus, by doubling the rate of load increase, the time of a given load and extension is halved. Let therefore β^1 represent the value of β under the foregoing conditions, when the rate is doubled and the time halved, then

$$y = \frac{\beta}{2} \cdot t^2 = \frac{\beta^1}{2} \cdot \left(\frac{t}{2}\right)^2 = \frac{\beta^1}{8} \cdot t^2;$$

or,

$$\beta^1 = 4\beta,$$

$$\left(\frac{d y}{d t}\right)^1 = \beta^1 \cdot \left(\frac{t}{2}\right) = 2\,\beta t = 2 \cdot \frac{d y}{d t}$$

$$\left(\frac{d^2 y}{d t^2}\right)^1 = \beta^1 = 4\,\beta = 4 \cdot \frac{d^2 y}{d t^2}.$$

Hence, by doubling the rate $\frac{d p}{d t}$, we have likewise doubled the velocity $v_0 = \frac{d y}{d t}$, and quadrupled the original acceleration.

(6) *The Wicksteed loop.*—The theory of vibration just explained scarcely accounts for the occasional appearance of a plastic wave in what otherwise ought to be a straight line, or a rising curve. This singular wave goes by the name of the Wicksteed loop, having been first observed on diagrams traced by the Wicksteed single-lever testing machine. Most probably it is due to a premature display of plasticity or incohesion of the metal, which disappears under increased tension. It seldom occurs in wire experiments, when the metal is more likely to be homogeneous than in test-pieces of larger cross-section. At all events, it would seem safe to ascribe this loop-effect to some peculiar attribute of the metal, which permits the above-mentioned premature display of plasticity or local incohesion; inasmuch as it is not a general, but rather an exceptional feature, occurring only in experiments upon special brands of iron or steel.

(7) *Wire exper.men s.*—The conclusions of this paper are restricted to ordinary bar and plate curves. Whether or not wire extension curves are also approximately cissoidal is a question to which I have not so far applied any graphic test. But, in any case, even if wire curves were of a different character, the given general method of solution would still subsist, the details of construction of the velocities and accelerations being modified to suit the nature of the curve.

Fig. 3

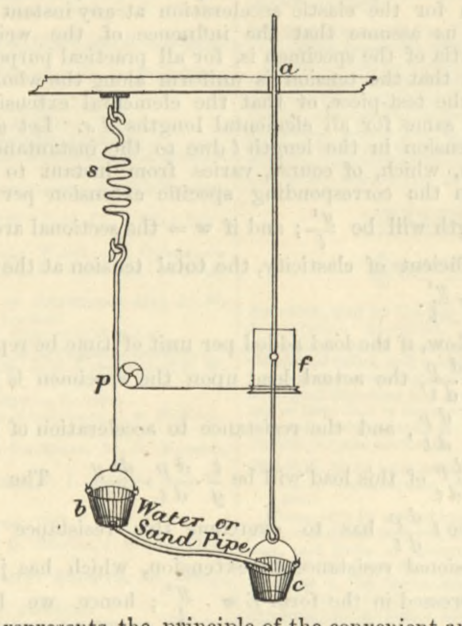


Fig. 3 represents the principle of the convenient apparatus set up in the Yorkshire College by Professor Barr for making wire experiments. The line $a\,c$ is the wire with an index finger at f for tracing the curve upon a revolving drum; b is the discharging, and c the receiving tub; p is a pulley carrying a cord, fastened to the spiral spring s. In the initial stage b is full and the spring drawn down; then, as the sand flows out from b to c, the wire lengthens, whilst the spring contracts, and revolves the drum at so many inches drawn, or so many lbs. of sand delivered per division of time. It was during an experiment performed by Professor Barr with this time-test apparatus that I first witnessed the influence of rate upon the character of the curve. In the next part of the paper we shall deal with the method of assaying extension curves for cissoidicity.

(*To be continued.*)

Progress in the United States Navy.—Captain Bunce, of the Atlanta, has officially reported the result of firing a couple of rounds from the guns of the new ship on July 15, at Gardiner's Island. He says:—"The result of this firing has been to completely disable both 8in. breech-loading gun carriages, and to throw doubt upon the efficiency of the 6in. breech-loading gun carriages and the three-pounder rapid-fire gun mounts. The arrangement of the battery has proved to be bad, as some of the guns have to be abandoned by their crews that the other guns may be fired at the target." The report enclosed shows in detail the extent of the damage, which consists mainly in breakage of electric light plant, driving in of panels, disarrangement of joiner work, breakage of cabin windows, and a slight splintering of the deck.

THE ORIGIN, COMPOSITION, AND USE OF BASIC SLAG.

At the present time the attention of the agricultural world, both here and in Germany, is being directed to the substance known as "basic slag," "basic cinder," "Thomas slag," "Thomas process slag," and under many other names. This substance is produced in the Thomas-Gilchrist process for dephosphorising iron. This process is essentially an improvement of the Bessemer process, and the improvement consists, firstly, in lining the converter with lime; secondly, in adding an additional quantity of lime to the molten iron after it has been run into the converter. The history of this simple, but remarkable and valuable, discovery is of too recent a date and too well known to need repeating here; but it is well to remark that although the discovery was made in England, it is in Germany that some of the more interesting chemical questions in connection with the slag are being investigated with characteristic zeal and pertinacity.

The chemistry of the formation of basic slag is briefly this. During the conversion, which lasts about fifteen minutes, under the influence of the strong air blast bubbling through the molten metal, the impurities become oxidised, producing an enormous rise in temperature, which greatly aids the process of conversion; in this way the manganese is converted into manganic oxide, the carbon into carbonic anhydride, the silicon into silicic anhydride, and the phosphorus into phosphoric anhydride, and what is most important, the phosphorus thus oxidised is immediately removed from the metal, inasmuch as it combines with the lime; part of it therefore remains in the lining, but the greater part rises to the surface along with the other oxidised impurities, and constitutes the "basic slag."

A comparison between the slags produced with and without the basic lining is given below. It must, of course, be understood that the slag varies considerably according to the quality of iron charged into the converter, and, taking this into consideration, we have adopted the composition of an average quality slag in both cases. The numbers are per cent.;—

	Non-basic slag.	Basic slag.
Silicic anhydride (silica)...	46·75	8·20
Alumina	2·80	1·10
Iron oxide (ferrous oxide)	16·86	8·06
„ (ferric oxide)	—	5·14
Manganese oxide (manganous oxide)	32·23	5·24
Lime	1·19	49·90
Magnesia	0·52	3·40
Alkalis	traces	—
Sulphur	none	0·60
Phosphoric anhydride	0·01	19·03

Now although slags from different samples of iron may differ considerably in composition, yet there will always be a great and decided distinction between any sample of non-basic converter slag when compared with any sample of basic slag; and that distinction will be in the relative percentage of lime and phosphoric acid. In the special sample of basic slag examined above, the various constituents were found to be in the following forms of combination:—

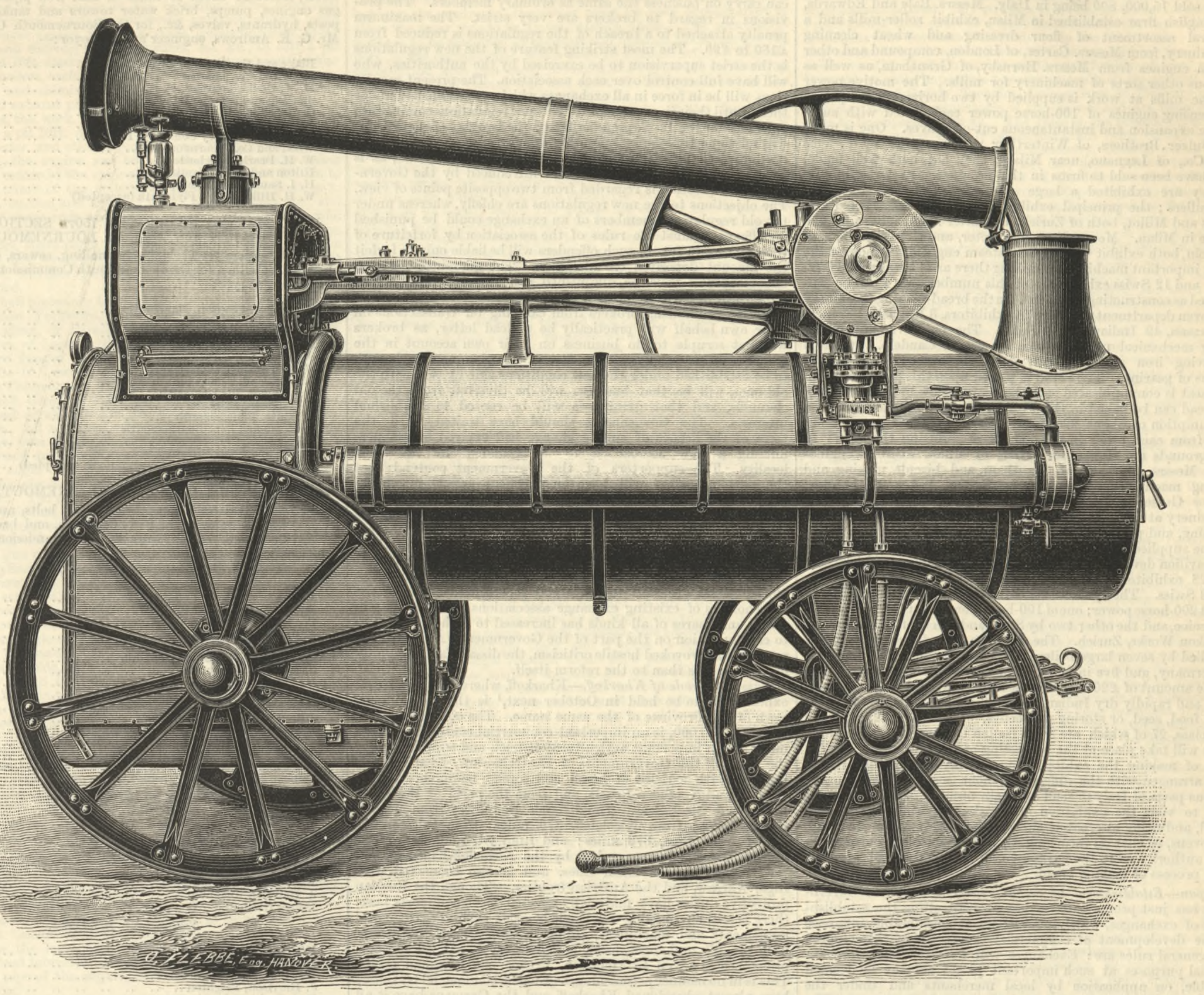
Tetracalcium phosphate	49·02	per cent.
Calcium silicate	15·85	„
Free lime—calcium oxide	11·00	„
Calcium sulphide	1·35	„

The other constituents were present in the form given in the previous table. It will be noticed that the whole of the phosphoric acid is present as tetracalcium phosphate, that iron is present partially as ferrous and partially as ferric, and that the amount of free lime is not very great. It does not contain any iron phosphide. The iron in the slag does not appear to exercise any deleterious action on plants, inasmuch as very good crops have been grown after heavy dressings of basic slag.

With regard to the lime and phosphoric acid, a point of great interest arises. It would appear that under the influence of the very exceptional condition, such as the enormous heat, the molten metallic mass, the excess of lime, &c., a remarkable and novel compound of phosphoric acid with lime is formed, and is found crystallised in the slag. Now as these constituents, the phosphoric acid and lime, of the slag are the most important when considering its manurial value, naturally enough utilitarian investigators took up this side of the subject, and they were rewarded by the discovery of the very interesting fact that the lime appeared in this new form. Opinions differ as to the actual constitution of this compound; some regard it as a salt of a new form of phosphoric acid capable of combining with four equivalents of lime, others consider it merely as a basic salt of ordinary phosphoric acid; but whatever difference of opinion exists as to the constitution, there is no doubt about its composition, that is, that four equivalents of lime are chemically combined with one equivalent of phosphoric acid. It is universally acknowledged among chemists that phosphoric acid is tribasic—that is, capable of holding three equivalents of a base in combination; but we find that in the slag-lime salt the phosphoric acid is holding together four of base, and is really exceeding its strength. Hence, if such really is the case, we may presume that the lime is not held very tightly. If we for a moment turn our attention to other forms of phosphate of lime we shall find that the solubility and manurial value are greatest in the salts containing the smallest percentage of lime, and that as the proportion of lime increases so the solubility and manurial value decrease; thus superphosphate, monocalcium phosphate, $CA\,H_4\,P_2\,O_8$ is known to everybody as a very soluble substance, and a quick-acting and useful manure. Precipitated phosphates, or other forms of dicalcium phosphate, $CA_2\,H_2\,P_2,\,O_8$, is only soluble to a very limited extent, and is far inferior to superphosphate as a manure, whilst tricalcium phosphate, $Ca_3\,P_2\,O_8$, is not only insoluble, but is also comparatively quite valueless as a manure. Reasoning from analogy, we should be quite justified in assuming that the tetracalcium phosphate would be considerably more untractable than the tri-

THE NEWCASTLE ENGINE TRIALS.—COMPOUND PORTABLE ENGINE.

MESSRS. J. AND H. McLAREN, LEEDS, ENGINEERS.



calcium compound, and consequently less soluble and less valuable as a manure. Experiments show, however, that far from this being the case, in reality the basic slag phosphoric acid is more effectual as a manure than even dicalcium phosphate or raw Peruvian guano or bone meal. Such being the case, we have very good reason for supposing that the explanation given above is correct, for owing to the strained state of combination between the lime and phosphoric acid in the basic slag, any matters in the soil capable of combining with lime, such as carbonic acid, humic acid, acid juices of plant roots, and certain soluble salts, can attack and remove lime from its comparatively loose combination in the slag, and in this way bring about the destruction and demolition of the whole combination which results in the phosphoric acid becoming available to plant life. The easily decomposable nature of basic slag with various reagents, and its solubility, have been experimentally proved by numerous investigations.

It is evident from this fact that it is superfluous and wasteful to treat basic slag with acids in order to render its phosphoric acid available to vegetable life. In fact, the slag simply requires to be ground very fine indeed, or else, as some say, to be ground coarsely and exposed to air for a few weeks, then it is in a fit state to be applied as a manure.

The fact that basic slag is a very valuable manure has now passed far beyond the region of doubt. The experiments that have been made in this direction are very numerous indeed, German agriculturists having more especially given the matter their most serious attention. In looking through a great many of these experimental results one is struck by their contradictory nature, but on carefully considering the question it will be found that the differences are not so much due to the slag as to the mode of conducting the experiments, or the soil, or the climate, or other varying conditions. Compare, for instance, these results. It will be noticed what a difference soil makes. These experiments were made with the same sample of slag:—

Description of soil	Yield of grass in kilos. per hectare.	
	Unmanured.	Manured with 600 kilos. basic slag per hectare.
Wet moor land	5600	7750
Sandy water meadow	3966	4350
Meadow land with sand subsoil	4480	4525

Many such examples might be adduced, in which comparisons have been made from experiments which are not comparable. Wagner in Darmstadt has made a series of very elaborate experiments, in which he has eliminated as far as possible such conditions and influences as would interfere with comparison of the effect of manuring with different kinds of phosphatic manures. From his results it is shown that taking the increase in yield given by superphosphate as 100, that the phosphates named below would yield the relative amounts indicated by the figures.

Superphosphate	100
Basic slag, very finely ground	61
Basic slag, finely ground...	51
Peru guano—raw	30
Basic slag, coarsely ground	13
Bone meal, steamed...	10
Ground coprolites	9

Such increases in yield have been obtained with both barley and wheat and other crops. The finest basic slag grains were none larger than 0·1 mm. in diameter; the next degree of fineness consisted of 83 per cent. of 0·1 mm., 17 per cent. between 0·1 and 0·2 mm.; the coarse contained 52 per cent. between 0·1 and 0·2 mm., and 48 per cent. 0·2 to 0·4 mm. It will hence be seen how important a factor pulverising is. In fact, the value to the farmer depends on the amount of phosphoric acid present in the slag, and on the degree of fineness to which the slag has been reduced.

As one might expect, basic slag is very suitable for putting on acid soils, and has been used with success in the recovery and cultivation of moor lands. It has also proved successful on clay lands, on meadows, in vineyards, and in orchards; and in fact will no doubt be found generally useful as a phosphatic manure, where such are required, and where there is not too much lime in the soil. In using basic slag instead of superphosphate, double the quantity of phosphoric acid should be allowed as would have been applied as superphosphate.

COMPOUND PORTABLE ENGINE.

IN previous impressions we have published engravings of the engines of Messrs. Foden and Sons, and of Messrs. Davey, Paxman, and Co. We now give above a perspective view of the compound engine of Messrs. J. and H. McLaren. This engine has already been fully described in our pages. It will suffice to say here that it has cylinders 5¾in. and 9in. diameter and 15in. stroke. Copies of the official diagrams taken at Newcastle will be found on page 105 in our issue for August 5th inst.

AT a meeting of a special committee of the Featherstone Local Board—West Riding—held on Friday last, Mr. Malcolm Paterson, M. Inst. C.E., was appointed to report on the best means of supplying the district with water.

ABSTRACTS OF CONSULAR AND DIPLOMATIC REPORTS.

Austria—Means employed to increase export trade.—During 1886 several earnest and well-chosen efforts have been made to increase the export of Austrian manufactures to foreign countries. The Minister of Commerce has issued an address to the several Chambers of Commerce, recommending them to send young men to foreign centres of trade for the purpose of studying the business, conditions, and habits of the people, and to prepare the ground for the establishment of factories and branch houses of Austrian firms. A fund has been started by the Chamber of Commerce at Vienna, and thus far £12,750 has been collected to defray the travelling expenses of these students. It has also been proposed to employ these students as representatives and salesmen of Austrian manufacturing establishments, and thus to ensure their support while they are devoting their time to the study of foreign commercial relations. The Export Society of Vienna has during the past year pushed with considerable vigour the establishment of sample depôts of Austrian goods in foreign markets, and as another means of encouraging the export trade, a sample depôt of foreign manufactures has been started in Vienna, mainly for the purpose of informing Austrian manufacturers of the character, kind, price, &c., of goods in demand and use in foreign countries, so that when this depôt or museum is complete, an Austrian exporter or manufacturer need not travel to foreign countries so as to acquaint himself with the fashions or necessities of the people dwelling therein, but can visit the museum, and there be informed more minutely as to his chances of success, should he desire to furnish the goods in demand. He will see the kind of goods required, can estimate their cost of manufacture in his factory, can also be informed of their price in the market in question, so that it would seem to be a simple calculation for him to decide whether to make the venture or not. In addition to this the manufacturer has other auxiliaries at home to assist him in his efforts to extend his trade with the greatest possible safety. The Export Society of Vienna is in constant correspondence with Austrian Consuls and merchants in foreign countries, and is ready to impart the very valuable information thus gained t any Austrian merchant who may apply for it.

Italy—Milan Bakers' and Millers' Exhibition.—This exhibition, having for its object the improvement of baking, breadmaking, and corn-grinding, was opened on 19th May last. The milling industry of Italy employs about 70,000 hands, and 170,000 horse-power, 15,000 of which are water-power. The gallery of machinery in motion, in which mills, complete with all the necessary machinery for wheat cleaning and grinding on the gradual process system are being exhibited at actual work, is interesting, although on a very limited scale, there being but two such mills, one by an Italian firm, Besana, Carloni, and Co., of Milan; the other by a Swiss firm, Daverio, of Zurich. The former cleans and grinds ten tons of wheat in twenty-four hours; the latter, very similar in arrangement, eight tons in the same time. The machinery of the mill of the Italian firm is not all made in Italy, the roller-mills being from Messrs. Kraus, of Germany, but an arrangement has been made with this firm to construct their roller-mills in Italy. The elevating, flour-dressing, and wheat cleaning machinery are principally copies of American and English machines, but they are well made. Messrs. Gauz, from Buda-Pest, who have a branch house in Milan, are large exhibitors of their roller-mills, of which they have sold 15,000, 800 being in Italy. Messrs. Bale and Edwards, an English firm established in Milan, exhibit roller-mills and a general assortment of flour dressing and wheat cleaning machinery, from Messrs. Carter, of London, compound and other steam engines from Messrs. Hornsby, of Grantham, as well as various other sorts of machinery for mills. The motive power to the mills at work is supplied by two horizontal compound condensing engines of 100-horse power each, fitted with automatic expansion and instantaneous cut-off valves. One is made by Sulzer Brothers, of Winterthur, and the other by F. Vosi and Co., of Legnano, near Milan; they are both well made, and have been sold to firms in this province. In an adjoining gallery are exhibited a large number of various machines for millers; the principal exhibitors being Messrs. Escher and Wyfs and Millot, both of Zurich, the latter firm having a branch house in Milan. Messrs. Ruston, Proctor, and Robey and Co., of Lincoln, both exhibit various sized steam engines. Amongst the most important machines for milling there are 11 Italian, 28 German, and 12 Swiss exhibitors; of this number only 4 can be considered as constructing engineers. In the bread-making machinery and oven department there are 64 exhibitors, 3 English, 2 French, 8 German, 49 Italian, and 2 Swiss. The only oven apparently using mechanical means is one by Signor Candelo. It has a revolving iron plate, 10ft. in diameter, turned by hand by means of gearing. The bread is placed upon this plate, to which the heat is communicated both above and below by flues; 4500lb. of bread can be baked in this oven in twenty-four hours, with a consumption of about 220 lb. of coal. The other ovens differ only from each other in the manner of diffusing the heat. In the grounds an Italian firm Riva, of Milan, exhibits engines from Messrs. Marshall, of Grantham, and biscuit making and baking machinery at work from Messrs. Baker, of London. Signor Guiseppe Locarni, of Vercelli, exhibits rice cleaning machinery at work, including the entire process of brightening, cleaning, and pearling the rice; the machinery is driven by an engine supplied by Messrs. Garrett and Sons, of Leiston. There is a pavilion devoted to electric lighting machinery, of which there are 28 exhibitors, 6 English, 2 French, 3 German, 14 Italian, and 3 Swiss. The dynamos are driven by three steam engines of about 200-horse power; one of 100-horse power is by Neville and Co., of Venice, and the other two by Soein and Wick, of Basle, and the Oerlikon Works, Zurich. The steam to the different engines is supplied by seven large boilers, one being made in England, one in Germany, and five in Italy. The Government offer premiums to the amount of £200 for the machines that will most economically and rapidly dry Indian corn and rice, so as not to injure their food, seed, or storing properties. There are 32 entries in this class, 27 of which are from Italian constructors. The final trials will take place at the harvesting of the new crop. With a view of making the exhibition practically instructive, it has been arranged with the different benefit societies of bakers in various parts of Italy to send a certain number of selected workmen to visit the exhibition and make experiments; making bread, and using alternately the different systems of machines and ovens, so that on returning to their homes they can speak with authority as to the advantage of the mechanical over the hand process of making bread.

Japan—Establishment of exchanges.—The Japanese Government has just promulgated a law for controlling the establishment of exchanges, which must exercise considerable influence on the development of commercial enterprise in this empire. The general rules are: Exchanges will be established for commercial purposes at such important places as may be deemed suitable, on application by local merchants and under the sanction of the Minister for Agriculture and Commerce. The articles dealt in on these exchanges are such as the Minister of Agriculture and Commerce may, on the application of the promoters, sanction. To establish an exchange a certain number of persons qualified as members in Ozaka and Tokio, not less than thirty, and in other places not less than fifteen, must apply through their respective municipal governments for the sanction of the minister. The expenses of establishing and maintaining exchanges are to be borne by the members thereof, and may be met by certain charges, approved by the minister, on the transactions. Exchanges shall be under the control of the minister, and subject to the inspection of the municipal governors. If any transaction is at variance with an existing law or order, or with the public interest, the minister may cancel or suspend part or the whole of such transaction, disqualify the members concerned in it, prohibit or suspend the licence of the brokers, and remove or suspend permanently or temporarily the names of members from the list. The minister may cancel the rules, and may abolish, annul, or suspend the judgments of exchanges; he may also appoint committees to inspect the affairs of exchanges, ascertain whether the necessary rules are being complied with, and superintend the business generally. No commercial transaction shall be carried on except during the fixed hours of business. Each member must deposit as personal security a sum of not less than £54 and not more than £540. Persons desirous of becoming brokers must apply to the minister for a licence, for which they shall pay a fee of £9. A broker must be a member of exchange and deposit security to the amount of not less than £180, and not more than £3600. The business of a broker is limited to one exchange he will not be permitted to enter into any transaction on his own account, must carry on his business in person, and will not be allowed to use a representative for the purpose. All disputes relating to transactions in exchanges shall be brought for arbitration before the committee. From their decision no appeal shall be allowed to a court of law, except when questions of law are involved. The minister may prohibit any person from engaging outside exchanges in business similar to that carried on inside. The only exchange which existed in Japan before the opening of the country to foreigners was the Rice Exchange of Ozaka, which is still the centre of the rice trade. In the autumn of 1876 rice exchanges were permitted generally throughout the country on certain conditions. In 1878 the Government published regulations for the establishment of exchanges, where operations could be carried on in Government bonds in money, and in the shares of the national banks, and of all other associations and companies, the existence of which was sanctioned by the central authorities. The new regulations are applicable to exchanges of all kinds, and will come into operation on September 1st next. The new regulations, compared with the old, show many important points of difference. The amount of capital required for the establishment of an exchange is no longer subject to a minimum limitation, but the number of promoters necessary before a licence can be obtained is increased. Operations in all kinds of commerce will be permitted if approved by the central authorities. Business transactions will be of two kinds—transactions to be settled on the spot and time bargains. Instead of being, as at present, practically unrestricted, membership will be limited to *bona-fide* merchants residing in the locality of the exchange. Foreigners are no longer to be debarred from becoming members of an exchange or brokers. The officers of an exchange with the exception of the director and assistant-director can carry on business the same as ordinary members. The provisions in regard to brokers are very strict. The maximum penalty attached to a breach of the regulations is reduced from £180 to £90. The most striking feature of the new regulations is the strict supervision to be exercised by the authorities, who will have full control over each association. The present regulations will be in force in all exchanges which are established under them, until their licences expire. The new regulations coming into existence on the 1st September next; the two sets of regulations will for some time be in operation concurrently. The changes contemplated have attracted much notice in Japan; and, as is usually the case with new measures introduced by the Government, the question is regarded from two opposite points of view. The objections to the new regulations are chiefly, whereas under the old regulations members of an exchange could be punished for offences against the rules of the association by forfeiture of their shares, in future such offenders will be liable only to forfeit the amount deposited on admission. The guarantee for good behaviour will thus be diminished and the confidence of the public will be weakened, with results injurious to trade. The provision prohibiting brokers from carrying on transactions on their own behalf will practically be a dead letter, as brokers will not scruple to do business on their own account in the names of other people. The effect of allowing new exchanges to be established under the new conditions side by side with the old ones, will be that business will be diverted from the old channels, and that great loss will be caused to established interests. The Government should have waited until the term of the licence of such exchange had expired before permitting a new association to be founded in the same locality. The supporters of the Government contend that the new measures will have an excellent effect in checking unsound speculation, and thus raising the standard of commercial morality. It is agreed that shareholders in existing exchanges have no right to complain if the Government terminate their licences at the end of the five years for which they were granted. On the whole, the general feeling is that the Government have taken a step in the right direction. The official classes are said to be largely represented amongst the shareholders of existing exchange associations, and gambling in stocks and shares of all kinds has increased to such an extent as to call for action on the part of the Government. Although the measure has provoked hostile criticism, the dissatisfaction applies more to details than to the reform itself.

Russia.—Trade of Kharkoff.—Kharkoff, where an agricultural exhibition is to be held in October next,[1] is the Government town of the Province of the same name. The city has a population of 170,000, is an important commercial centre, lies in the midst of an important agricultural district, and supplies nearly the whole of the Governments of Ekaterinoslow, Kharkoff, and Poltava, with articles of home and foreign manufacture from Central and Northern Russia, and from the ports of the Azoff, Baltic, and Black Seas. The distance by railway from Moscow is 488 miles; from Nicolaieff, 370 miles; from Odessa, 553 miles; from Riga, 873 miles; and from St. Petersburg, 883 miles. The city is approached by the Nicolaieff-Kharkoff, and the Koursk-Kharkoff-Azoff lines, and is also connected with Riga, Warsaw, and the Austrian frontier. Though the Russian protective duties have materially affected foreign imports here, there is still an opening for English goods such as agricultural implements and machinery, copper goods, cutlery, hardware, iron, bar, pig, and sheet, locks, nails, and steel. At the present, preference is given to American, French, and German goods. This is in no manner astonishing, as English commercial travellers have almost abandoned Kharkoff, and the Germans have it all their own way. Though trade is now very bad, the French and Germans, particularly the latter, manage to do business through the medium of their travellers. Why should not the English be equally enterprising? During the last fair—of which there are five annually, and at which it is estimated £4,000,000 changes hands—held in Kharkoff, there were thirty German commercial travellers staying at one hotel, against one Englishman, and more Germans were at other hotels and lodging houses. The question of distance should be taken into consideration, Germany being so much nearer. It is surprising that English goods reach Kharkhoff principally *viâ* Riga, as the freight by that route must be heavier than by Nicolaeiff and Odessa, since the distance by rail from the latter ports are 503 and 320 miles respectively shorter, so that the difference in the greater sea freight would be more than made up by the lesser freight by rail. Coal used in the manufactories of Kharkoff and the neighbourhood is brought from pits in the Governments of Ekaterinoslow and Kharkoff. A specimen examined burnt brightly, had plenty of gas and the appearance of the best Newcastle coal. The coal now extracted from these pits is superior to what it was three years ago, and is sold at two-fifths of the price of good Russian coal at Odessa; but the Odessa Gas Company say that they cannot get the same quality of gas from Russian as from English coal, and engineers and masters of Russian steamers much prefer English coal to that of their own country. There are resident in Kharkoff from forty to fifty British subjects employed as clerks, mechanics, and tradesmen. One firm carries on business as agricultural implement and machine agents.

United States—Deposits of manganese ore.—Ores containing manganese are of two kinds, manganese and manganiferous iron ores. In fixing the dividing line between these two ores, the standard of shipment in English chemical works has been adopted, 70 per cent. of bioxide equalling 44·252 parts of the metal per 100. Ores containing less than this percentage of manganese can be used in the manufacture of ferro-manganese and high manganese spiegel, while some ores with an excess of manganese can be used for low spiegels. Manganese is found widely distributed in this country, is almost as plentiful as the deposits of brown hematite ore, and occurs as a constituent of most of that class of ores, and sometimes to such an extent as to make the ore a manganiferous one. At times pockets or veins of manganese are found alongside of iron ore, especially in the Appalachian ranges, and more particularly in Virginia. Only four localities yielded any considerable amount of ore in 1885. These were Batesville, Arkansas, Cartersville, Georgia, Crimora, and Leetsmines, Virginia. The Crimora mine contributed two-thirds of the entire quantity produced in the United States, which was 26,495 tons, 23,258 tons being manganese and 3237 tons being manganiferous iron ores. The origin of manganese has never yet been authoritatively settled. It is thought to be similar to hematite ore in origin, and to have been deposited from solution. The most valuable deposits of manganese have been found in pockets, usually embedded in a tenacious clay, which requires washing to be removed.

[1] See ENGINEER, March 11th, 1887, page 186.

TENDERS.

SEA WATER SCHEME FOR WATERING ROADS, &c., AT BOURNEMOUTH.

LIST of tenders for watering roads and flushing sewers with sea water, including about 13 miles of cast iron pipes, engine-room, gas engines, pumps, brick water towers and tanks, street water posts, hydrants, valves, &c., for the Bournemouth Commissioners; Mr. G. R. Andrews, engineer and surveyor:—

	£	s.	d.
Blake and Co., Staffordshire	8877	13	3
Frere and Co., London	8843	0	0
H. W. Gould, Southall, N.	8810	14	6
Sterling and Swann, Manchester	8775	0	0
G. Harrison, Brighton	8739	19	7
E. J. Perkins, Lymington	8600	9	0
Dorset Ironfoundry Company, Poole	8486	5	6
Wood and Co., Bournemouth	8378	1	3
W. H. Dearle, Chichester	8217	6	0
Hilton and Sons, Birmingham	7885	0	0
H. I. Sanders, Southampton	7883	8	0
W. H. Hill and Co., Plymouth (accepted)	6768	0	0

ROAD MAKING UNDER THE 150TH SECTION PUBLIC HEALTH ACT, 1875, AT BOURNEMOUTH.

List of tenders for kerbing, channelling, sewers, catchpits, road and path metalling, for the Bournemouth Commissioners; Mr. G. R. Andrews, surveyor:—

	£	s.	d.
Sterling and Swann, Manchester	2437	10	0
Frere and Co., London	2275	19	9
Wm. Hoare, Bournemouth	1769	14	1
S. Minty, Bournemouth	1688	0	0
Geo. Troke, Bournemouth	1662	0	0
W. H. Dearle, Chichester	1637	0	0
C. Stickland, Bournemouth	1596	16	7
Geo. James, Bournemouth	1559	17	10
J. Harrison, Brighton	1554	16	11
J. White, Bournemouth	1540	0	0
F. Hoare and Son, Bournemouth	1540	10	8
John Locks, Christchurch	1520	16	1
Hilton and Sons, Birmingham	1480	6	9
W. H. Saunders and Co., Bournemouth (accepted)	1289	3	4

STORM OUTFALL, BOURNEMOUTH.

List of tenders for the supply of pipes, bolts, nuts, screw piles, &c., laying the same in the bed of the sea, and brickwork in connection therewith, for the Bournemouth Commissioners; Mr. G. R. Andrews, engineer and surveyor:—

Section (a).—Supply of Pipes.

	£	s.	d.
Dorset Ironfoundry Company, Poole	3480	13	11½
Wood and Co., Bournemouth	3064	7	3
Cochrane, Grove, and Co., London	2751	4	6
E. J. Perkins, Lymington	2724	14	8½
W. H. Dearle, Chichester	2708	18	9
Jukes, Coulson, and Co., London	2688	3	9
J. Harrison, Brighton	2473	11	6
E. Howell, Poole	2439	10	0
Butterley Company, Alfreton	2428	9	2
Staveley Iron Company, Chesterfield	2379	15	0
Hilton and Sons, Birmingham	2362	10	3
J. and S. Roberts, West Bromwich	2349	17	0
The Tees Side Iron Company, London	2337	7	4
The Clay Cross Company, Chesterfield	2231	12	6
Frere and Co., London	2127	8	8
Duncan Brothers (mild steel), London (accepted)	1900	0	0

Section (b).—Laying Pipes.

	£	s.	d.
H. I. Sanders, Southampton	5310	0	0
Frere and Co., London	3987	0	0
Hilton and Sons, Birmingham	3059	0	0
Duncan Brothers, London	2400	0	0
W. H. Dearle, Chichester	2314	10	0
E. J. Perkins, Lymington	1923	2	0
J. Harrison, Brighton	1518	10	0
Dorset Ironfoundry Company, Poole (accepted)	802	15	0

Section (c).—Brickwork.

	£	s.	d.
Hilton and Sons, Birmingham	377	0	0
H. I. Sanders, Southampton	330	0	0
W. H. Dearle, Chichester	264	15	0
J. Harrison, Brighton	243	0	0
E. J. Perkins, Lymington	239	14	6
Dorset Ironfoundry Company, Poole	203	7	6
Wm. Hoare, Bournemouth (accepted)	148	0	0

PUBLIC CONVENIENCES AT BOURNEMOUTH.

List of tenders for the erection of public urinals and lavatories, both under and above ground, in various parts of Bournemouth, for the Bournemouth Commissioners; Mr. G. R. Andrews, engineer and surveyor:—

	£	s.	d.
Crook and Sons, Southampton	2409	10	0
Barrow and Entwistle, Bournemouth	2386	10	0
W. H. Dearle, Chichester	2291	16	0
F. Hoare and Son, Bournemouth (accepted)	2178	0	0

DRAINAGE WORKS, &c., FOR THE HAILSHAM UNION, POLEGATE, SUSSEX.

List of tenders for drainage works, outfall works, and machinery; Mr. P. O. Blaber, engineer, and Mr. G. Fuller, surveyor:—

CONTRACT NO. 1.—*Pipe, Sewer, Manholes, &c.*

	£	s.	d.
Thomas Rees, Staplehurst	1798	0	0
John Jackson, Enfield	1645	0	0
Bostel Brothers, Brighton	1500	0	0
G. Osśenton, Erith, Kent	1463	0	0
Piper and Sons, Hastings	1448	0	0
John Moon, St. Leonards	1371	0	0
Innes and Wood, Birmingham	1354	19	6
J. Harrison, Brighton	1337	0	0
James Hayward, Eastbourne	1309	10	0
A. Cattley, London	1296	0	0
Parsons and Sons, Hove	1258	0	0
W. H. Dearle, Chichester (accepted)	1191	17	0

CONTRACT NO. 2.—*Outfall Works and Engine-house.*

	£	s.	d.
Innes and Wood, Birmingham	415	19	3
Parsons and Sons, Hove	410	0	0
G. Ossenton, Erith, Kent	345	0	0
W. H. Dearle, Chichester	306	11	0
J. Harrison, Brighton	290	0	0
T. Reeves, Staplehurst, Kent	286	0	0
James Hayward, Eastbourne	274	0	0
A. F. Cattley, London	260	0	0
Berry and Bussey, Lewes (accepted)	235	16	0

CONTRACT NO. 3.—*Machinery.*

	£	s.	d.
Sylvester and Co., Newcastle, Staffordshire	431	5	6
C. A. Wells, Lewes	295	7	6
Innes and Wood, Birmingham	273	18	6
W. H. Dearle, Chichester	272	5	0
Parsons and Sons, Hove	262	0	0
T. Reeves, Staplehurst	257	0	0
James Hayward, Eastbourne	255	4	0
A. Shaw, Lewes	253	13	9
J. Harrison, Brighton (accepted)	239	0	0
G. Ossenton, Erith, Kent	225	0	0

THE FERRY-BOAT DUCHESS OF EDINBURGH.

IN our last impression we fully described this vessel, and we now give on page 154 details of her machinery. Figs. 14 and 15 show her boilers, Fig. 16 her paddle-wheels, while Figs. 17 to 21 show the reversing gear. In a succeeding impression we shall publish further engravings of this boat.

PUMPING ENGINES—INDIAN STATE RAILWAYS—UMARIA COLLIERY.

Tenders were opened recently for the construction of colliery plant for India. The work required under this specification consists of the construction, supply, and delivery at one or more of the ports named in the tender of the following:—One horizontal compound differential surface-condensing pumping engine, complete; two plunger pumps, with quadrants, connecting rods, spear rods, suction and delivery piping, girders, &c. &c., to suit a pit 240ft. deep and 10ft. diameter; three locomotive type multitubular semi-portable boilers, each 30-horse power nominal, with all fittings, steam piping, and chimneys, complete; one steam feed pump, with steam and exhaust piping and steam stop valve, complete.

The whole of the work is to be complete in every respect for pumping from a pit 10ft. diameter and 240ft. deep, including all steam, feed, water, and other piping between the main pumps and the condenser, the engine and boilers—the nearest boiler being 50ft. from the centre of the engine—sufficient bends and T's are to be supplied to admit of the boilers being placed in any position to the engine, all suction and delivery pipes, bolts, girders, &c., and connecting and spear rods and quadrants of wrought iron or mild steel, balance weights, bed plates, plummer blocks, foundation bolts, and plates, spare parts, drawings of the masonry foundation for the engine, and everything necessary for the erection of the work in India, whether mentioned in this specification or not, must be supplied.

The boiler shell plates are to be made of iron, of the description known as "Best Yorkshire," and manufactured by either the Lowmoor, Bowling, or Farnley Iron Companies, or by Messrs. Taylor Brothers, of Leeds. The tube and fire-box plates, and all plates that are flanged or otherwise worked in the fire, and all rivets are to be of Lowmoor iron, the rivets being made by the Lowmoor Iron Company.

All the turned, bored, or fitted parts of the work, and all bolt heads, nuts, and screw threads, are to be made to Whitworth's standard sizes. All meeting surfaces are to be machined. All joints and pins, nuts of cylinders, valve covers, and glands are to be case hardened in animal charcoal—not potash—and finished bright. The edges and flanges of the valve casings, cylinder covers, packing glands, stop-valve covers, and glands are to be finished bright. The cylinders are to be steam-jacketted, felted with the best hair felt, cleaded with well-seasoned teak wood, in a substantial manner, and polished. Each cylinder is to be fitted with gun-metal, bright finished, indicator cocks, pipes, and gearing, and with gun-metal water-relief valves, taps, and pipes at each end of the cylinders. Sufficient non-conducting material of the description known as "Heenan's" patent, for covering all the steam pipes is to be supplied.

All the plates and angle irons of the boilers are to be machined on all edges, and where they have to be caulked they are to be machined to an angle of 1 in 8. Each piece must have the brand or stamp of the manufacturer clearly stamped on it, the shell plates on the outside, and the fire-box on the inside, in such a position that it can be readily seen on the finished work. The whole of the holes in the boilers, either for rivets or bolts, are to be drilled to a uniform pitch after the plates have been bent and fitted together; those for rivets are to be drilled through both plates at one setting, and the burr cleaned off on both sides of each plate after drilling. The stop valves on the boilers and main steam pipes are to be of cast iron, and machined on all meeting surfaces, the valves, seats, and spindles are to be of gun-metal, and the hand wheels, covers, and nuts turned and finished bright. All packing glands and bushes for the engine, boilers, or pumps, are to be of gun-metal machined into their places, and finished bright. The safety, feed, relief, blow-off, and all other valves on the engines, boilers, or feed pipes are to be of gun-metal, with gun-metal seats machined into their places, and ground up perfectly true. All pipes for the engine, boilers, and pumps are to be flanged, and are, with the exception of the copper steam and feed pipes for connecting the boilers, to have a strong rib at the back of the flange between each bolt hole; they are to be machined on the face, the bolt holes drilled to a template, and fitted with bolts, turned under the head, and faced on both sides of the nut. A visible drop feed lubricator of approved description is to be fitted to the steam pipe of the engine, between the stop valve and the cylinder casing.

The engine is to be of the horizontal compound differential surface condensing type, and is to work at a piston speed of 150ft. per minute, a steam pressure of 140 lb. per square inch, and is to be in general accordance with our engraving. The bed-plate or framing is to be of cast iron, of box girder section, and about 18in. deep; it is to be cast in convenient lengths for shipment, machined at the ends for connecting together and to the end and intermediate girders. The whole is to be connected together with mild steel bolts turned and made a driving fit into drilled holes; after connection it is to be planed on the surfaces to receive the cylinders, piston-rod guides, and all parts fitted to it. The high-pressure cylinder is to be 17in. and the low-pressure 34in. diameter, each with a piston stroke of 6ft. The cylinders are to be of cold-blast iron as hard as can be bored, and perfectly free from honeycomb and all other defects or blemishes. They are to be steam jacketted; the jackets covered with best hair felt, cleated with well-seasoned teak wood, bound with brass bands, and then polished. A steam stop valve is to be fitted to the steam pipe or valve casing in a convenient position for regulating the supply of steam. The steam chests of the high and low-pressure cylinders are to be connected with a bright copper pipe, $1\frac{1}{2}$in. bore, and a gun-metal stop valve for the purpose of starting the engine.

The steam slide valves are to be made of cast iron machined and scraped so as to be steam-tight. The valve gear is to be of the description known as "Davey's patent differential valve gear;" it is to be of the most improved construction, and fitted with balance shutter. Adjustable valves are to be put on the back of the low-pressure slide valve to overcome the want of proper balance in the load of the engine in sinking, should the engine be applied to that work. Suitable trip gear is to be applied to prevent accident in the event of a "riding column" of water. The cataract cylinder is to be lined with gun-metal plug, and the valve spindle is to be of steel. The hand-wheel and all wrought ironwork is to be finished bright, and all joints and pins are to be case-hardened.

The pistons for high and low-pressure cylinders are to be of the description known as "Goodfellow's," with two external and one internal V-ring of cast iron, the bolts of the junk ring are to have gun-metal nuts. The piston-rods are to be of mild steel, accurately turned and fitted, and finished bright throughout. The stuffing-boxes and glands are to be bushed with gun-metal.

The condenser is to be of the surface condensing type, fitted with brass tubes 2in. diameter and about 7ft. long, and must be so arranged that the entire quantity of water from either, or both, of the main pumps can be passed through it to effect the condensation. Suitable valves must be provided on the inlet pipes to the condenser to prevent the return of the water to the main pumps, and to shut off either when the water from one pump only is being used for condensation. The condensers must have suitable doors or covers at each end to facilitate the cleaning or removal of the tubes and for repairs, and these doors must be so placed that it will not be necessary to disturb the joints or connections of the inlet or outlet water pipes.

Two single-acting plunger pumps, each 15in. diameter, with a stroke of 6ft., are to be supplied; they are to be worked off a crosshead on the end of the piston-rod, and provided with quadrants, sole plates, plummer blocks, with gun-metal bearings, connecting-rods, spear-rods, suction and delivery piping, pump girders, all the necessary fittings and connections, and everything necessary for a pit 240ft. deep. The crosshead is to be made of mild steel forged to shape and finished bright; it is to be fitted with two slippers having adjustable gun-metal liners and two guide bars with large wearing surfaces; the quadrants are to be built up of wrought iron plates blocked with pitch pine; the gudgeons and pins are to be of mild steel, turned and finished bright; the edges of the plates are to be machined or neatly dressed off and filed to shape; all holes in the quadrants must be drilled or bored out.

A single connecting-rod is to be provided between the engine crosshead and the first quadrant, and a pair of connecting-rods between the quadrants; the latter must be wide enough apart to allow the spear rods to be drawn between them. The connecting-rods are to be machined at the ends and finished black, except the part in the engine-house, which must be finished bright; they are to be fitted with gun-metal bushes made adjustable for wear, by straps, gibs, and cotters, &c., and must be fully described in the particulars accompanying the tender.

The suction and delivery valves are to be of the description known as "Morris," of the Kent Waterworks, and are to consist of a series of india-rubber rings $\frac{3}{4}$in. thick, clipped by their lower edges round cylindrical cast iron seatings, the seatings being perforated with holes $\frac{5}{8}$in. diameter, and spaced $1\frac{1}{4}$ centres. The suction piping for the pumps is to be 10in. bore, in two lengths of 9ft. for each pump. A suction strainer is to be fitted to the suction pipe of each pump. The pumps are each to have a separate delivery pipe of sufficient length for connection between the pump and the surface condenser, and is to include sufficient length and bends for conveying the water, after passing through the condenser, to the outside of the engine-house. The pipes are, as far as possible, to be in equal lengths of 9ft. each, 9in. diameter in the bore, $10\frac{3}{4}$in. diameter outside, and flanged at each end, the flanges being $14\frac{1}{2}$in. diameter, machined on the face, and drilled to a template for six bolts, $\frac{5}{8}$in. diameter, pitched in a circle of $12\frac{1}{4}$in. All bolts, nuts, &c., and thin rubber washers—with the addition of 20 per cent. for waste—for jointing the pipes, must be supplied. The plungers of the pumps are to be of gun-metal, with gun-metal bushed packing glands and bushes. They are to be fitted with balance weights, balance box, and weights, as shown.

The boilers are to be of the locomotive multitubular semi-portable type, each supported by a cast iron water tank under the fire-box, and by a cast iron stand under the smoke-box, and are to work at a steam pressure of 140 lb. per square inch.

The barrel of the boiler is to be made of $\frac{7}{16}$in. plates, in two rings, each of one plate, arranged telescopically, the smallest diameter being 3ft. 10in., and the length of the barrel being 9ft. The vertical seams are to be lap jointed and single rivetted, $2\frac{1}{2}$in. lap, $1\frac{3}{4}$in. pitch of rivets, and $\frac{3}{4}$in. diameter of rivets. The vertical and longitudinal seams are to be butt jointed and double rivetted, with inside and outside butt strips, $7\frac{1}{4}$in. wide by $\frac{5}{16}$in. thick, except only where the vertical and longitudinal seams meet. The butt strips are to be so rolled that the fibre of the iron may be in the same direction as in the plates they connect. The front tube plate is to be $\frac{3}{4}$in. thick, flanged forward to carry the smoke-box, and secured to the boiler barrel by an angle-iron ring, bored, faced, and turned on the edges. When finished, this angle iron ring must be nowhere less than $\frac{5}{8}$in. thick, and it must be zig-zag rivetted to the barrel, but single rivetted to the tube plate. A wrought iron ring 18in. diameter, made of one plate $\frac{1}{2}$in. thick, welded and flanged, is to be rivetted to the back plate of the boiler barrel. Suitable wash-out plugs are to be inserted in smoke-box tube plate, butt over and under the tubes, and on the wrapping plate of fire-box shell, and back plate, corners of foundation ring, and in any other place they are required. The smoke-box tube plate and back plate of the fire-box are to be stayed by suitable gusset plates to the barrel plates of the boiler and fire-box wrapping plate.

Palm stays will also be fixed to the boiler barrel and front plate of fire-box. Transverse stays must be placed above the top of the fire-box to support the sides of the fire-box shell.

The boilers are to be arranged side by side in a boiler house, the distance between the centres of the boilers being 7ft. They are to be connected to one main steam pipe by a branch about 4ft. long between it and the stop valve on the boiler. The main steam pipe is to be of copper weighing 10 lb. per superficial foot and not less than 6in. diameter. Each boiler is to have the following fittings:—One steam stop valve, one gun-metal self-starting and lifting injector, Gresham and Craven's patent, of sufficient capacity for feeding the boiler when working at its full power, arranged to take to pieces for cleaning or repairs, and with all necessary pipes, valves, strainer, &c., for connection to the boiler and feed-water cistern; one feed regulating valve, with gun-metal valve, seat, spindle, hand wheel, and index; one clack box having a gland cock placed between the clack and the boiler, two wash-out plugs and seatings having the threads on the outside, on each side of the fire-box casing, on a level with the crown of the fire-box; one mud plug at each of the bottom corners of the fire-box casing, two mud plugs on the back plate of the fire-box casing, on a level with the crown of the fire-box, and three or more mud plugs in smoke-box tube plate. All the mud plugs are to be $1\frac{1}{2}$in. diameter, with the same rate of taper, and with eleven threads to the inch. Each boiler is also to be fitted with one gland blow-off cock, two glass water gauges and cocks opening with a screw, one scum cock, whistle, pressure gauge to indicate up to 200 lb. per square inch, and which must be of Bourdon's own make, and all other usual and necessary mountings and fittings. All the above-mentioned mountings are, with the exception of the stop valve casing, to be made of gun-metal, and they are all to be finished in the best possible style; all joints connected with them are to be faced perfectly true, and made with boiled oil. Wherever possible, the fittings are to be fixed on to seatings rivetted on the boiler or fire-box casings. All the nuts are to be machined and polished. The taper of all cock plugs is to be 1 in 6; they are to be arranged for and packed with asbestos on the principle known as "Dewrance's." All fittings are to be polished bright. The boilers are also to be supplied with two tube brushes and one set of firing tools, consisting of one poker, one pricker, one rake, and one shovel.

A steam feed pump of the "Cameron" or other specially approved type is to be supplied for feeding the boilers, independent of the injectors. It must be of sufficient size to feed the three boilers when working simultaneously at full power. The plunger, valves, and seats are to be of gun-metal. The pump is to be connected with flanged copper steam and feed-water pipes, with a gun-metal bright finished stop valve on each.

TECHNICAL INSTRUCTION.

The following excellent letter has been addressed to the editor of the *Times* by Professor Thompson:—

"Sir,—Now that the Technical Instruction Bills have both been read a second time without a division, some comment upon the matter of these Bills and upon their probable bearing on technical education, if passed in their present form, may not be out of place. Those who have worked for years at this question, and have watched the slow but steady awakening of the public mind to this crying national want, may well feel disappointed at the narrow scope and unsatisfactory character of the measures now put forward. A Bill to enable South Kensington classes to be supported out of the local rates for the benefit of the few most bookish of all among the scholars of our elementary schools seems hardly an adequate response to the national cry. In the measure, or measures, now before the House the one feature that is most prominent is the proposal to hand over piecemeal to the Science and Art Department everything that can be called technical education from its very definition downwards. Technical instruction is henceforth to be that which the Science and Art Department prescribes; all that the Science and Art Department prescribes is henceforth legally to be called technical instruction, whether there is anything technical about it or not. The South Kensington officials, not the local authorities or school managers, are to decide what subjects shall or shall not be prescribed for teaching in the different localities. Such a proposal will assuredly be received with profound distrust by the majority of those who have attempted the teaching of technical classes in the provinces.

"I happen, Sir, to know something of the working of the Science and Art Department, having at one time come into relation with it as a student, at another time as a teacher, and in each case have been driven by its red-tapeism to dispense with the aids which its organisations offered. My own fees at the Normal School of Science I paid rather than enter as a free student under the impracticable conditions that environed the studentship awarded to me. I have long ceased to teach under the conditions imposed by the department—conditions which tend to sterilise and fossilise all good work. It would be quite impossible to carry on much of the present work of the City and Guilds' Technical College here at Finsbury if the arbitrary rules and regulations of the Science and Art Department were to be imposed upon us. The rules of the Science Directory, for example, would entirely preclude a grant being earned on any one of our students in practical chemistry, because our laboratories, which we believe to be not only more modern but better than those prescribed by the rules of the Science and Art Department, do not accord with the stereotyped prescriptions issued from South Kensington. To put our chemical classes under the rules of the Science and Art Department would simply ruin them. If I turn to the branch of science that is my own pursuit, physics, I find that it is, by the inexorable rules of the Science and Art Department, cut up arbitrarily into two 'subjects'—(1) heat, sound, and light; and (2) electricity and magnetism. If I get together, say, a class of apprentices from the optical workshops of London, and teach them optics, or if I get a class of young engineers and teach them heat, then by the rules of the Science and Art Department this is not technical education at all; there is no grant for such teaching. If I teach the opticians what they do not want, heat and acoustics, as well as their optics, then I am giving them technical instruction. Or I may teach them building construction, or geology, or zoology, or naval architecture—not that I know anything of these branches of science—and I am equally giving them technical instruction, for these are subjects 'prescribed' as such by the Science and Art Department; but directly I settle down to teach these apprentices the optics that they want to know—the one subject that is technical to their industry—I am no longer giving technical instruction as defined by this Bill. Another consequence of this arbitrary prescription of three sciences in one 'subject' is that, in the highest stage, no one of the three can be thoroughly taught, a smattering of each being the requisite thing to procure passing of the examination and payment on its results. Again, the regulations of the Science and Art Department make it impossible, in every school working under its scheme, for more than two prescribed subjects to be taught on the same day (except Saturdays). They also put a premium upon quantity of teaching as against quality—firstly, by stopping payment on results if the student is clever enough to take honours, unless he has previously gone through the examinational mill of passing in a more elementary stage in a preceding year; and, secondly, by refusing to recognise the value of any further teaching to a student who has once passed the so-called honours stage of the prescribed examinations. As an additional absurdity it may be mentioned that the Science and Art Department recognises as a teacher qualified to teach and to earn payment in any and every one of the prescribed subjects of technical instruction every person who holds a degree from an English University, whether it be Master of Arts of Oxford or Bachelor of Theology of Durham. This will never do in a scheme of national technical education, in which the one important thing, so far as selection of teachers is concerned, is that they shall be in touch with the technical requirements of the respective industries which their teaching is to benefit. Unfortunately it is true that the vast majority of the science teachers under the Science and Art Department are not in this position, but are schoolmasters who have in a most praiseworthy way, and in many cases by the help of the Science and Art Department itself, obtained some acquaintance with one or two of the sciences. Excellent though the original idea of the Science and Art Department may have been, it has certainly resulted in a vast amount of superficial and book-learnt science being taught, and in the development of a vast array of little text-books specially designed to cram students with the *minimum* of knowledge requisite to earn a grant by passing the South Kensington examination. Books written for workmen by men who have never worked constitute the very antithesis of a sound material for a technical education. For the text-book and the schoolmaster who has learnt, the true modern technical education substitutes the laboratory and the instructor who has worked. This the Science and Art Department has yet to discover. In saying this I am saying nothing in disparagement of the extremely able staff of administrators at South Kensington; they know their own work; I believe they do it well, and that they honestly endeavour to promote what they think to be its usefulness to the nation. If they can break with old traditions, take up new blood, and show themselves able to come into touch with local requirements, then all may yet be well. But a fear that the evil traditions, the prevailing academic notions, and the all-too-abundant red-tape of the past may prove too strong in the future is at the bottom of the profound distrust with which this measure is regarded by some of its best friends.

"Thanks to the munificence of the City Guilds, their Technical College, which I have the honour to direct, has no need to lean for subsistence upon the system of payments by results in the prescribed 'subjects' of the Science and Art Department. I am far from saying that in the abstract a closer alliance between the teaching in some of the college classes and the examinational scheme of the department would be undesirable—that would depend upon conditions. The examination scheme would need to be modified, its requirements simplified, its standards raised. But it would be an evil day for the students of the Technical College, for its staff, and, I believe, for the quality of the instruction it affords, when the energies now devoted to that which is found to be most helpful in the direct application of science and art to the various industries should be turned aside to the helot work of earning payment on results in the prescribed routine of the Science and Art Department as at present constituted. Surely it is not too much to ask that, as a necessary antecedent to the passing of this Bill some pledge be given by Government that the Department o Science and Art shall be itself reformed.

"I am, Sir, yours faithfully,

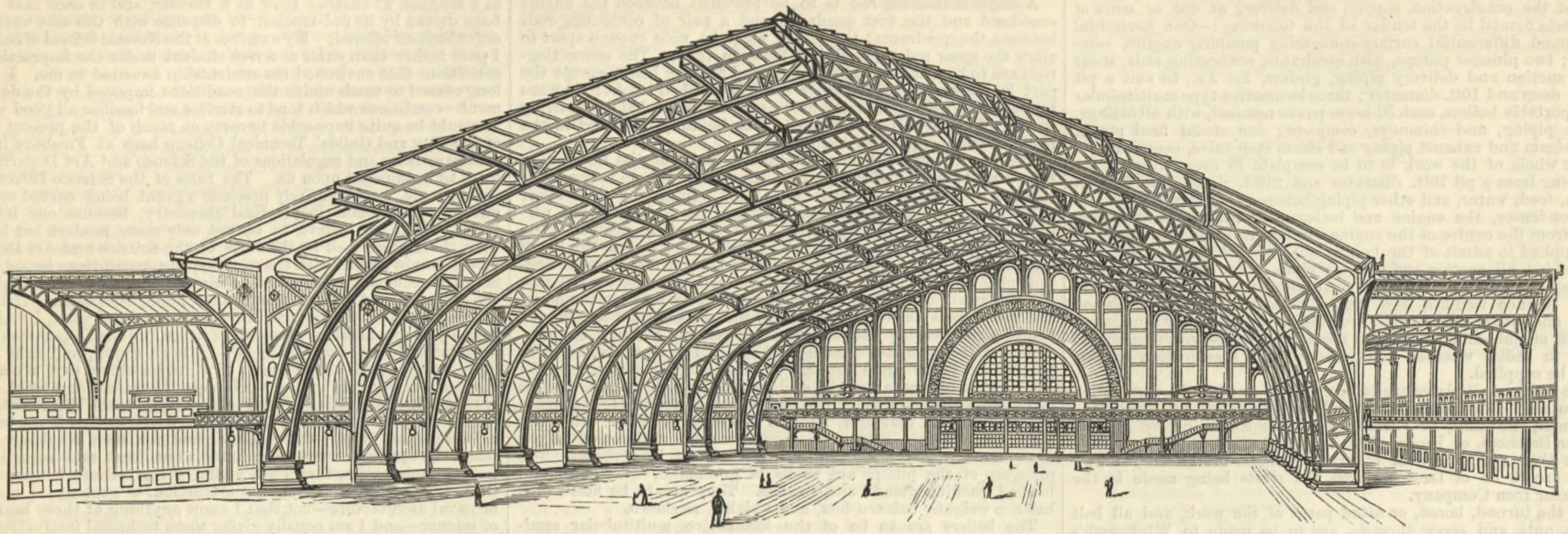
"Silvanus P. Thompson.

"City and Guilds' Technical College,
Finsbury, August 13th."

The Institution of Civil Engineers.—A Supplemental Charter has just been granted to the Institution of Civil Engineers, by which the power to acquire and hold lands, &c., has been increased from £1000 yearly value—as in the original Charter of 1828—to a sum not exceeding £8000 annual value, provided that the property is used and enjoyed solely for the purposes of the Institution, and not otherwise.

Liverpool Engineering Society.—The fifth excursion of the season will be held on Wednesday, 24th inst., when, by permission of Mr. H. Bramall, M. Inst. C.E., a visit will be paid to the Clifton Hall Collieries, belonging to Messrs. Andrew Knowles and Sons. Mr. John Knowles has also kindly given permission for the members to visit his cotton mill at Pendlebury, which is of the most improved and recent type. Members will assemble at Tithebarn-street Station, and proceed to Clifton Junction by train leaving at 9 a.m Members desiring to visit the underground workings should come provided with a cap and suit of overalls; those not desirous of going underground will, after inspecting the surface arrangements, visit the Pendlebury Collieries—surface—and proceed to Mr. Knowles' cotton mill, after which they will rejoin the underground contingent and return to Liverpool by the 5.27 train from Pendlebury.

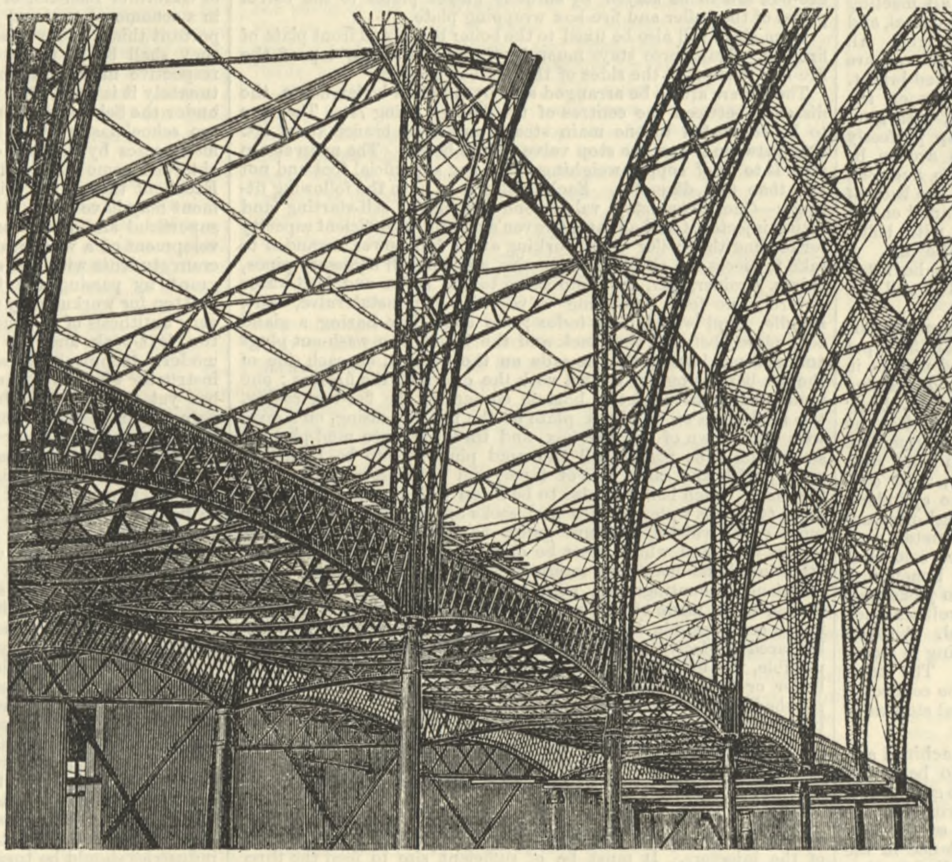
THE PARIS INTERNATIONAL EXHIBITION OF 1889.



THE GREAT MACHINERY HALL OF THE PARIS EXHIBITION, 1889.

THE PARIS UNIVERSAL AND INTERNATIONAL EXHIBITION OF 1889.

Great Roof of the Machine Court.—In continuation of the illustrated particulars already published in our impressions of the 10th and 24th of June of the roof of 110·60 m. in span, we now give a general sectional view and details of the panels or sections of a bay of 21·50 m., partly illustrated in the above-mentioned numbers. The purlines are twelve in number, including the two which support the centre covering girder, the construction of which differs from that of the other ten. These two centre purlines, to which we shall refer later on, are formed of a plate 1·05 m. deep and 8 mm. thick, of two pieces, 0·300 m. and 9 mm. thick, and of four angle irons 70 by 70 by 7. The uprights, composed of a plate and four angle irons, give rigidity to the whole girder, and serve at the same time to connect the rafters inside and the ridge brackets on the outside of the great nave. The other ten purlines are formed of a lattice girder with vertical ties and one series of inclined struts in the form of N—see Fig. 19, page 506, June 24th. The lattices are composed of two flat iron bars 0·120 m. by 0·9 mm., which fix into the two plates of 0·350 m. The thickness of the lattice of the two purlines next to the principals, where the strain is greatest, is 0·9 mm. The depth of these purlines is 8 m. in the centre (nearly 6ft). As Fig. 1, p. 469 (June 10th), indicates, the depth of the ends of the purlines varies in its several divisions. In fact, the panels being all in vertical planes, the intersections of the arc, of which the principal is composed, increase gradually in depth from the extreme purline No. 1 to No. 5; but in order to avoid complications of structure, it has been arranged that the depths of the purline shall be the same. The distribution of the panels is somewhat different, but the construction of all is absolutely the same. On page 506, June 24th, Figs. 9 and 10 show the detail of the great centre joint of the principals, and enlarged views of parts of the lateral galleries, with the spandrils between the principals and these side galleries. The principal is jointed at three points, at its summit and at the springings. This disposition is now becoming general; partly because it greatly facilitates calculations, inasmuch as it gives definiteness to the direction and nature of the stresses, and also has the advantage of giving freedom for the movements due to variations of temperature. The depth of the lower part of the arch of the principal is 3·70 m.—12ft. This depth is maintained as far as No. 5 panel, from which point it diminishes gradually until at the centre it is 3 m. This will give an elegant and light character to the whole principal. As the several engravings, Figs. 9, Figs. 10 to Fig. 34 show, the main member of the principal is composed of two flitches of 0·450 m. by 9 mm., leaving between them a width of 0·400 m. These two flitches are bound together by a plate of 0·750 m. by 7 mm., and by four angle irons of 100 by 100 by 10 mm. The flange plates increase from one at the top to six at the lower part of the arch. The division of the principals into small and large bays gives decorative effect to the arch, and has the advantage of permitting an equal distance of 10·59 m. to be maintained between the purlines, while preserving their vertical position, which was indispensable on account of their great height. Page 506, of 24th June, gives in detail a small and large lattice of that part of the principal comprised between panels 1 and 2. The girder connecting the foot of the principals is a plate girder. The vertical section, Fig. 31, next to the axis of the panel, shows the disposition of the several parts. The lower part of the joint pin bearer rests upon a cast iron plate, fixed by several large bolts to the solid masonry foundations. In order to facilitate the transport of the principal from the workshop to the place of its erection, the portions have to be limited to a length of 5 m. to 6 m. The joints take place in the middle of each of the large bays, taking care to alternate the joints of the angle irons. The spandrel has the same construction as the arch itself; it is formed of two plates of 0·400 m. by 9, united by a plate of 6·750 m. by 7 mm., and four angle irons of 100 by 100 by 10 mm. The vertical part of the spandrel, outside the principal which receives the arches of the lateral galleries and the ridge panel, is strengthened by two plates of 0·150 m. by 7, and four angle irons of 100 by 100 by 10 mm. The ridge panel is connected with the principal by means of bolts, to avoid the difficulties of rivetting, which are very great at this height. To this purline the ridge is fixed, supported by a number of brackets fastened to the uprights of the purline. A slight difficulty presented itself at the point of contact with the principal, where the two sheets to be fastened together are of very different thicknesses. This was overcome by the method indicated in Fig 2, page 469, June 10. On the outside of the principal a special disposition has to be adopted to prevent the rain from penetrating. The 60 by 60 by 6 mm. angle irons of the framework are cut, a flat piece of iron of 0·400 m. is added, and between the angles and the sheet iron a sheet of lead is inserted, which carries off the water. The section represented in Figs. 29, 31, is immediately below the lattice girder of the floor of the lateral galleries. It shows the angle irons, 90 by 90 by 9 mm., of the arches, which continue to the bottom.



PORTION OF THE OLYMPIA HALL, KENSINGTON.

We give above a perspective view of this machinery hall roof, from which a general idea of its size and character may be obtained. For this and other particulars we are indebted to *Le Genie Civil*. The roof is certainly of fine design, but in spite of its size it will probably have a heavy appearance. For comparison we give a perspective view of a portion of the elegant roof of the Olympia Hall Addison-road from the designs of Mr. Max am Ende.

EXPERIMENTS ON THE IGNITION OF MINE GASES AND COAL DUST.

On the 3rd inst. some interesting experiments, to show the effect of firing different explosives in a level filled with mine gas and fine coal dust, were conducted by some of the upper officials of the Royal mines on the Saar, at the König Pit, in the presence of a numerous party of specialists interested in the subject.

A level or tunnel 50 metres long and 1½ metres high had been constructed of strong timbers and planking, well bound and braced with iron, two-thirds of which was sunk below the level of the ground, the upper part of the level having a rounded form. In this level a number of small windows for observation inside, also numerous holes with stoppers, to act as safety valves, were introduced, as well as trapdoors for facilitating an entry. As the subsequent firing of the explosives took place at the front end of the level, the shock here being the greatest, it was closed up by a strong wall, and in this tunnel the experiments were made. To expedite the clearing out of the products of combustion after each experiment, a mechanical blast was applied. The gas was led into the level by a pipe from a small reservoir holding about 2 cm., and this again was drawn direct from the König Mine itself into the holder.

Trial No. 1 was carried out with common blasting powder, while the air in the level was impregnated with 12 kilos. of fine coal dust, but without mine gas; 4 metres of the level had been stopped off for this trial by a screen of two thicknesses of impervious canvas, and a small mortar was fixed in the front wall, out of which the powder was exploded.

The effect was considerable. It could be seen through the windows how the coal dust flared up with a strong flame when the explosion of the powder took place. It drove out the wooden plugs, plastered with loam, with great force, and large volumes of smoke issued from the openings. This trial showed clearly what danger there must be when the powder flash in a mine takes place when it is filled with coal dust, which, however, is almost always the case, and when mine gas is present as well, which in this experiment was not the case.

Trial No. 2 was with "Sekurit,[1]" in presence of coal dust and 4 per cent. of mine gas, the same portion of the tunnel being used as in No. 1 trial, and the same quantity of coal dust. Instead of a violent explosion, as had been observed with the powder, it was here just the opposite. The Sekurit cartridge was ignited by electric spark, and it exploded with a feeble report. An ignition of the gas or the coal dust did not take place, which scores a point for the new explosive as against powder, so far as ignition is concerned.

Trial No. 3 was with gelatine-dynamite with water, in presence of coal dust and 8 per cent. of mine gas. The level was filled with coal dust as before, and then the 8 per cent. of gas was let in, which would form an exceedingly dangerous composition in a mine. The gelatine-dynamite cartridge was enclosed in an outer shell or casing, and the narrow annular space filled with water, so that the cartridge was surrounded with a thin film of liquid. The effect was just the same as in No. 2 trial. The cartridge exploded, but could not ignite the gaseous mixture, clearly attributable to the moisture, as No. 4 experiment proved.

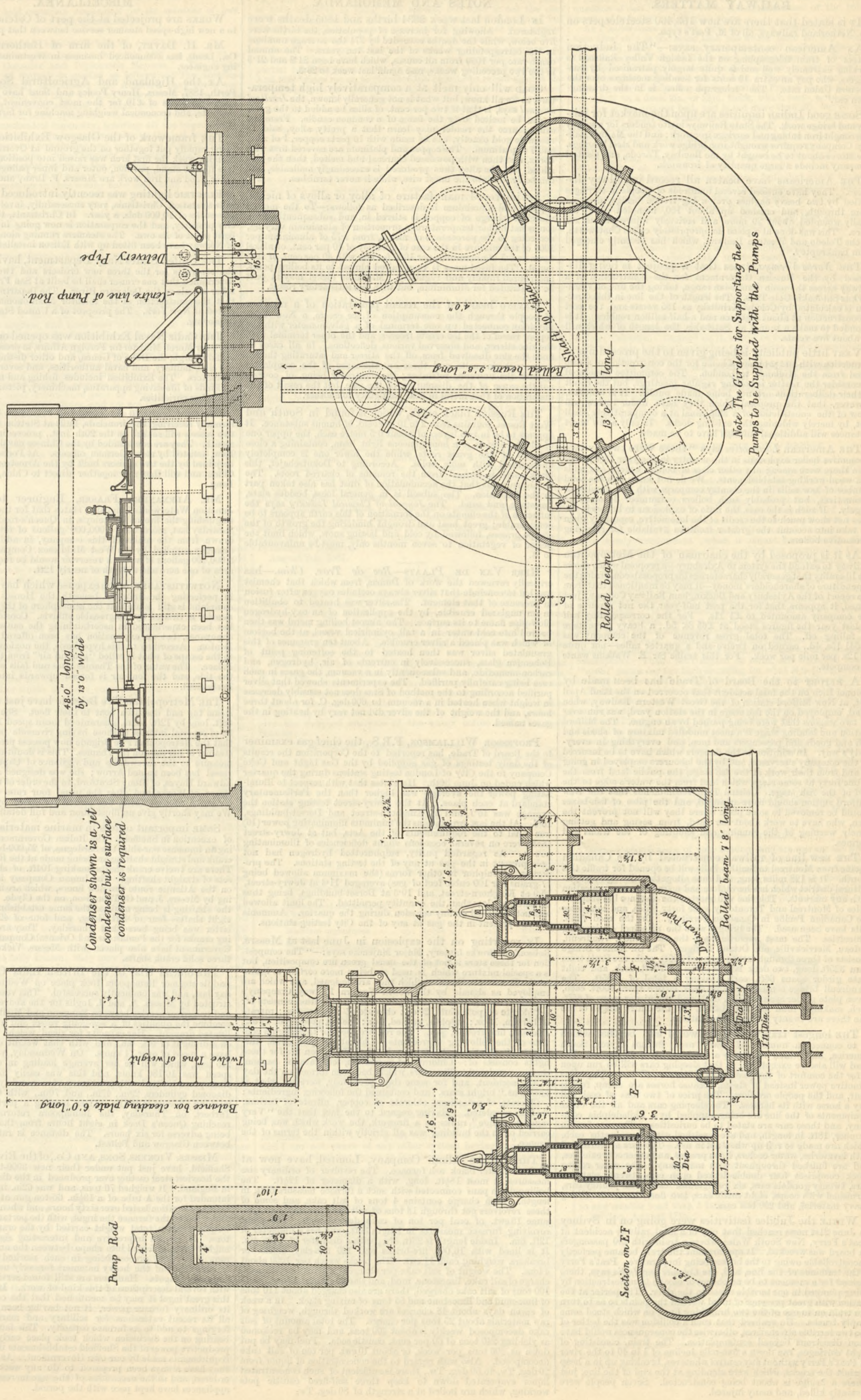
Trial No. 4 was with gelatine-dynamite, without the surrounding of water. The same mixture of air, gas and coal dust as in No. 3 trial was employed; also a similar cartridge, but without the covering of moisture—as already said—was exploded. The effect was a most violent one. The gas exploded with great force and the shock was felt throughout the whole level, while the smoke rushed out at every opening. At one place the side of the very strong structure was burst open, and timbers, &c., broken. From this it is evident, when compared to No. 3 trial, that surrounding the cartridge with water prevents the ignition of gas in a mine. It is presumed that the water is instantly turned into spray and then as quickly into steam, which envelopes the flash and prevents its contact or communication with the gas. Other experiments with Sekurit as against carbonite cartridges were instituted in the open air, which were declared satisfactory by those present, but are not of sufficient interest to give in detail here.

The death is announced of Mr. John Kirkaldy, until lately senior partner in the firm of John Kirkaldy and Son, of West India Dock-road.

[1] "Sekurit" is a new explosive invented by M. Schoeneweg, chemist, of Dudweiler, on the Saar.

DIFFERENTIAL PUMPING ENGINES, UMARIA COLLIERY.

(For description see page 149.)



RAILWAY MATTERS.

It is stated that there are now 103,460 steel sleepers on the Netherland railways, all of M. Post's type.

An American contemporary says:—"The induction system of train telegraphing on the Lehigh Valley Railroad is working extremely well and is quite largely patronised by passengers, who pay an extra 10 cents for sending messages over the Western Union rate. The 'telegraph office' is in the drawing-room car."

Some good Indian inquiries are upon the market for railway and bridge work. The State Railways invite tenders for a supply of wrought iron tubing and carriage ironwork; and the Madras Railway Company requires wrought iron bridge work and steel bearings. The stores about to be bought by the Bombay, Baroda, and Central Company include a large quantity of ironwork.

The Americans have beaten all record in railway disasters. They have enticed several hundreds of people in carriages hauled by two heavy engines over a big trestle bridge, dropped them through, and crushed up about 100, mangled about 50, fatally wounded about 20 more, and seriously injured about 200 more. This was done at a place inappropriately called Chatsworth, on the Toledo and Western Railway, which has recently emerged from bankruptcy.

The *Novoe Vremya* states that a project is being discussed by the Russian Government for the construction of a railway across the main Caucasian range, taking the line of Vladikavkaz-Satchakis-Gele-Tiflis. The length of the line in this direction is calculated by Colonel Krinitzky as 185 versts and the cost of construction at about eighteen and a-half million roubles. It is intended to make a tunnel at Satchakis, the length of which will be about five versts.

Very little publicity is being given to the proceedings in connection with the proposed scheme for the construction of a ship canal from the Midlands to London. The committee appointed to consider the matter is holding regular meetings, but the result of their deliberations are not being made public. It is believed, however, that the proposal which they have under review will allow of the construction of a ship canal at a comparatively small cost, by merely widening the existing docks. In only a few short distances will additional cuttings have to be made.

The American *Locomotive* says "there were twenty-two locomotive boiler explosions in this country in the year 1886; more than there were among any other class of boilers except saw mills and wood-working establishments. We do not know how the total number of saw mills in the country compares with the number of locomotives, but probably such boilers outnumber locomotives largely. If such is the case, the ratio of explosions to boilers in use does not show much to the credit of the locomotive, especially when we take into account the greater facilities available for repairing locomotive boilers."

As it is proposed by the chairman of the Metropolitan Railway to extend the system to Aylesbury—a proposal which shows the liberality that generally characterises his proposals concerning the expenditure of shareholders' money—it may be mentioned that from the report of the Aylesbury and Buckingham Railway Company just issued, it appears that for the past half-year the net revenue of the company amounted to £1 11s. For the corresponding half of last year the figures stood at £65 6s. 5d., a heavy percentage of falling off. The total gross revenue of the company was £1641 15s. 4d., earned on twelve and a quarter miles—not quite £2 12s. per mile per week. For this traffic Sir E. Watkins wants to compete.

A report to the Board of Trade has been made by Colonel Rich on the fatal accident that occurred on the 22nd April last, at New Milford station of the Great Western Railway, when a lad, employed on the fish stage in the station yard, was run over by two wagons that were being pushed by an engine. The Milford station and landing stage is a most muddled mixture of sheds and fish and goods and passengers and men, and everything in everybody's way. In addition to the dangers which have to be incurred by the company's servants, and by the labourers employed in going to and from their work at the fish stage, the public land from the public ferry at some steps, which lead from the water's edge to the end of the fish stage. Colonel Rich recommends that the New Milford station should be re-arranged, and the piles of fish-boxes should be removed to some place where they will not prevent the men, who have to work about the yard, from seeing and getting timely warning of the running and shunting of the trains and engines.

The new line of railway constructed by the Canadian Pacific from Montreal to Smith's Falls will be opened for traffic this month. It is 128 miles long, and runs altogether through an agricultural district which has heretofore had no railway communication with any markets. This line will shorten the distance between the cities of Montreal and Toronto by some forty miles, and completes the Canadian Pacific in Canadian Territory. On the road 72 lb. rails have been used. The bridges were the principal engineering difficulties. The most important are the St. Anne's, Vaudreuil, Rideau, Merrickville, and Ottawa Bridges. The St. Anne's Bridge consists of three through lattice spans of 100ft. each, one Pratt truss span 325ft. long, two deck lattice spans of 100ft. each, and eight plate girder spans 66ft. each, making a total of 1385ft. The Vaudreuil bridge consists of eight deck lattice spans 100ft. each, seven plate girder spans of 71ft. each, and two girder spans of 65ft. each, making a total length of 1427ft. In the entire length of the line there are twenty intermediate stations.

The longest tramway in the world will be that which is to connect a number of towns near Buenos Ayres, South America, and which will have a total length of 200 miles. The road will also be exceptional in that sleeping cars will be run upon it for the comfort of the passengers. Horses will be employed as a motive power instead of steam, because horses are cheap, fuel is dear, and the people are slow. The price of two tons of coal will buy a horse with its harness. The sleeping cars and all the other equipments of the line are being supplied by a Philadelphia company, and these cars are stated to be curiosities. They are four in number, 18ft. in length, and are furnished with four berths each, which are made to roll up when not in use. The cars are furnished with lavatories, water coolers, linen presses, and other conveniences, and are finished throughout with mahogany. The other rolling stock comprises four double-decked open cars, twenty platform cars, twenty gondola cars, six refrigerator cars, four poultry cars, furnished with coops, eight cattle cars, two derrick cars for lifting heavy material, and 200 box cars.

While the Jubilee festivities were going on in Sydney on June 21st news reached that city of a fatal railway accident at Peat's Ferry, New South Wales, where a train with 250 passengers on board was wrecked. It appears that the train became perfectly uncontrollable owing to the brakes being inoperative. Peat's Ferry is the terminus of the line, and, the *Colonies and India* says, there seemed for a moment to be no chance of escape from destruction by being plunged in one terrible wreck in the river. The porter at the station with great presence of mind worked the points so as to turn the train on to one of the two branching lines, on which stood some empty trucks. He realised that such a collision was the better of the two terrible alternatives, otherwise the consequences would have been disastrous beyond contemplation. The train, consisting of eight carriages, ran down a five-mile incline of 1 in 40 to the river at Peat's Ferry without any control whatever, breaking up in a heap against the trucks, which were standing at the end of the line, just where a bridge is about being constructed. Seven people were instantly killed, and many injured.

NOTES AND MEMORANDA.

In London last week 2634 births and 1885 deaths were registered. Allowing for increase of population, the births were five below, while the deaths exceeded by 271 the average numbers in the corresponding weeks of the last ten years. The annual death-rate per 1000 from all causes, which have been 24·8 and 21·8 in the two preceding weeks, rose again last week to 23·3.

Gold will only melt at a comparatively high temperature, as we all know, but what is not generally known, the *Jewellers' Journal* says, is that if two per cent. of silica be added to the gold, it can be melted over the flame of a common candle. From the same source the reader may learn that a pretty alloy, said to resemble gold exactly, can be made with 16 parts copper, 1 of zinc, and 7 of platinum. The copper and platinum are covered first with borax, and then with powdered charcoal and melted, then the zinc added, and the alloy thus produced is exceedingly malleable, and can be drawn into the finest wire, while it never tarnishes.

An improved manufacture of alloy or alloys of nickel, copper, and aluminium is described as follows:—To the melted nickel the charge of copper is stirred in, and subsequently, at a somewhat higher temperature, a proportion of aluminium varying, according to the percentage of nickel, from 1·75 of aluminium per 1000 of the mixture in the case of an alloy of 10 per cent. of nickel down to 0·5 of aluminium per 1000 for one with 40 per cent. of that metal. The fused mass is then raised almost to its boiling point, and poured rapidly and regularly. Malleable nickel may in part be substituted for aluminium, but with less satisfactory result.

Having heard of the recent prostration of a number of people through the consumption of ice cream, a New York physician connected up one terminal of a galvanometer with the copper vessel of the ice cream freezer, and the other terminal with the zinc stirrer, and observed various deflections. In all cases he finds the zinc dissolved from off the stirrer and saturating the ice cream with zinc salts, and these are the cause of the complaints against the universal refresher; the electricity being, of course, not the cause of the dissolution of the zinc, but the result of the dissolution of that metal in near contiguity to another.

The Russian black earth, which is found in South and West Russia, contains from 2 to 19 per cent. of humus substance. It appears to be in two layers of about 0·5 metre each, the upper one of which consists of a homogeneous light loam, containing a close network of fine grass roots, while the lower one is completely undermined with mole holes. According to Dokutschajef, this black earth is formed from the remains of charred roots. The author suggests that the accumulation of dust has also taken part in the formation. The subsoil is in general loess, besides slate, limestone, and sand. The *Journal of Chemical Industry* says the influence of the climate on the formation of this earth appears to be considerable; great heat and drought hindering the growth of the steppe grasses, followed by cold and lasting snow, which limit the period of vegetation to seven months only, must be unfavourable to it.

Herr Van de Plaats—*Rec de Trav. Chim.*—has critically reviewed the work of Dumas, from which that chemist was led to conclude that silver always occludes oxygen after fusion in presence of that element. The silver was heated to ebullition in an unglazed crucible, by the application of an oxy-hydrogen blow-pipe flame to its surface. The almost boiling metal was then poured into cold water in a tall, cylindrical vessel, at the bottom of which was placed a silver crucible. About ten grammes of this granulated silver was then heated to the softening point of Bohemian glass, successively in currents of air, hydrogen, and carbon-monoxide, and subsequently in a vacuum, the gases in each case being carefully purified. The experiments showed that silver purified according to the method of Stas does not sensibly decrease in weight when heated in a vacuum to 600 deg. C. for about three hours, and the weight of the silver did not vary by heating in the gases named.

Professor Williamson, F.R.S., the chief gas examiner to the Board of Trade, has reported to the Corporation the results of the daily testings of gas supplied by the Gas Light and Coke Company to the City of London testing stations during the quarter which ended on June 30th. He states that with respect to illuminating power the average was higher than the Parliamentary standard at each place. At the Jewry-street testing station the average was 16·1, and at Kinghorn-street and Dorset-buildings, 16·6. At the last two stations the minimum illuminating power (16) was equal to the requirements of the Acts, but at Jewry-street there were on several occasions slight deficiencies of illuminating power. As regarded purity, sulphuretted hydrogen had not been present in the gas at any of the testing stations. The proportion of sulphur in other forms (the maximum allowed being 17 grains per 100 cubic feet of gas) averaged 11·4 at Jewry-street, 10·9 at Kinghorn-street, and 10·3 at Dorset-buildings, being thus considerably less than the quantity permitted. The limit allowed was not exceeded on any occasion during the quarter. Ammonia was not present in the gas at any of the City testing stations.

In reporting on the explosion in June last at Messrs. Robson's fireworks factory, Major Majendie says:—"The composition for these stars is not of the usual green fire composition, but is a special mixture which is used as being more certain to ignite on the Roman candles, for which they are designed, and which are employed as signals by the South-Western Railway Company's steamers trading from Southampton. The composition consists of:—Chlorate of potassium, 20 oz.; chlorate of barium, 4 oz.; nitrate of barium, 10 oz.; sulphur, washed, 6 oz.; shellac, powdered, 1½ oz.; charcoal, fine ground, ⅝ oz. The red fire used for these lights consists of the following ingredients:—Chlorate of potassium, carbonate of strontium, shellac, powdered. The green fire for these lights consists of:—Chlorate of potassium, chlorate of barium, shellac, powdered. The stars which had been formed on the day of the accident, and for some days previously, were all what is known as "bright stars," and contained the following ingredients:—Chlorate of potassium, chlorate of copper, nitrate of barium, shellac, powdered. Having regard to the fact that the "Very signal cartridge" ranks as a firework, the work which was being carried on in the building was all strictly within the terms of the licence."

The Widnes Alkali Company, Limited, have now at work a monster black ash furnace. The revolver of ordinary size measures at most 18½ft. long, with a diameter of 12½ft. The boiling-down pans connected with such a furnace measure 60ft. in length. Each charge contains 4 tons of salt cake, and some of these revolvers get through 18 tons of salt cake per day, and consume 13 cwt. of coal per ton of cake decomposed. The giant revolving furnace measures in length 30ft., and has a diameter of 12ft. 6in. Inside length is 28ft. 6in., with a diameter of 11ft. 4in. It is lined with 16,000 fire-bricks and 120 fire-clay blocks or breakers, weighing each 1¼ cwt. The bricks weigh per 1000 about 4 tons. The weight of salt cake per charge (*i.e.*, contained in each charge of salt cake, limestone, mud, and slack) is 8 tons 12 cwt. For 100 tons of salt cake charged, there are also charged about 110 tons of lime-mud and limestone and 55 tons of mixing slack. In a week of seven days about 48 charges are worked through, weighing of raw materials about 25 tons per charge. The total amount of salt cake decomposed weekly is about 400 tons, and may be reckoned as yielding 240 tons of 60 per cent. caustic soda. Fuel may be put down as 200 tons per week, or about 10 cwt. per ton of salt cake decomposed. Also with regard to the concentration of liquor from 20 deg. Tw. to 50 deg. Tw., there is sufficient of such concentrated liquor evaporated down to keep three self-fired caustic pots working, which are boiled at a strength of 80 deg. Tw.

MISCELLANEA.

Works are projected at the port of Ostend with a view to a new high-speed steamer service between that port and Dover.

Mr. H. Davey, of the firm of Hathorn, Davey, and Co., Leeds, has commenced business in Westminster as a consulting engineer.

At the Highland and Agricultural Society's Show, Perth, 1887, Messrs. Henry Pooley and Sons have been awarded a special premium of £10 for the most convenient, easily erected, accurate, and economical weighing machine for farm carts and live stock.

The framework of the Glasgow Exhibition buildings is being rapidly put together on the ground at Overnewtown, and on Monday week the first arch was raised into position. The contractors for the stand, pavilion, outer and inner palings, gates, and all other wood and iron work are Messrs. F. Braby and Co.

Electric lighting was recently introduced at the Central railway station, Christiania, very successfully, involving a loss to the gas works of 10,000 dols. a year. In Christiania, the gas works are city property, and the corporation is now going in for an electric light plant of its own. The steamers running along the west coast of Norway have been fitted up with Edison installations.

The United States Navy Department, having considered the contracts for the three new cruisers and two gunboats, has determined that one cruiser shall be built at San Francisco, and the other vessels on the Delaware River. The Department has ordered that the construction of the monitor Miantonomas shall be completed at New York. The prospect of a United States Navy is thus improving.

The Cadiz Naval Exhibition was opened on the 15th inst. by Señor Moret, Minister for Foreign Affairs, in presence of the Duke of Edinburgh, the Duke of Genoa, and other distinguished visitors, the civil, military, and naval authorities, and several thousands of spectators. The Exhibition includes fishing and naval appliances, all kinds of life-saving apparatus, machinery, pictures, and Moorish and other curiosities.

General Tcheng Ki Tong has returned to Paris, after formally receiving the ironclads, built at Stettin, for China. The two vessels will set sail on the 20th inst., proceeding first to Portsmouth. They are commanded by the Chinese naval officers, Lin and Kew, assisted by some German officers. At Portsmouth they will be joined by the two cruisers built by the Armstrong Company for China, and will then sail together direct to China, under Admiral Lang.

Mr. Alexander Fraser, Engineer to the Grand Junction Waterworks Company, states that for the purposes of extinguishing the fire at Whiteley's, in Queen's-road, Bayswater, on Saturday last, more that 3,000,000 gallons of filtered water were drawn from the mains of this company, in addition to a large quantity supplied by the West Middlesex Company. To contain 3,000,000 gallons of water a reservoir would be required having an area of one acre and a depth of nearly 12ft.

Notwithstanding the expense which has been incurred in perfecting the drainage beneath the Houses of Parliament, complaint is still made that the atmosphere of the Palace of Westminster is vitiated by disagreeable effluvia. Considerable difficulty has been experienced in ascertaining the cause of this serious annoyance, but an explanation has been offered by Mr. Bailey-Denton. According to this hypothesis, the noxious odours are due to the escape of what is called "ground air" from the subsoil of the Palace. The water of the Thames rises and falls with the action of the tide, and the foul air is forced upwards into the Houses of Parliament.

The Metropolitan Fire Brigade have just added another steam tug and despatch boat to their fleet. She is steel plated, 66ft. long by 12ft. beam, guaranteed mean speed 14 miles. It will be of especial interest to those having riverside property to know that the Metropolitan Fire Brigade now possess probably the fastest steamer of her class on the Thames. This is doubtless due in a great measure to the shrewdness and vigilance of Captain Shaw. The vessel has been named Arrow; she was designed and built by Mr. Edward Hayes, of Stony Stratford, to the order of the Metropolitan Board of Works, and after the usual four runs each way on the measured mile at Erith, was passed for speed by Captain Shaw. We may shortly give an illustration and full details of this vessel.

Some important orders in marine material are in course of execution in Sheffield. The Italian Government are constructing an immense war-ship, the Sardegna, of 25,000-horse power. The crank and straight shafting are being made at the River Don Works. There are twelve crank shafts, making 104ft. of shafting, and two sets of straight shafting. The Inman Company is about to place on the Atlantic route two new liners, which are in course of building by Messrs. J. and G. Thompson, on the Clyde. For these ships the shafting is being made at the same establishment. There are eight shafts—four of 45ft. long, and four of 42ft. One of the latter was being bored last Thursday. They are also constructing cranks for the Peninsular and Oriental Company. The Italian Government have also placed with Messrs. Vickers an order for three solid crank shafts.

The official trial of the British India Company's new paddle steamer Ramapoora took place on Wednesday and Thursday last, and was eminently successful. This vessel has been constructed by Messrs. A. and J. Inglis for the above company's mail and passenger service between Rangoon and Moulmein, and has to combine the qualities of a sea-going vessel and a river steamer of limited draught. Her capacity for dead weight cargo is 400 tons on a draught of 9ft. 6in., and with that weight on board she will have a speed of over 14 knots. On Wednesday, when loaded with 215 tons, which will be her average loading in daily service, her speed was 16·186 knots, and this was easily maintained. The Ramapoora is fitted with machinery of a novel type, having three diagonal cylinders, 29in., 47in., and 70in., with 6½ft. stroke; the working pressure is 160 lb. After landing a party at West Loch, Tarbert, on Thursday, the Ramapoora returned to Glasgow, reaching Queen's Dock in eight hours from that point, the tide being adverse for six hours. The distance is rather greater than between Glasgow and Belfast.

Messrs. Vickers, Sons, and Co., of the River Don Works, Sheffield, have just put under their new 3000-ton forging press the heaviest steel casting ever produced in the district, or probably in England. It weighed 70 tons, and was 62in. in diameter, being intended for the A tube of a 13½in. 66-ton gun at Woolwich. The heating operation lasted over sixty hours, and when the glowing mass glided out of the furnace the ingot, with the portar-bar and balance-weight, made a total weight carried by the crane of at least 120 tons. It was an impressive and interesting sight to watch the mighty ingot squeezed into shape between the anvil-block and the ram, the whole process being in such marked contrast to the terrible thuds of the heavy hammers formerly used to manipulate large-sized ingots. Hammers are still found serviceable in dealing with several descriptions of this kind of work. In connection with this great ingot it may be mentioned that the company has used its ordinary furnace power, it not having been necessary during all its recent extensions for military and marine castings and forgings to add to its furnace capacity. This fact has a significant bearing on the discussion which took place early last year on the productive power of the Sheffield establishments in regard to heavy requirements made by our own Government. As a matter of fact, they have always been prepared to do any work which might be ordered, and as the necessities of the age increased the plant and appliances have kept pace with the period.

LETTERS TO THE EDITOR.

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

AMERICAN LOCOMOTIVES IN AUSTRALIA.

SIR,—I notice in your issue of July 8th, 1887, on page 23, an "Abstract of Consular and Diplomatic Reports." The United States Consul at Sydney is quoted as follows:—"The American locomotives recently introduced into Australia have given very general satisfaction, and they will soon supersede all others. Until recently the Australians seemed to think that the old-fashioned English locomotive, built upon the *lever-motion principle*, was the perfection of mechanical ingenuity, ignoring all the improvements made by the Americans in locomotives during the last forty years. The English engine is too clumsy and heavy, and it must give way to the American one. The English locomotive wears out too rapidly, and does great injury to the roadway. A recent report of the Commissioner of Railways in New Zealand states that the American locomotives in that colony have more than realised what was expected of them." I would ask your readers what dependence can be placed on the statements of a gentleman who speaks of the "*lever-motion principle*." The whole report is a piece of American brag. English engines are not heavier than American, and contain far less unnecessary metal, and have for the same power thicker boiler-plates, larger wearing and bearing surfaces, and stronger and better proportioned axles and crank-pins. All these things contribute to make the English engine more durable. If the Australians want flexible engines, bogies, and equalising levers, they can be supplied with English engines. Thousands of engines running in England have these devices, which are, indeed, both of English origin, and one was used and the other patented long before the railway era. I have had some experience with both English and American engines, and have used the former on a colonial road with long grades of one in forty, five chain curves, and very bad water. Notwithstanding these trying conditions the English engines did their work admirably. Most of them were built by Neilson, of Glasgow, and Stephenson, of Newcastle.

The real cause of the dissatisfaction expressed—in New Zealand chiefly—with some English engines is that, owing to some unexplained cause, some orders have gone to firms in England who do not regularly make locomotives, and are not famous for the quality of the work turned out. I feel, however, convinced that the workmanship of most English makers is infinitely superior to that of the best American builders. The proof of the pudding lies in the eating, and as one English firm exported in 1885 more locomotives than all the American firms put together, it is evident that English makers are doing a larger trade than America in exporting locomotives.

A COLONIAL LOCOMOTIVE SUPERINTENDENT.

MULTI-CYLINDER ENGINES.

SIR,—You published in your impression of the 22nd ult. a quotation from the *United States Mechanical Engineer* which well deserves the thoughtful consideration of steam engineers. The essence of that extract is that for one thing the expressions "triple or quadruple expansion" are misleading, and that it would be more correct to apply the numerical classification to the actual grades of expansion rather than to the number of cylinders. Besides this the writer of the article goes on to comment with much truth upon the paradox involved in securing economy of fuel by the multiplication of cylinders, attended as that multiplication is by greatly increased condensing surfaces and waste spaces of clearance in increased extent of port provision, and moreover the incidentally increased sources of friction, as the article says, "In plain words this is a paradox, for it is not only contrary to good mechanical practice, but it is opposed to common sense. Nevertheless it is a fact that triple cylinder and quadruple cylinder expansion engines are much more economical for shipowners than are compound or single cylinder engines." Just so, if a growing preference for a particular class of propelling engine is evinced by all the great ocean carriers who are usually sharp, clear-headed business men, fully competent to know what is best for their interest, be any proof, then that proof is forthcoming that multi-cylinder engines are most economical of fuel, nay more, that they economise fuel so greatly as to yield a saving in this direction more than sufficient to compensate for the increased cost of purchasing and maintaining such machinery. All this, however, is beside the paradox that such economy is obtained under a set of conditions inimical to it. I may very well leave to your readers themselves to calculate the relative number of square feet of cylinder side and end surface respectively, to which the number of cubic feet of steam of, say, 140 lb. pressure above the atmosphere is exposed, and the practically most limited time during which such exposure exists for the development of 5000 I.H.P. If, as theory seems to show, theory resting on the investigations of the most able experimenters and reasoners, shows that metallic surfaces such as cylinders and their passages present are really heat sieves, through which the heat escapes as water from a leaky vessel, then obviously the smaller the area of such surface the better. Yet actual daily practice seems—I use the adjective advisedly—to confute this proposition. Thinkers, however, will not draw hasty conclusions; before forming an opinion they will ask—have we *all* the conditions before us? Every steam engineer of any standing knows well that the whole of the phenomena attendant on the action of and the laws governing the transit of steam through an engine are not fully known; they may yet be perfectly elucidated, but they are not yet so. Leaving them for the present, I may ask, has it been absolutely demonstrated that high-pressure steam must be used successively in cylinders of ascending grades of diameter? or to put the question in another way, can designers and builders, or marine engineers as a body, confidently assert that no more can be done than has been done to use high-pressure steam in one, or at most two cylinders? Can they prove to the satisfaction of competent critics that for efficient engines the area of the piston and the initial pressure of the steam upon it have a fixed ratio, and that that ratio has, beyond all cavil or doubt, been arrived at? I venture to think it has not. It is common to say that high-pressure steam, acting on a very proportionately large piston, leads to such undue strains as to place the arrangement beyond the limits of practical engineering. I dissent from this view, but will return to it presently, and will first deal with the question on the basis of cylinder capacity and economy. By using a series of cylinders through which the steam successively passes, an ever-increasing area of piston is rendered necessary, because the efficacy of each piston, save the last, depends on and is measured by the difference existing between the driving pressure, on what we may call its "live side," and the back pressure or its "dead side." The consequence of this is, that for a cylinder of given weight and size only a certain amount of work is got out of it. In fact, the multi-cylinder engine does not deserve to be called a high-pressure engine at all. It does not do so as regards effective pressures, because, as we know, the efficiency depends on the difference, as I have already pointed out, between the driving and the back pressures, and therefore, so far as proportion of weight of machinery to work done goes, the so-called high-pressure is not a whit better than the low-pressure engine. The real difference, of course, is one of temperatures, so far as the first and succeeding cylinders are concerned; but then either there is or there is not loss of heat in the transit of the steam from cylinder to cylinder. If the steam could be used in a single cylinder—that is, if the total expansion could be all effected in one cylinder—all the extra cooling surfaces, the clearance spaces, and port space would be saved, as well as the multiplicity of valves, valve gears, and steam and other pipes. In a word, there would be a saving of first cost, of room, of maintenance, and of working expenses, besides other advantages. Now I will consider the objection raised against the use of high-pressure steam on one large piston, and first the relations of piston speed to propeller speed. Within reasonable limits it is known that "the faster the better for both." As far as the shaft and propeller are concerned, there is little difficulty in using high speeds, but such is not the case with the reciprocating parts of the engine, and if nothing but side-by-side cylinder engines were used the argument that greater piston speeds could be used in them than in tandem engines, owing to better balancing of parts, it would be a good argument in favour of using a number of cylinders; but in reality tandems or partial tandems seem quite as popular as the side-by-side type. And this brings me on to consider the objections raised against the use of high-pressure steam in a single or at most in two cylinders. In the case of the triple engine, having a crank to each cylinder, I find that when the engine is in full operation there is a total mean statical stress of a crushing nature on the main shaft journals and their bearings. Let me assume for the sake of argument that at a given point in the revolution this stress at its maximum of shaft neck equals collectively 500 tons, then sufficient area of bearing surface is provided for it; but in the case of the multi-cylinder engine this surface is divided over two brasses to each cylinder in the type of engine under notice. Has it been proved beyond doubt that this subdivision of stresses and stress bearing areas is better than a unification of both? Or, has it been proved that, admitting for the moment that steam stresses of more than a certain magnitude may be used in a cylinder, but not on a single pair of journal bearings, however large, may it not be found possible to fit the one large cylinder with not only duplicate piston rods, which is already done with perfect success in oscillating paddle engines, but with duplicate connecting rods also; to, in fact, employ the same guides, connecting rods, &c., for one cylinder that are at present used for three? Then again, as regards the cylinder, it may be quite true that the present methods of shaping and securing the cylinder ends is such as renders them unable to withstand the great stresses; but why should not other methods be devised? Are the cylinder engineers to be beaten by the boiler men? Each year sees improvement in cast steel making; let that material or wrought iron be used for ends. It is neither our function nor our intention to assume to teach the many eminent marine engineers and naval architects in daily practice their business in this matter, but there are certain points about this whole question of multiplying cylinders in our steamships which need, deserve, and soon will actually and imperatively demand attention. We have not yet reached, we might almost say we have not got within a measurable distance of the limit of pressure which boilers can be constructed to withstand, and as we have not yet got a good, or indeed any expansive or non-expansive rotary engine, it is highly expedient to "try back" a little, and make quite sure that steam of greater pressure than is now thought possible cannot be used in cylinders of a given magnitude. Sea-going men tell curious things about the respective records made by each of a series of cylinders, and analyses of some of their indicator diagrams and other data sometimes show evidence to the effect that one or another cylinder of a series contributes little or nothing to economy of fuel, and its only apparent value is as an equaliser of strains. If this can be generally shown, then it remains to be seen if the strains cannot be equalised by some simpler method. One thing is pretty certain, that however pressures may be increased, we cannot very well keep on multiplying cylinders at pleasure.

M. E.

August 6th, 1887.

WATER SOFTENING.

SIR,—It is with great pleasure that I accede to the request of Messrs. Gimson and Co. and T. W. Kennard to furnish your readers with the result of my experience in the softening and purification of water for domestic purposes, and I should have done so before but I had no wish to monopolise your columns, and I gave such information as I considered most interesting to the majority of your readers.

I must admit, however, that my time has been chiefly occupied in treating water for steam boiler and other industrial purposes, but in places where the reagent was lime water, the softened water is used for domestic and culinary purposes as well.

All my analyses are made by Mr. Puttemans, assistant chemist to the City of Brussels, and to satisfy your scientific readers, I give the detailed analyses of the water before and after purification:—

1.—*River Water* (*Demer*), *Town of Hasselt.*

	Before purification. Grains per litre.	After purification. Grains per litre.
Silice	0·016	0·004
Anhydride sulphurique	0·059	0·034
Chlore	0·024	0·021
Alumine et oxyde de fer	0·036	0·008
Chaux	0·048	0·040
Matieres organiques	0·110	0·052
Residu salin	0·252	0·144
Titre hydrotimetrique	17°	8°

2.—*Well Water, Railway Station of Vilvorde.*

	Before purification. Grains per litre.	After purification. Grains per litre.
Silice et sable	0·028	0·012
Anhydride sulphurique	0·131	0·111
Chlore	0·092	0·092
Alumine et oxyde de fer	0·028	traces.
Chaux	0·368	0·072
Magnesie	0·049	traces.
Matieres organiques	0·104	0·046
Residu salin	1·108	0·408
Titre hydrotimetrique	67°	27°

3.—*Well Water, Government Schools, Laeken.*

	Before purification. Grains per litre.	After purification. Grains per litre.
Silice	0·028	0·020
Anhydride sulphurique	0·184	0·139
Chlore	0·049	0·042
Alumine et oxyde de fer	0·004	traces.
Magnesie	traces.	—
Chaux	0·268	0·060
Matieres organiques	0·040	0·020
Residu salin	0·776	0·396
Titre hydrotimetrique	56°	20°

The reagent used is lime water, and from the above results there cannot be, I presume, any doubt left in your readers' minds as to the efficacy of my apparatus, not only for industrial, but also for domestic purposes, as the water treated is very bad, and more especially so when compared with Thames water at Staines.

I would call your attention not only to the reduction of the hardness, but also to the great reduction of the organic matter, and I am not aware of any other system having produced such results. I shall be happy to tender any further information your readers may require.

ANDREW HOWATSON.

46, Boulevard Anspach, Bruxelles,
August 13th.

MONITORS AND TURRET SHIPS.

SIR,—You have raised a very interesting question in your article of the 29th ult., and with your leave I propose to say something concerning Mr. Cobb's letter which appeared in your last number.

Mr. Cobb reminds me of an old saying about "angels fearing to tread." I will leave out the preceding portion of the passage. The summary manner in which he deals with the whole question is, to say the least, amusing, although I fancy to be amusing was not what he intended.

In the first place, he says that if the four 80-ton guns of the Inflexible were carried in four separate ships the cost would exceed a million and a-half. This I dispute, and I should be glad to have an explanation from Mr. Cobb of what he means. There ought to be no difficulty whatever in building for £200,000 a ship which would carry one 80-ton gun in a central turret. I find, however, that the Inflexible is by no means to be taken as a standard, because in your last issue I find drawings of the Trafalgar, which will carry four 67-ton guns, and the cost will be very little short of a million. However, we need not waste time in discussing this question of cost; let us go on to the consideration of the relative merits of monitor and English ships.

As I understand you, Sir, you say that a monitor would be the *beau ideal* ship in the sense that she would have no top hamper; she would carry a tremendous battery and nothing else. Mr. Cobb argues that she would be sunk by plunging fire. Nothing of the kind. I reckon she would be no worse off in this respect than any ship which relies on a plated deck. There is a large number of very powerful ships in your own and the French navies which rely for safety on a deck 2in. or $2\frac{1}{2}$in. thick, which rests, so to speak, on the top of the armour belt, and is not more than 2ft. out of water. How much better off would such a ship be than a monitor with an armoured deck 4ft. out of the water; the enormous weight now wasted in deck structures being utilised in augmenting the depth of the belt. Furthermore, he says that the guns of the monitor, being carried low down, they would be used with little effect against an English ironclad. This is all very well, provided the action were fought in a smooth sea; but what would happen in a breeze? There is no reason, of course, for supposing that in a modern improved monitor the guns would be carried at the water's edge, as Mr. Cobb seems to think.

The monitor would present a mark so small that she would be extremely hard to hit; the big ironclad a mark so large that it would be hard to miss her.

I could go on and point out not a few more fallacies in Mr. Cobb's argument, but it would take up too much of your space. The subject is a very large one, and even Mr. Cobb will not, I think, be prepared to deny that what you have said concerning the disaster which must follow the destruction of ventilators and chimneys, and deckhouses, is of very high importance. On board the Devastation, I am told, they burn seven tons of coal every day in driving the ventilating fans and the electric light. Without these fans life on board is as impossible as it would be in a coal mine or the black hole of Calcutta. Depend on it, it will be found possible to defeat a British ship by smothering her crew, unless some precautions are taken which have not yet been heard of.

It may be said that the monitor is not sea-going. Our own wretched little Miantonomah crossed the Atlantic twice with perfect success, and she carried the biggest gun afloat at the time. Ventilation was maintained by fans. This ship, however, conveys but a poor idea of what a turret ship might be and ought to be.

Morley's Hotel, August 15th. U. S. N.

THE STRESSES IN THE IOWA BRIDGE.

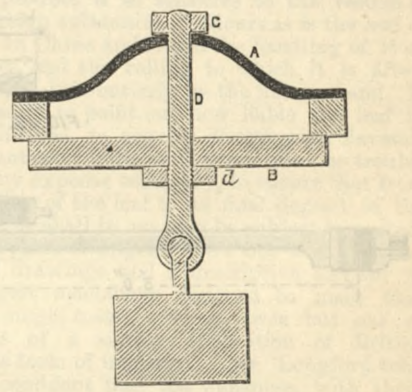
SIR,—Kindly permit me to make a few remarks upon the graphic treatment of the stresses in the Claremont Bridge, Iowa, published in your current issue. Your readers may remember that you published a series of bridge and roof solutions by me of the same character in the columns of THE ENGINEER, beginning so far back as the spring of 1883, in which I applied for the first time the method of truss disintegration and graphic termination, both to simple, and to what are sometimes ambiguously termed "redundant" structures. A truss is only "redundant" when it cannot be rationally divided into its component trusses. This method was approved at the time by those whose opinion I most highly valued, and seems to have been largely adopted across the Atlantic. But I beg to explain that I did not then understand, nor do I now, that "disintegration" means the bold elimination of struts on the principle that "they only serve to carry the load from the lower to the upper panel points." If Mr. Cunningham will look at Levy's diagram of the Pont d'Arcole, Paris—a simple truss, in which both upper and lower panel points are loaded—he will at once see that such is not generally the case. Nevertheless, it may happen that in the particular case under review, little harm will come of this simplifying assumption. Then, with regard to form, the dignified name of "arch" seems far too high-sounding for what is nothing more than a whipple truss, with a slight twist and a few internal modifications.

The reactions, which form the only analytical part of Mr. Cunningham's solution, can just as easily be found graphically from the condition that the funicular of vertical forces must pass through the three hinge-centres. By this method I find the thrust to be 61,180 lb., and not 58,333 lb. as given in the paper. The difference is, however, slight. Checking the graphic result by the theory of moments, I find a thrust of 62,416 lb. The mean of my two values is, therefore, 61,796 lb. Any slight scalar error in the lithographed proportions of length and depth of the given skeleton outline would account for the above differences; or, perhaps, Mr. Cunningham, when taking moments about the left hinge, accidentally omitted to include the half load at the key.

16th August. ROBERT H. GRAHAM.

A PROBLEM IN STRAINS.

SIR,—Perhaps some of your readers who are solving the interesting camp stool question will aid me with a solution of the following problem, which concerns questions of more structural importance than may appear at first sight. In the sketch A is a spring. B is a stiff girder. C C are two nuts on the bolt D. By screwing up these nuts a strain of 5 tons is put on the bolt.



Now let a weight of 1 ton be hung on the bolt as shown. What will be the strain on the bolt at the upper nut?

On the one side it is asserted that it will now be 6 tons, because to the initial strain due to the spring is added that due to the weight.

On the other side it is said that the strain on the top nut will still be 5 tons, but that 1 ton will be taken off the upward pull on the lower nut; and that no difference will be felt by the top nut due to any smaller load than 5 tons. Which party is right?

Brixton, August 17th. X.

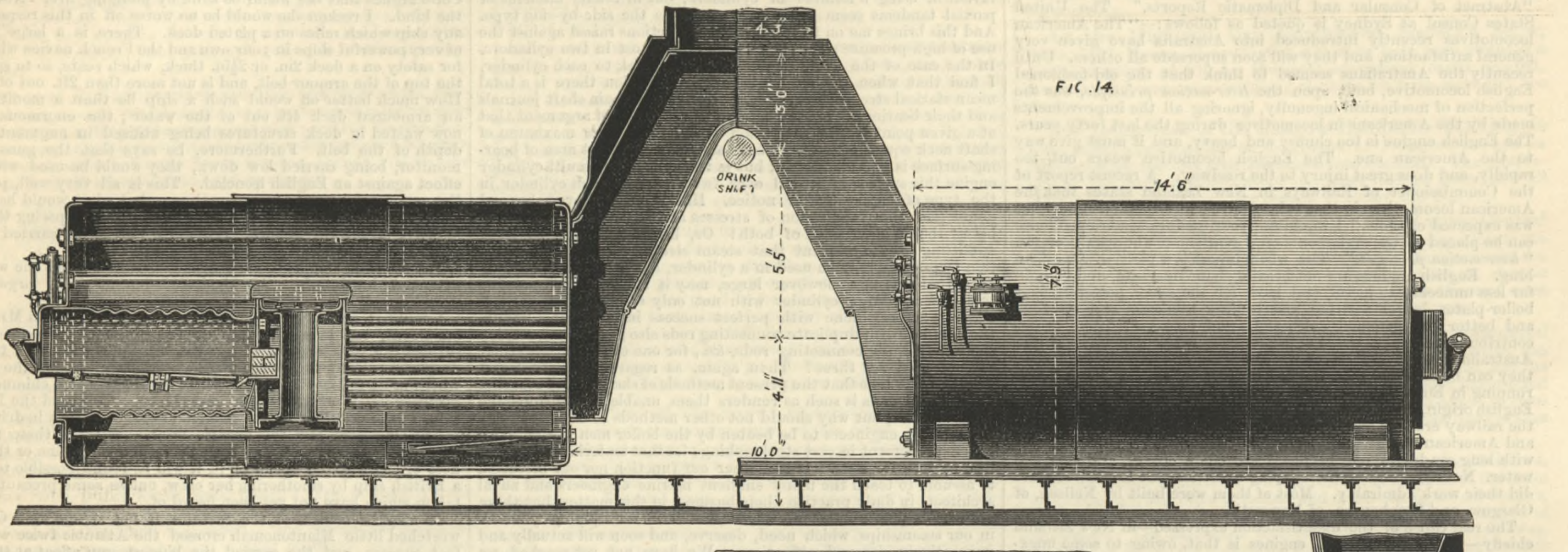
(*For continuation of Letters see page* 161.)

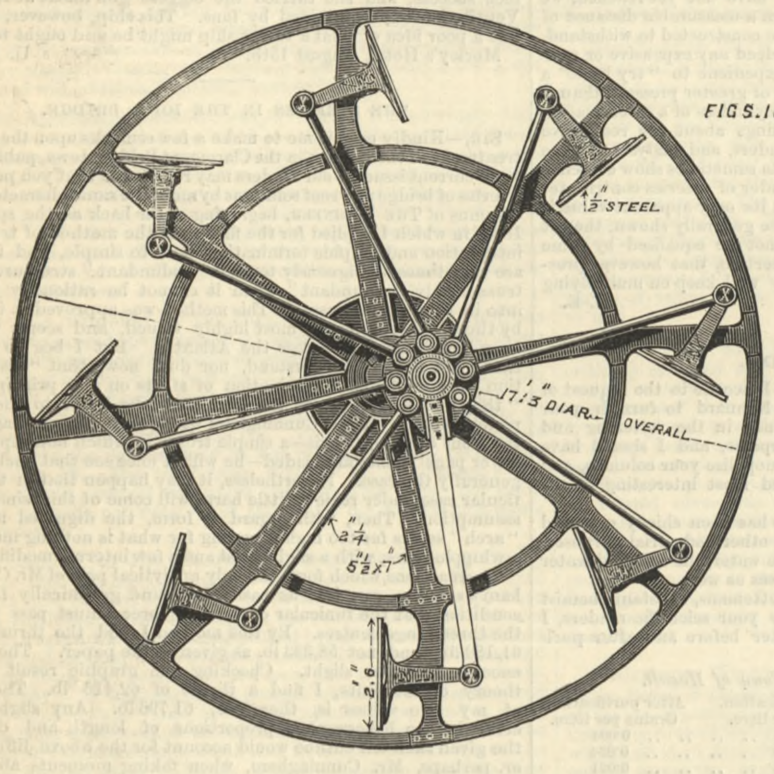
THE *Revista Tecnologico Industrial* records the fact that out of 1758 copper mines in the Ufa Government only twenty-eight are in operation. Charcoal was used in the treatment of the ore, and the gradual destruction of the forests in the district has led to a scarcity of fuel, which has tended to a considerable extent to bring about this decline of a once flourishing industry. When the metal was at a high price, some Ural marks of copper—specially the Parhkoff mark—were much esteemed. The quantity raised now is so small that working hardly pays; the expense of transport preventing the metal from competing in the market. It is therefore said to be in contemplation to cease working altogether.

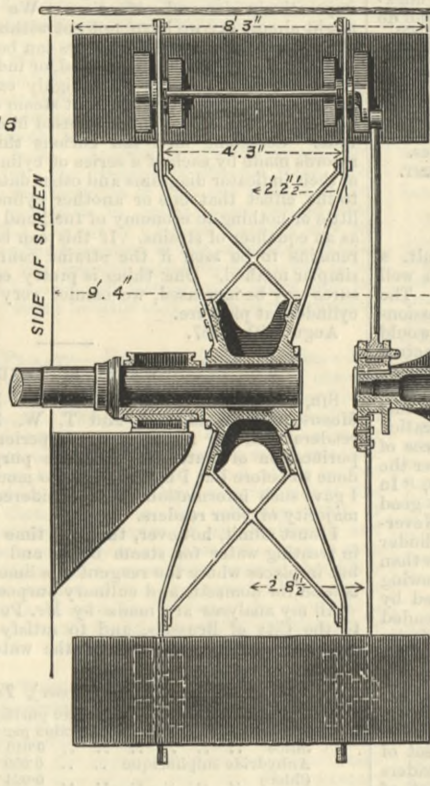
S.S. DUCHESS OF EDINBURGH.—DETAILS OF MACHINERY.

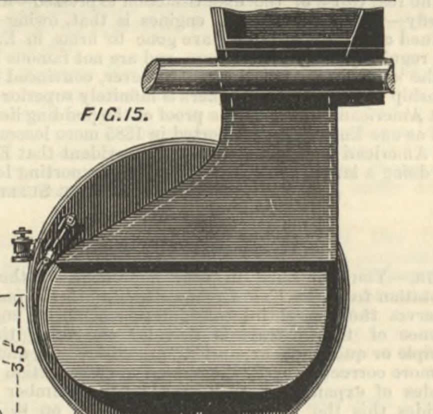
CONSTRUCTED BY MESSRS. J. AND J. THOMSON, GLASGOW.

(*For description see page* 148.)

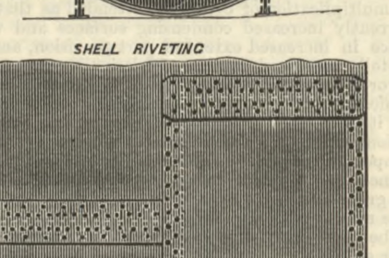


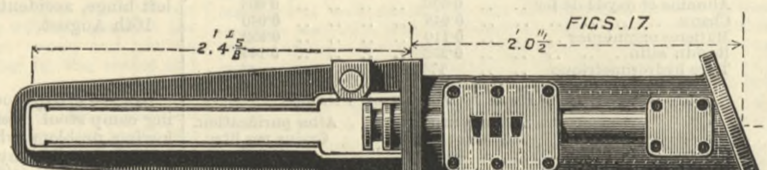


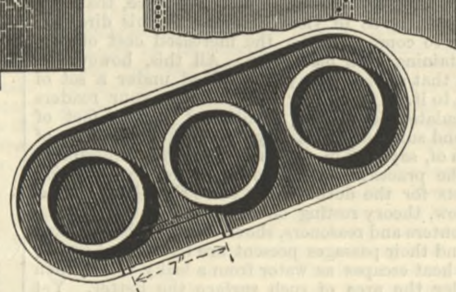


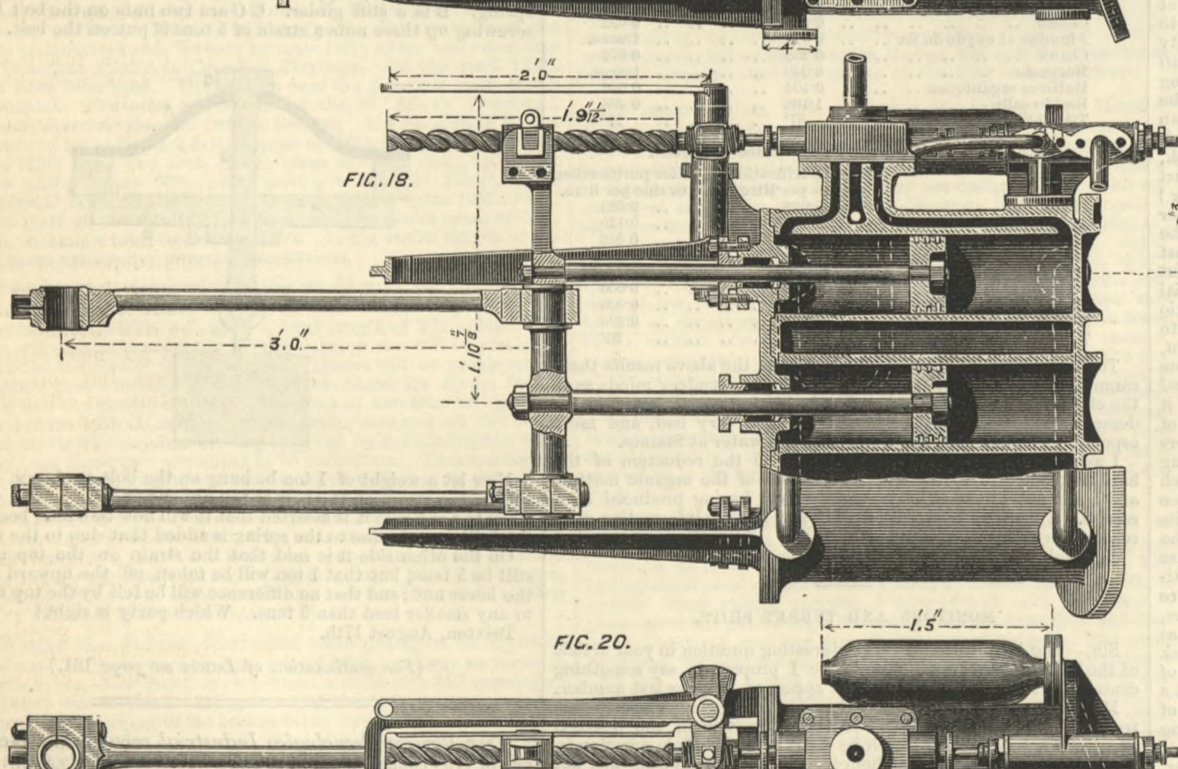


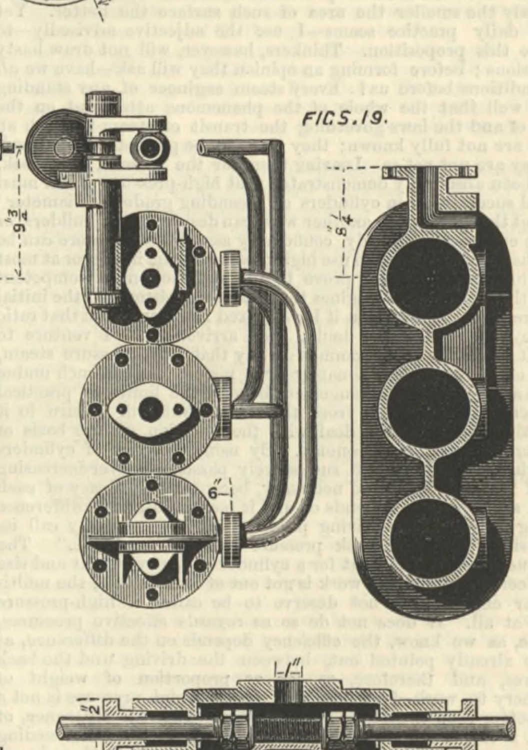
SHELL RIVETING

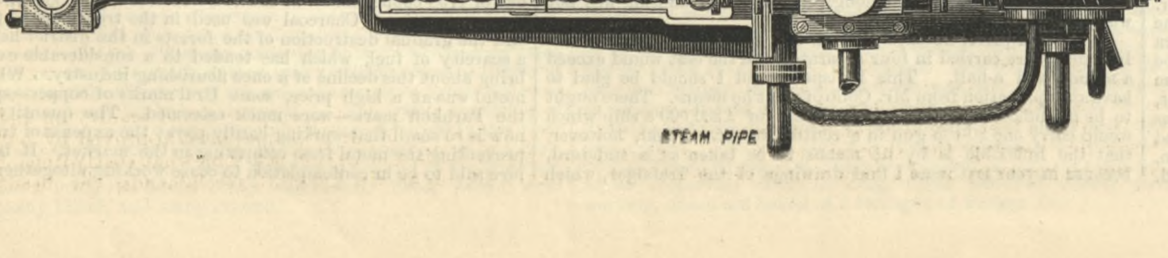


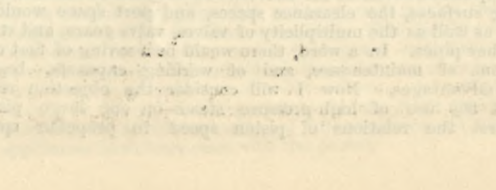












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PUZZLED.—*Your governor is "hunting"—a very common complaint with governors, and very commonly due, not to the governor, but to the throttle valve. This cuts off the steam too suddenly and completely. Instead of reducing the supply moderately, it cuts it off almost altogether. Double-beat valves are not suitable for the purpose.*

C. W.—*Some gas engines are made double-acting. Generally speaking, the single-acting engine is more efficient, the cycle of operation is more economical, compression is more effectively, and with less loss, done, and the heat loss through the walls of the cylinder is less. Yes; you might convert a steam engine, but the cost would be very heavy before you would get it to work well.*

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DEATHS.

On August 10th, at Calcutta, of dysentery, ROBERT ONGLER CLAYTON, C.E., aged twenty-nine years, only son of the late Rev. J. P. Clayton, M.A., of Bedford.

On May 26th, at Panama, of yellow fever, HENRY ROBERT HOWELLS MARTIN, A.I.C.E., eldest son of Henry Martin, C.E., Hanwell, aged thirty-six.

THE ENGINEER.

AUGUST 19, 1887.

THE MANAGEMENT OF MARINE BOILERS.

As far back as June, 1874, the corrosion of boilers in the Navy, steaming in connection with surface condensers, became so serious an evil that a Committee was appointed to investigate and report on the subject. The Committee worked away for years, and was reappointed from time to time. A final report was produced and laid before Parliament in 1880. The inquiry carried out was of the most elaborate and searching description. The result was inadequate to the trouble taken and the expense incurred. In few words, it may be said that the Committee was unable to arrive at any positive conclusion, but the weight of its opinion lies in the two following passages, which we quote from page 46 of the Blue-book issued in the spring of 1880:—"Dry air or water free from air has no action upon iron, but moist air or water containing air are two powerful agents of corrosive action. The chlorides contained in sea water render it a more powerful corrosive agent than fresh water; but even sea water when deprived of air by boiling has scarcely any action upon iron. This Committee fully agree with the late Committee, that the deterioration of boilers is principally due to the action of the air having access to them when not under steam, or carried into them with the feed when under steam. They consider also that the greater deterioration of boilers in the Royal Navy, as compared with those of the mercantile marine, is chiefly if not entirely due to the fact that her Majesty's ships are necessarily so little under steam, and that the boilers are thereby much more "exposed to the action of moist air than in the merchant service." Among the remedies suggested is that of working with the water of considerable density, and on page 48 we find the following passage:—"Increasing the density of the water in the boiler reduces the quantity of air admitted; but it is desirable to supplement that by extracting the air from the feed-water itself. This has been effected to some extent in the case of land boilers by the use of open topped feed heaters, whence the free air escapes, and the air in solution is largely expelled by the heat. Feed tanks for containing a reserve supply of feed-water, and to give more time for the air to free itself from the water as it comes from the hot well, have also been fitted to engines generally for some time past. The trial which was made under the observation of this Committee of an apparatus for mechanically extracting the air carried along with the feed-water in a free state indicates that that air at least may be readily removed by some simple arrangement." Many things have happened since 1880, but the system under which marine boilers are worked in the Navy may be on the whole regarded as an outcome of the passages which we have quoted.

In the mercantile marine it is the study of every sea-going engineer to get a thin scale in his boilers as soon as possible. This scale should not exceed a worn sixpence in thickness, and it ought to be as equally distributed as possible all over the surface of the boiler in contact with water. In practice it extends, because of the splash of the water, to a large portion of the steam space as well. This scale is found to completely protect the boiler plates, furnaces, and tubes from corrosion; but it is a delicate affair, and requires to be cautiously dealt with. If the supplementary feed is much used, the scale will become too thick. If fresh or river water is pumped in, it may be dissolved, in whole or in part, to the very great danger of injury to the boiler. In some cases it is difficult to get it to form at all; in others it forms irregularly. The use of too much oil, or of oil of the wrong kind, in the cylinders may convert it into a most mischievous fatty deposit, which, settling on the furnace crowns, prevents the passage of heat to such an extent that the crowns are over-heated and come down. At the best it is a non-conductor, and as such causes waste of fuel. If it could be dispensed with so much the better. Indeed, it is easy to see that much would be gained. Now, in the British Navy scale is never permitted, according to present practice, to form in the boilers; and any waste that takes place is made up with fresh or distilled water. The boilers do not corrode, moreover, and the results are quite satisfactory, so satisfactory that it may be said that all the troubles which led to the formation of the Committees from whose report we have quoted have been entirely overcome, and that by very simple means. In the mercantile marine the feed pumps draw directly from the hot well, and being usually much too large for their work, they send in a good deal of air with the feed. In the Navy there are two sets of feed pumps. One draws from the hot well and delivers into a tank, the other set, or feed pumps proper, draw from the tank, and matters are so arranged that they will pump "solid water" or nothing. In a word, air cannot get access to them, and, of course, they never send any into the boiler. Zinc is also used, great care being taken to secure thorough metallic contact with the boiler plates, and a curious result has been noticed—the whole steam space surface becomes coated with white oxide of zinc.

We believe that the facts we have just stated are not generally known, and they can hardly fail to interest many of our readers. Unfortunately the coming down of furnaces is a very common occurrence; so common, indeed, that one firm down the river Thames has found it worth while to provide special appliances for heating the plates, and jacking them into shape again. Such casualties, however, always imply danger and cost money, not only for the actual repairs, but for demurrage or delay of the ship. If the presence of scale could be easily dispensed with, furnaces would not come down. The practice of the Royal Navy leads to the belief that it is quite possible to work with fresh-water, and yet to incur no risk, provided, as we have shown, the feed pumps cannot pump air into the boilers. The difficulty which remains is the supplementary feed. In the Navy the double bottoms of ships are sometimes utilised to carry a supply of fresh water for the boilers. It would not be impossible to utilise ballast tanks for the same purpose in the mercantile marine under certain conditions which are often present. The better plan, however, would be to fit on board some simple form of donkey boiler, of small size, which would send its steam into the surface condenser. The supplementary boiler ought, however, to be worked at considerable pressure, otherwise the temperature would not be sufficiently high to throw down in it the carbonate and sulphate of lime and magnesia; and it is obvious that special arrangements would have to be made for keeping the supplementary boiler clean. These would, however, be of a very simple character. The supplementary boiler could be worked with sea water at a pressure of, say, 100 lb. on the square inch, and the steam would be delivered under a reducing valve to the condenser. The sea salt would be kept out of the small boiler by the usual process of blowing off. This would not get rid of the lime, however; and so from time to time the boiler would have to be treated to a strong dose of caustic soda, or something of the same nature, which would dissolve the lime salts, which would then be blown out. There seems little reason to doubt that the expedient would quickly pay for itself, and it is certainly worth while to test the system in actual practice, to ascertain if it will work as well in, say, an Atlantic steamer as it does in a man-of-war.

MACHINERY FOR THE EAST.

At a time when one of the most engrossing questions of the day is the possibility of opening new markets for our manufacturing industries, it is impossible to lay too much stress upon the desirability of giving careful study to the reports of our Consuls and Vice-Consuls in foreign countries. We have endeavoured to aid that study by the publication of abstracts of such reports; but we desire to direct particular attention to one of these, because it strongly emphasises advice which we have ourselves repeatedly given. Nothing, as it has appeared to us, can more directly militate against our success in opening new markets than the almost entire disregard which British manufacturers have hitherto shown to adapt the designs upon which they work to the necessities and prejudices of the people among whom they hope to find purchasers for their productions. The experience of almost each day multiplies evidence of the unwisdom of such disregard. Only within the last few days intelligence has come to hand which shows that the successful competition in China of Indian manufactured cottons with those produced by British looms is largely—almost entirely—due to the fact that the former are more allied in the texture given to them to the peculiar character to which the Chinese have been accustomed through long centuries of native workmanship, than are the latter. We might cite numerous other instances, but the one selected will suffice to illustrate the desirability of giving full attention to the particular recommendations of the report we propose to refer to.

Few among the many reports received from our diplomatic agents abroad are more worthy of careful reading and consideration than is Vice-Consul Longford's able paper on Japan. We have but recently pointed out in this journal how rapidly the natives of that country are advancing towards successful competition with ourselves in many branches of manufacture. Mr. Longford, however, has brought prominently under notice a department in which as yet they have made no progress, and it is one in which European enterprise may yet find a field for development. He tells us that as regards the manufacture of silk the Japanese have been ready to avail themselves of the best form of machinery constructed in this country and that it only needs an effort on the part of our manufacturers to induce them to as readily avail themselves of machinery for the preparation of their tea crops. At present, we are given to understand by Mr. Longford, the Japanese adhere closely to their old custom of hand preparation of this important article of their export. Now it is well known that it is more to careful preparation than to any speciality of cultivation, nature of soil, &c., that the fine appearance and delicate flavour of tea is due. At the present time, Indian and Ceylon teas grown by Europeans and prepared by them with the most efficiently designed machinery, are to a very large extent superseding in the home markets those of China and Japan. Indeed, the formerly strongly-marked relative proportions of import into this country, which used in favour of China teas, is rapidly becoming to be reversed. That this is in the main due to the superior methods pursued by European curers in the manipulation of the leaf is universally admitted.

No natural product is so sensitive to the results of contact with foreign substances or odours as is the leaf of the tea plant. In China and Japan the handling of it on the drying-plates, and the rolling to which it is afterwards subjected, is done entirely by the human hand. It is scarcely necessary to point out how liable the leaf is, under such conditions, to acquire disagreeable flavours. Now, the tea-planters of India and Ceylon think no trouble too great, nor any expense too heavy, to ensure that from the actual plucking of the leaf to its final deposit in the exporting chests, it shall in no way be subject to contact with the human palm or fingers. We but a short time back published drawings and a descriptive account of some of the latest machinery designed to meet that desire; but the single instance we gave was but one of many hundreds of a similar application of British ingenuity to this form of industry. Mr. Longford tells us that he is confident that the Japanese, with their strong appreciative qualities, only need to be instructed in the art of tea-curing by machinery to adopt such a method as readily as they have done in the case of the treatment of their silk crops. But when doing so, he is prepared with the caution which we have ourselves always advocated. He dilates upon the impolicy of sending out machines for speculative sale which may be unfitted to the specialities of the country and its people. He writes:—"I am far from recommending, be it remembered, speculative shipments of machinery, even of that which has already been satisfactorily tried in other countries. What I do recommend strongly, and have recommended in previous reports, is that expert machinists should be sent to Japan to study what would suit the conditions of the country and the people; and manufacturers who were guided by their recommendations would, I believe, have no reason ultimately to regret the costs of any experiments made by them." Now, the provision and erection of a complete set of tea-drying and rolling apparatus on the principles most approved by our planters in India and Ceylon is a somewhat costly item of outlay. But if, as Mr. Longford recommends, the needs of the natives are locally studied, it might be found possible to effect a large reduction on such cost, and yet to produce machinery sufficiently adequate to ensure such an improvement on the native mode of manufacture as would induce the gradual extension of its use and the desire to purchase machinery of a more fully developed character. The appreciative qualities of the Japanese to which we have above alluded would certainly induce such a result. Situated as are our machine manufacturers at the present time, we believe it behoves them to neglect no suggestion which may tend to the extension of their markets. Mr. Longford's contribution towards this end has no crudity in its character. It names a want, and points out how it may be supplied to the advantage of both manufacturer and purchaser, and we shall feel surprised if it remains long without finding those among us to act upon it.

THE DURABILITY OF IRON AND STEEL SHIPS.

THE general adoption of water ballast in steamships has introduced a factor of much importance in determining the durability of mercantile vessels. In the development of mechanical science it not infrequently happens that while pursuing a specific object, some of the necessary consequences of its attainment are lost sight of or neglected. This has been the case in regard to the water-ballast system in steamships. The sole object in view when having recourse to water-ballast was, of course, to shift speedily and cheaply from the place of discharge to that at which the next cargo is to be received; and for this the shipowner was willing to pay the extra cost which is necessarily incurred by the addition of an inner bottom, with its girders and arrangements for pumping and flooding, and to carry the extra weight of hull which these items involve. But having adopted the water-ballast system, the shipowner accepted, for better or for worse, all the consequences which follow in its train. Some of these are distinctly advantageous to him and to all concerned, while others are beneficial to nobody. For instance, it is an advantage to have an inner as well as an outer bottom to a ship, and although an inner bottom was not an essential feature of the water-ballast system in its first inception, it speedily became so. Many steamers have been saved from total loss after stranding by the presence of an inner bottom, and many more would have been saved if their inner bottoms had been structurally efficient. But while the water-ballast system possesses advantages other than those for which it was called into existence, it is also attended with certain evils, and of these the chief is that of comparative inaccessibility for examination, cleaning, and repair. The ordinary double-bottom ballast tank is bad enough in this respect, but the more modern cellular bottom is far worse.

"Out of sight out of mind," is a fragment of proverbial philosophy the truth of which receives frequent illustrations in every walk of life, but nowhere more so than on shipboard—and especially in a hard worked steamer. The loss of the troopship Megæra was due to deterioration which had taken place in a comparatively inaccessible compartment, and consequently unknown to those on board. Every shipowner and shipmaster of experience knows how important it is to have all parts of an iron or steel ship clear for inspection, and for the inspection to be frequent. For that purpose the ceiling in the bottom of a ship is no longer fastened to the reverse frames, but is fitted in loose hatches which may be readily lifted every time the hold is cleared of cargo. The prudent shipowner will fit a false bottom in his chain locker, and will support his fresh water tanks several feet above the ceiling, in order that the frames, floors, &c., may be as readily got at there as elsewhere in the vessel. He will not allow close lining to be fitted inside the framing of the forecastle, and will be very sparing in its use under the poop, preferring to leave the iron or steel work of the vessel everywhere exposed as much as possible for frequent inspection and painting. Sailing ships remain so long in port at the completion of each voyage as to afford ample opportunity for lifting hatches, cleaning timbers, repairing cement, and painting the iron or steel whenever necessary. Moreover, the hold of a sailing ship is a clear open space, which can be easily examined and kept in order, especially if such precautions be observed in the construction as have just been alluded to. There is absolutely no excuse for the master of an iron or steel sailing ship, constructed and ceiled in the way we have described, if he fails to keep her free from oxidation in every part. But with a steamer the case is very different, and especially so when she is fitted for water ballast. Under the most favourable circumstances for attaining simplicity of construction a steamer will always contain a great many holes and corners which, being "out of sight," are liable to be "out of mind" also. The bunkers are rarely empty, and when they are it is not often that they are inspected, cleansed, or painted unless at the periodical surveys instituted by the Register Society which has given her a class. How the matter fares in some of those steamers which are not classed at all can be roughly guessed at, when it is remembered how short is their stay in port, and how unlikely it is, therefore, that any other part than the outer surface of the plating can ever get the benefit of a chipping hammer or a paint brush. The iron and steel portions of the hull, in the spaces occupied by the machinery, boiler and coals, are necessarily very liable to wasting by oxidation, even under the most careful management; but when no thought is given to any other consideration than that of driving the vessel as hard as possible to make her pay—a profit now without regard to the future—the wear and tear by corrosion is enormous. This is so even when no water ballast arrangements are fitted; and when ballast tanks and cellular bottoms are added to the ordinary holes and corners of a steamship, the mischief works still more widely and speedily.

The interior of a water ballast tank is not exactly the place that any sane person would go to in order to spend a happy day. Indeed, we cannot conceive that anyone who could keep outside such a tank would experience the least desire to explore its secret passages. To crawl upon one's hands and knees upon sharp angle bars or slimy cement, in a damp, cold, confined atmosphere, flavoured with the smoke of tallow candles or naphtha lamps; and to occasionally dip one's hands, knees, and elbows into a foot or so of filthy water, is not an enjoyable experience; nor are the responsible duties of a surveyor performed with ease and certainty under such circumstances. Yet this is one of the attendant consequences of the water-ballast system. When the inspection of the interior of such a space is compulsory as a condition of classification, we may be sure that it will be performed; but have we such a guarantee when there is no compulsion in the case? If it is unusual for the master or overlooker to lift limbers unless under compulsion, we may be quite sure that neither of them will delay the vessel while the ballast tanks are being overhauled. Out with one cargo, in with another, and off to sea, is now the order of the day, and nothing less is said to pay a profit. How then can we expect the holds to be left empty while manhole covers are taken off, tanks cleaned out, and ironwork dried and recoated. Not only does wear and tear rapidly proceed unseen within the tank, but scarcely less serious is the wasting which takes place in the tank top itself, below a ceiling that is rarely or never lifted. Drainage from cargoes and decomposed organic materials lying between the ceiling and the inner bottom plating very soon act injuriously upon the latter, so as to reduce its thickness, and this form of deterioration often proceeds at a very rapid rate. It will thus be seen that the adoption of water-ballast tanks and cellular bottoms in steamships has made it more than ever necessary that careful and frequent periodical investigation should be made of those vessels, not only for the purpose of maintaining their efficiency and value, but also for purposes of safety. Unfortunately the tendency just now seems to be quite the other way. The large steamship companies, which hitherto did not resort to water ballast, are now adding to their fleets ships fitted with cellular bottoms upon the McIntyre principle. Many of these ships come under the survey of the Board of Trade only, and, so far as we are aware, the regulations of the Board do not insist upon an annual or other periodical inspection of the interior of water-ballast tanks. If such is the case, it appears to be fully time that the Board of Trade instituted such examinations upon parts of a steam vessel which, unless put under compulsory inspection, are so likely to be neglected altogether. The adoption of such regulations would be advantageous in other ways, inasmuch as it would lead to measures being taken for making a careful examination practicable, which is certainly not the case at present in many vessels. It is no use for a surveyor to crawl through the manhole in a tank top and grope his way through the cellular spaces between the two bottoms, unless he can see the state of the cement and examine the framework of the vessel. This is often an impossibility in consequence of the thick deposit of slime which rests upon the cement, the accumulation of water in some of the compartments, and the amount of oxidation which most steamship-owners permit within the cellular bottom spaces. It is essential to the proper examination of a cellular bottom that it shall be fairly clean and dry, and to bring this about the surface of the cement must be in all cases level with the drainage holes in the brackets, longitudinals, and floors. Under such circumstances it is very easy to clean out and thoroughly empty a tank, and when that is done there is a better chance of the floors, longitudinals, and frames getting an occasional coating of cement-wash than when the tank bottom is always covered with filth. In some lines of steamers the cellular bottoms are periodically flushed with a hose, drained and dried, after which they are inspected and then coated internally with cement-wash. Inspection in such cases is practicable, and comparatively pleasant. It is to be regretted, however, that such cases are rare simply because the competition of trade induces owners to continue sending their ships to sea without opening their tanks at all—so that when at last a survey is held the interior of their tanks is about as wholesome and inviting as a sewer.

The rapid increase of cellular bottoms will inevitably thrust this question upon the attention of both Lloyd's Register and the Board of Trade. The first-named society already requires periodical inspections to be held upon ballast tanks and cellular bottoms, but do not insist upon the spaces in question being so prepared as to make an examination trustworthy. So long as this is the case there will always be a risk of something being overlooked, and a certainty that the durability of the framing at that part of a ship being less than it should be. Cellular bottoms should be washed out at least once in the year, and the surfaces of iron and steel within them should be always covered with a thin coating of cement. When this condition is recognised and insisted upon with the same degree of frequency and care as is exercised in regard to the framing of sailing ships, an important step will have been taken in the direction of adding to the durability of steamships.

AMERICAN SHIPBUILDING.

IN a Parliamentary paper just issued there is a table which shows the course of the American shipbuilding trade for more than thirty-five years. For a large part of that time there are given detailed statements of the tonnage of vessels built on the sea-coast, on the Mississippi River and its tributaries, and on the great lakes. The total tonnage built in the United States is given from the year 1850, but for some of the early years the details named above are not given. From these statements we find that in 1850 the tonnage of the vessels built in the United States was 272,218, and it increased yearly until 1855, when the maximum tonnage was built—583,450 tons. Since that time there has been considerable fluctuation in the amount, and the vessels built,—the years 1864, 1874, and 1867 having been years of constructional activity, whilst recent years have shown a falling-off of importance. Since 1882 the total tonnage built has declined every year. It was 282,270 tons for the year 1882, it fell to 159,056 tons for the year 1885, and last year there was only built 95,453 tons—the lowest amount in any year in more than three decades. Taking the return from the period for which we have the division, we find that the vessels built on the sea-coast were highest in 1864, when 310,421 tons were built, and that last year there were only 64,458 tons built, but it will be noticed that this is the largest part of the shipbuilding work of the country. The tonnage built on the Mississippi River and its tributaries was highest in the year 1881, when 81,189 tons were put into the water, but it has fallen year by year since that time, and for 1886 there were only 10,595 tons constructed. On the great lakes there was the greatest activity in the year 1873, and in that year 92,448 tons was the extent of the vessels built; but last year the more moderate return of 20,400 tons was given as that of the vessels so built. It is evident that during recent years the shipbuilding industry in the United States has received a serious check, and that for the past year—which, it is to be observed, is the financial year of the States—the vessels built in the whole country did not exceed those built on some of the rivers of the United Kingdom separately. The merchant navies of the United States have not thus been greatly recruited by building in the period noticed, and it is by no means surprising to find that the tonnage of the vessels in the foreign trade has declined for years, and that it is thus now less than in any year for over three decades, and it is not one half of what it was in the year 1860. On the other hand, the portion of the merchant fleet "enrolled and licensed"—that is, the vessels employed in the river, lake, and home trade—has, since the year 1878, shown a slight but steady increase, though it is still below the tonnage described for the year 1875. It is tolerably clear that American vessels are being slowly driven off the open sea, and the fact that this is so should afford a little encouragement to our shipowners, for their vessels have not only to do what was our share of the trade of the world, but also to do an additional part—once done by other nations which, like the United States, have lessened their navy in the last few years.

THE PANAMA CANAL.

THE question we recently propounded in an article on the prospects of the work now proceeding at the Isthmus of Panama has, since that article appeared, been answered. It appeared to be questionable to us if the confidence hitherto shown by the French public in M. De Lesseps' great enterprise would continue to be exhibited under the circumstance of the large fresh demand made upon it. We now learn that of the 500,000 bonds offered, only 218,887 have been taken up. These latter only represent a total sum of 118 millions of francs, or roughly speaking, of about £4,720,000 out of the nine millions sterling asked for; and this in spite of the very exceptional advantages offered as an inducement to subscribers. But very few individuals took up any large amount of these bonds, the average allotment being but two and a-quarter bonds for each applicant. We fear therefore that it cannot be said that our doubts as to the continuance of the unlimited confidence with which former demands were received were without foundation. It yet remains to be seen what course will be pursued to raise the further funds necessary if the works are still to be persevered with. Their abandonment would have a most disastrous effect upon French finance, and it may be that the Government of the Republic may deem it good statesmanship to provide the means for avoiding a calamity which would be little less than national in its effects. It is extremely singular that at the same time that doubts such as we have named have received at all events partial confirmation, geographers should have devoted their attention to calculations the result of which is to raise the further doubt as to whether the Panama Canal, if ever completed, can be made to pay with any traffic to be legitimately expected through it, as the construction it is now certain must prove so costly. They have calculated what distance a passage through the canal would save to any port in the extreme East or at the Antarctic. They point out that from England, Bombay, Ceylon, Madras and Singapore are more easily accessible from the East than from the West. China has its shortest route by Suez and the Cape, and its longest by Panama; and there is only a difference of 500 miles to Sydney by four routes, while Melbourne only shows a difference of 200 miles by three routes. To New Zealand there is a possible saving of over a thousand miles *viâ* Panama; and to Yedo, in Japan, a saving of 1700 miles. But canal dues would possibly make this short cut a costly one. There would, however, certainly be a great gain in the route by Panama between the Atlantic coast of America and the Pacific. But now that it is known that the expenditure on the canal must enormously exceed first estimates, it is, to say the least, very doubtful if the latter gain alone can prove at all commensurate with such outlay; and yet it would seem that it is the trade of the Pacific coasts of America alone that we can regard with certainty as secured traffic for the Canal. We have before us, as we have recently pointed out, the serious effect of the competition of the Cape route under recently altered conditions with that by the Suez Canal, and the above-quoted calculations—though advanced but late in the day—seem to show that the passage through the Isthmus of Panama, with the heavy dues it must entail, is not likely to be less unfavourably affected by similar and other causes.

THE DAIRY SHOW.

THE twelfth annual show of the British Dairy Association will take place on the 6th, 7th, 8th, 10th, and 11th of October next, in the Royal Agricultural Hall, and will be much more extensive, comprehensive, and important than hitherto. Besides, a large number of prizes will be given for cows, goats, pigs, butter cheese, bacon, hams, churning, and butter-making. Prizes are offered for packages for conveying eggs, butter, cheese, and cream, for butter-making and dairying on the Devon and other systems, for hand and power cream separators, vehicles for conveying milk, including vans, carts, and trucks, for dairy fittings and silos. Special provision is being made for the exhibition of implements, fittings, seeds, roots, domestic fittings, and other articles. The manufacture of butter and cheese has now fallen so much into the hands of the machine-maker that except where carried on on the old-fashioned small scale, dairy work will in future become almost entirely mechanical. The churn used to be the nearest approach to a machine in any dairy, but churns did not offer very much scope for the inventive capacity of the irrepressible mechanist, and so he set to work to help gravity and decomposition, and improved the quantity of the cream, obtained it in a few minutes instead of several hours, obtained better skim milk and increased the quantity of butter. Dairy shows have therefore some importance now which they had not a few years ago.

IRON TRADE ARBITRATION BOARDS.

THE importance of maintaining Arbitration Boards for the settlement of wages questions is admitted by all iron and steel masters who have had any wide experience of wages disputes. Unless some vigorous action is adopted it seems only too probable that the Arbitration Board, which for eleven years past has existed in South Staffordshire, will become extinct. The matter is of the greater importance, since the awards which have from time to time been given by the presidents of the Staffordshire Board have virtually regulated ironworkers' wages in all parts of England except Cleveland and South Wales. The passing away of the Staffordshire Institution would therefore be a serious inconvenience to iron and steel masters in other parts of the kingdom. In times of prosperity as many as sixty firms in the South Staffordshire iron trade, out of a total of eighty or ninety, have been subscribing members, but at the present moment the number has dropped down to fifteen, and this number includes some outside firms, such as Messrs. Charles Cammell and Co., Messrs. John Brown and Co., and others of note. Up to a couple of years ago North Staffordshire and Shropshire acknowledged their connection with the Board by making annual contributions, and some Lancashire and Derbyshire firms, as well as South Yorkshire, were members. As to the home firms, one of the main reasons of the secessions has been the ceasing of contributions from the men, which it has been the custom of the employers to double. A more powerful reason, which has affected the action of both local and district firms, has, however, been their capacity, in times of quiet trade like the present, to make lower wages terms, from an individual standpoint, with their operatives than would be possible under the regulations of the Board itself. When trade improves, however, the other side of the shield will be presented, and in view of this, wisdom by alike employers and employed consists in actively responding to the efforts which are are now being made to resuscitate the Staffordshire Board.

LITERATURE.

Des Ingenieurs Taschenbuch, von dem Verein Hütte. Thirteenth edition, 12mo., pp. 1144.—Berlin: Ernest and Korn. 1887.

On the publication of the twelfth edition of this very useful compendium of tables, formulæ, and other data, derived from every branch of engineering practice, we gave a somewhat detailed analysis of its contents, so that on the present occasion, when it appears in a new form for the thirteenth time, it will only be necessary to notice the principal alterations. These alterations are by no means inconsiderable, and in spite of some reductions, so much new matter has been incorporated that the text has increased by nearly one hundred pages. In the first section, mathematics, the tables of circumference and areas of circles have been amalgamated with those of powers, roots, reciprocals and logarithms. Other tables of circular properties, as well as the trigonometrical formulæ, have also been increased, and examples have been added to facilitate their use. The division relating to analytical geometry has been, to some extent, re-arranged. In the second section, mechanics, the principal alterations in the subjects of aerostatics are the addition of formulæ for windmill construction. The additions in the third section, heat, are considerable, especially in the tables of contraction of metals, melting and boiling points of various substances, evaporative values of different fuels, and the evaporative capacity of water at different temperatures and pressures. The fourth section, strength of materials, has been enlarged, among other things, by Reuleaux's tables, illustrating the deflections of beams under different conditions, and the general table giving the constants of strength for constructive materials has been considerably increased. In the fifth section, statics of building construction, several of the newer analytical methods of girder construction have been added to those contained in the last edition; while antiquated matters, such as the article on unstiffened suspension bridges, are removed. A sixth section, on geodesy, which is entirely new, deals mainly with the simpler operation of levelling, hypsometry, and the use of the compass and theodolite, but all reference to the higher problems, involving astronomical observations, is omitted. Probably this section is put in as an experiment, with a view to future enlargement; in its present form it is not quite satisfactory. The sections on machine construction, prime movers, and machine tools have not been much changed; the principal improvements are in the subjects of governors, boilers, and valve gears. Among the latter, however, no mention is made of Joy's gear. The tenth section, on shipbuilding, has been entirely re-written, and is greatly improved; all the newer information, such as Lloyd's rules for ship and boiler construction, and the freeboard requirements of the Board of Trade, being included. The examples of the dimensions of marine boilers are not, however, of the newest. The eleventh section, on railways, has received some interesting additions relating to longitudinal sleepers, and on marshalling stations, while the article on rolling-stock has been remodelled. The twelfth section, on iron smelting, is in the main unaltered, and leaves much to be desired—especially as regards the newer developments of open-hearth steel-making, both in quartz and dolomite bottoms. The melting of high manganiferous metal is also without notice. A remarkable statement at p. 798 of the twelfth edition, that the Ilveder furnaces are blown with sixteen-millimetre nozzles, is reproduced without correction. The additions in the section of technology are articles on jute manufacture and the production of cellulose from wood, while those on straw for paper making and brewing have been revised. The fifteenth section, on electrotechnics, has been entirely re-written; but, having regard to the great changes continually going on in this department of technical knowledge, only practical data in tabular form are admitted. The alterations in the tables contained in the appendix are numerous and well-considered. A very clear paragraph on the depreciation of silver—p. 1049—is especially noticeable.

COMBUSTION.

Although the spread of technical education and the multiplication of text-books has extended the means of acquiring information concerning processes of nature which take place continually around us, there must remain a considerable percentage of our readers who have either not had a special training in physics, or who are too much concerned with the practical affairs of everyday life to profit by the educational facilities available in all our great towns. It happens fortunately, however, that much information, useful and interesting, can be imparted to them in the pages of the technical press in such a form that but little time or labour need be expended by those who wish to acquire knowledge. We purpose in what follows to explain in simple language what takes place in a furnace—say that of a steam boiler—in a way that may be understood by those who possess little or no information on chemistry. In text-books such a subject as combustion must of necessity be treated more or less thoroughly, because it covers a wide field; but by narrowing what has to be said to a single set of conditions, it becomes possible to clear out extraneous matter, and further condensation can be effected by asking the reader to take on trust statements, the truth of which is demonstrated at greater or less length in more or less elaborate and complete treatises. We need hardly add that what we are about to say now will convey no new information to those who have had an adequate training in physics, and may accordingly be passed unread by them.

The combustion of coal is nothing more or less than its combination with oxygen gas. When a fuel of any kind combines with oxygen heat is produced. Why fuel should combine with oxygen no one can tell. It is one of Nature's secrets. The chemist tells us that the oxygen and the fuel have an "affinity" for each other. But when this statement has been made we are no nearer to understanding why combination takes place than we were before. In text-books nothing will be found as to why heat is produced by the combination. On this point an all but universal silence prevails. We are told, however, by a few writers of the old school that heat energy was stored up in the coal millions of years ago by the sun, and that this heat energy is liberated when the coal combines with oxygen. This is absurd. It will not be out of place to give here an explanation which is consistent with facts, and therefore appears to be satisfactory.

All bodies, substances, gases, and liquids are supposed to be composed of multitudes of particles or molecules of almost inconceivable smallness, and these are all supposed to be in motion among themselves. This motion is heat; that is to say, heat is neither more nor less than a kind of motion, and this internal vibration can be transmuted into perceptible mechanical movement, or, on the other hand, mechanical movement can be converted into the invisible motion called heat. How the change takes place no one knows, but the change is none the less a fact. Now the difference between a solid and a gas is that the motion of the particles or molecules of the gas is much greater in extent than is the motion of the particles of the solid. Also some gases have a greater range of motion than other gases. If by any means we can take the motion out of gas, say by compressing it into a vessel the sides and ends of which reduce the range of movement, then as nothing is lost in nature, the invisible and insensible motion of the gas, which it has lost, reappears as heat in a sensible form, and we find that the sides of the vessel become hot. Now the oxygen which combines with coal, has a very considerable range of internal motion, but when the oxygen has combined with the coal another gas known as carbonic acid gas[1] is produced, as will be explained further on; and the particles of this gas having a much smaller range of motion than the particles of the oxygen have, the difference appears in the form of heat.

It is not necessary to tell readers of The Engineer at any length that coal is not always the same. It is composed of various substances and gases. The principal are carbon, hydrogen, oxygen, and certain impurities which make the ash with which we are so familiar. The carbon, hydrogen, and oxygen are "elements,"—that is to say, they are not composed of separate substances combined together. They cannot be split up into anything else. In 1000 lb. of anthracite coal there are about 915 lb. of carbon, 35 lb. of hydrogen, and 26 lb. of oxygen. In a good bituminous or North-country coal there will be 800 lb. of carbon, 54 lb. of hydrogen, and 16 lb. of oxygen. The difference between the sum of these quantities and 1000 lb. is matter entirely non-combustible, which appears as ash. Of course there are an infinite number of variations in the proportions which the constituents of coal bear to each other, but the figures we have given fairly represent good Welsh and good North-country coals respectively.

The air we breathe is composed of two gases—oxygen and nitrogen. The latter appears to have no effect whatever on human life or combustion. It serves to dilute the oxygen. The two gases are mixed; they are not in chemical combination. By weight, approximately, 36 lb. of air contain 28 lb. of nitrogen and 8lb. of oxygen. In bulk they are mixed in the proportion of, roughly, 4 to 1. Four cubic feet of nitrogen and one of oxygen making five cubic feet of air. There are also present in air moisture in the shape of vapour, and a small quantity of carbonic acid gas. The accompanying table shows the composition of 100 lb. and 100 cubic feet of air accurately:—

	In 100 lb.	In 100 cubic feet.
Nitrogen	75·55	77·50
Oxygen	23·32	21·00
Vapour	1·03	1·42
Carbonic acid	0·10	0·08

As has been explained, the nitrogen is of no use in a furnace, but it cannot be kept out. We may neglect it, however, as far as combustion is concerned. It goes into the furnace nitrogen and it comes out nitrogen, neither being acted on nor acting on anything else, except in so far as it carries away with it a good deal of heat, which is accordingly wasted.

The carbon and hydrogen in the coal combine with the oxygen of the air in definite proportions. The hydrogen is not free in bulk in the coal. On the contrary, it is probably condensed into a very solid condition. To explain its precise condition would lead into chemical questions, which it is not necessary to consider here. The only proportion in which hydrogen combines with oxygen in combustion is one to eight by weight—that is to say, 8 lb. of oxygen and 1 lb. of hydrogen combine and produce 9 lb. of water, which is instantly converted into steam by the heat of the furnace. Carbon combines with oxygen in two distinct proportions—one consists of $1\frac{1}{3}$ lb. of oxygen and 1 lb. of carbon, producing $2\frac{1}{3}$ lb. of the gas known as carbonic *oxide*; the other proportion is $2\frac{2}{3}$ lb. of oxygen and 1 lb. of carbon producing $3\frac{2}{3}$ lb. of carbonic *acid* gas. The heat produced by the combination varies.

Here it will be well to explain that *quantity* of heat is a different thing from the *temperature* of heat; just as the *pressure* of steam in a boiler is a different thing from the *quantity* of steam in a boiler. In this country heat is measured by "units," the unit being that quantity of heat which could raise the temperatuie of 1 lb. of water 1 deg. on the thermometer. This being understood, the following table, which we copy from Rankine's "Treatise on the Steam Engine," will also he understood:—

Combustible.	Lb. of oxygen per lb. of combustible.	Lb. of air.	otal heat in units.	Evaporative power from 212 deg.
Hydrogen gas	8	36	62,032	64·2 lb.
Carbon imperfectly burned so as to make carbonic oxide	$1\frac{1}{3}$	6	4400	4·55
Carbon completely burned so as to make carbonic acid	$2\frac{2}{3}$	12	14,500	15

The figures in the last column show the weight of water that would be converted into steam if all the heat produced by burning a pound of the combustible named could be used for that purpose, the feed-water being heated to 212 deg. before being pumped into the boiler. We see that at the utmost it cannot exceed 15 lb., so that when we hear of boilers evaporating 15 lb. or 16 lb. of water per pound of coal we know there must be an error somewhere.

We may now consider what a thousand pounds of bituminous coal would evaporate. We have first 800 lb. of carbon; this will require for its combustion, we see from the preceding table, $800 \times 12 = 9600$ lb. of air, and the quantity of heat resulting will be $14{,}500 \times 800 = 11{,}600{,}000$ units. We have 54 lb. of hydrogen, which will require 54×36 lb. $= 1944$ lb. of air, and the resulting heat will be $54 \times 62{,}032 = 3{,}349{,}728$ units.[2] Summing up, we find that our 1000 lb. of coal will require 9600 lb. + 1944 lb. = 11,544 lb. of air, and that it will produce 11,600,000 + 3,349,728 = 14,949,728 units. In practice no such quantity is ever utilised, and we shall now proceed to show how the facts we have stated apply in practice.

In the first place, it will be seen from what we have said that 12 lb. of air per pound of carbon and 36 lb. of air per pound of hydrogen are the smallest quantities that will suffice. If less air be admitted, the quantity of oxygen sent into the furnace will not be sufficient, and the carbon instead of being burned into carbonic *acid*, and so giving out 14,500 units per pound, will only be burned into carbonic *oxide*, and give out only 4400 units, or about one-third of the proper quantity. But, furthermore, it is too much to suppose that all the oxygen can be seized by all the carbon in the rapid passage of the air through the furnace, consequently we must admit an excess of air to the furnace, because a great deal of oxygen always escapes uncombined. In practice the smallest quantity of air that will suffice is 18 lb. per pound of coal, and this quantity is often exceeded, 24 lb. being admitted. When too little air is sent in, carbonic oxide is produced, passes away up the chimney, and then getting plenty of air, takes fire at the top, and burns.

In old days, when locomotives were fired with coke, all the air was admitted through the fire-bars, and none over them, as there was no smoke to be prevented. As soon as steam was shut off the draught was checked. Sufficient air did not get into the fire-box, and carbonic oxide was produced, which subsequently caught fire when it got air at the top of the chimney; so that at night a locomotive might be seen coming into a station with a blue flame some 5ft. or 6ft. long from the chimney. This was put out at once by opening the fire-door. In coal-burning locomotives a great deal of air is admitted above the coal, and a fire-brick bridge or arch is placed in the fire-box, which helps to mix the air with the carbonic oxide, and so it is burned in the right place, namely, the fire-box.

The total quantity of air required for the combustion of 1000 lb. of coal in the best constructed furnaces, worked with a proper draught and a high temperature, will be $1000 \times 18 = 18{,}000$ lb., and with furnaces working more sluggishly and not so well constructed, $1000 \times 24 = 24{,}000$ lb. The volume of air varies with the temperature, augmenting as its heat increases. For our present purpose it will be enough to say that one pound at the ordinary temperature of 60 deg. occupies very nearly 13 cubic feet, so that for the combustion of 1000 lb. of coal $18{,}000 \times 13 = 234{,}000$ cubic feet, would be needed in the best furnaces. This would fill a chamber about 62ft. long, high, and wide, and its weight would be a fraction over eight tons.

We have said nothing of what becomes of the heat generated in the furnace. To do that would unduly extend this article; and an explanation of the conditions which are most favourable to combustion we shall possibly give at another time. It will be enough to say now that much of the heat produced, instead of going to the water in the boiler, is expended in heating the air to a high temperature, and that the conditions most favourable to good combustion are those which most effectively mix the air and the hot fuel and gases. Q.

[1] Called by modern chemists carbonic anhydride.

[2] It will be seen from the particulars of the composition of coal given above, that there is a percentage of oxygen in the coal already. There is some doubt as to the part played by this oxygen and the hydrogen, and some authorities have gone so far as to say that the hydrogen in coal should be neglected altogether as a heat producer. We have given the conclusions which seem more consistent with facts.

THE ELECTRIC LIGHTHOUSE ON THE ISLE OF MAY.[1]

By David A. Stevenson, B. Sc., F.R.S.E., M. Inst. C.E.

The lighthouse situated on the Isle of May, at the mouth of the Firth of Forth, has recently been lighted with electricity, and as this light, besides being, the author believes, the most powerful in the world, possesses several novel features, he has the pleasure of offering the following notes regarding it, trusting that they will prove of interest in connection with the visit to be made to the lighthouse on the occasion of the present meeting.

Previous lighting.—The Isle of May was originally lighted in 1636 with an open coal fire. In 1816 the Commissioners of Northern Lighthouses, having previously purchased the island with the right to levy tolls for the lighthouse, altered the light to argand lamps with silvered parabolic reflectors. In 1836 it was converted to the dioptric system, with a first-order fixed-light apparatus, and a four-wick burner; on the 1st December, 1886, the electric light was substituted, and shown in connection with a dioptric condensing apparatus. For the last fifteen years, the Commissioners of Northern Lighthouses, acting under the advice of their engineers, Messrs. Stevenson, had been anxious to establish an electric light on the Scottish coast, but it was not till 1883 that the Board of Trade were able to sanction the expenditure, and suggested its introduction at the Isle of May on the ground that "there was no more important station on the Scottish shores, whether considered as a landfall, as a light for the guidance of the extensive or important trade of the neighbouring coast, or as a light to lead into the refuge harbour of the Forth." Notwithstanding the difficult access and isolated position of the Isle of May, distant five miles from the Fife shore, which is the nearest land, it was resolved to accept the view of the Board of Trade, and to introduce the electric light there. The necessary plans and specifications were accordingly prepared by Messrs. Stevenson, and the works, begun in June, 1885, were completed and the new light installed by 1st December, 1886.

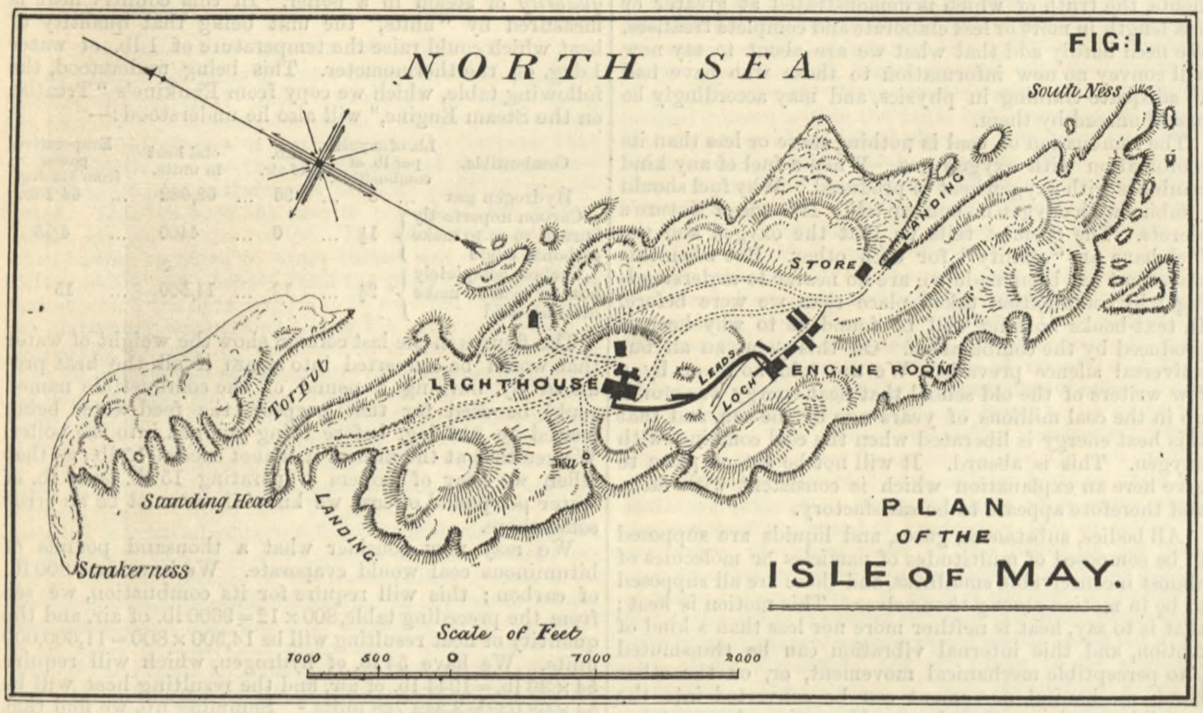
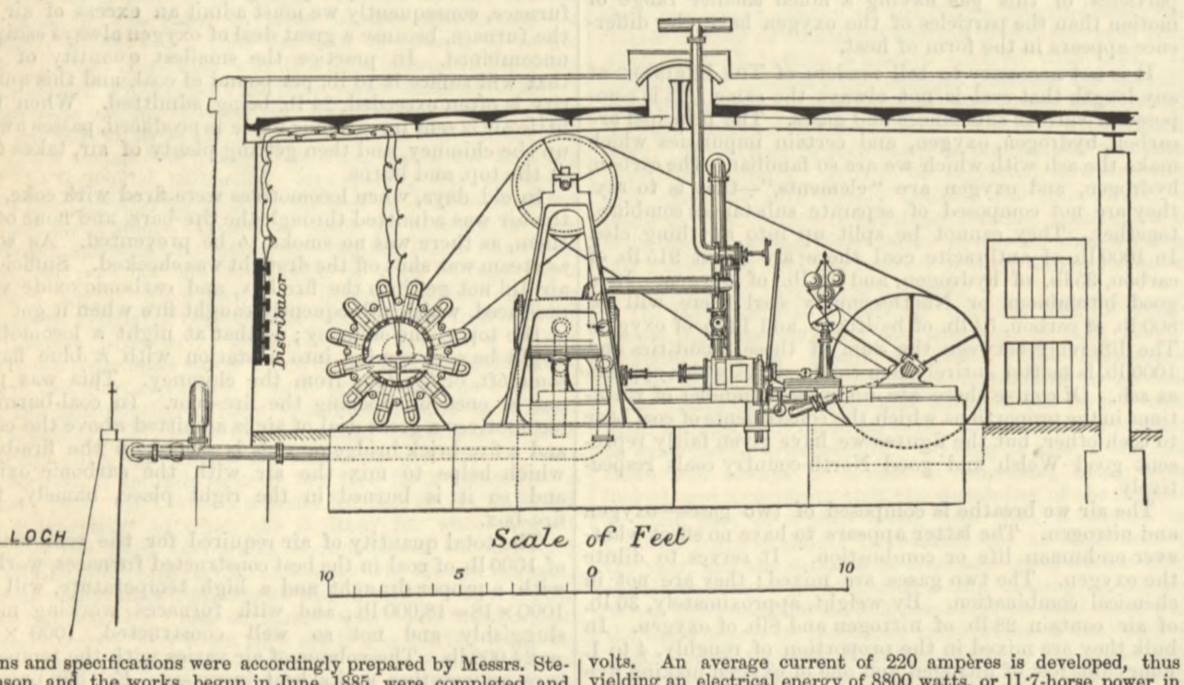


Fig 2.

SECTION OF ENGINE ROOM



Site.—Fig. 1. The existing establishment consisted of a lighthouse tower with accommodation for three keepers, placed on the summit of the island; and the additional buildings which it was necessary to provide were dwellings for three more keepers with their families, an engine-house, boiler-house, chimney stalk, workshop, coal store, &c. It was decided to place the whole of the new buildings and machinery near the base of the island, and to lead the current up to the tower by conductors. This decision was arrived at, because it was considered that the fact of being able to place the engines close to the small natural fresh-water loch, situated 270 yards from the light and 175ft. below it, from which fresh water for feed and condensing purposes could be readily obtained, and also the saving which would be effected by not having to convey the fuel to the top of the island or to pump up water, would compensate for the loss of energy due to such a length of conductor; while the saving of the cost of carriage of the materials and machinery to the top of the island, and of piping and pumping machinery, would more than counterbalance the original cost of the conductors. The buildings were constructed in a plain and substantial manner of fire-brick, built in Portland cement, and roofed with concrete and Val-de-Travers, carried on rolled beams and buckle plates. This part of the work was executed in an expeditious and satisfactory manner by the contractors, Messrs. Stratton, Edinburgh, notwithstanding the difficulty of getting materials taken to and landed on the island.

Generators.—It was originally intended by Messrs. Stevenson to use the Brush compound-wound Victoria dynamo, giving a continuous current, and supplying a single automatically-fed arc lamp with the positive carbon below. This system was selected as being at once cheaper, and as giving a stronger light power for the engine power applied, than the magneto-electric machines, which had hitherto, with success at least, been exclusively used in lighthouses. The placing of the positive carbon below was adopted in order that the strongest light might be thrown upwards, so as to be dealt with by the upper part of the dioptric apparatus, and thus be more effectively utilised. The Brush Company at once set to work to produce a lamp of the above description, giving, with a current of 100 ampères and 70 volts, a light of 30,000-candle power in a horizontal line, steady and suitable for burning in a lighthouse. This unfortunately they were unable to accomplish, even after numerous trials; and at last, as the buildings on the island were nearly completed and it became necessary at once to procure reliable apparatus, recourse was had to the more expensive alternate current machines of De Meritens, which, though not so powerful, are admirably steady in working, and had given excellent results in several lighthouses and also at the South Foreland experiments. The generators at the Isle of May are two of De Meritens' alternate-current magneto-electric machines of the L type, and are of the largest size hitherto constructed, weighing about 4½ tons each. The induction arrangement of each machine consists of five sets of twelve permanent magnets, sixty in all; and each magnet is made up of eight steel plates. The armature, 2ft. 6in. diameter, is composed of five rings with twenty-four bobbins in each, arranged in groups of four in tension and six in quantity. It makes 600 revolutions per minute. With the circuit open, each machine developes an electro-motive force of 80 volts, measured at the distributor; and with the circuit closed through an arc, 40 volts. An average current of 220 ampères is developed, thus yielding an electrical energy of 8800 watts, or 11·7-horse power in the external circuit. The five rings are so arranged that one-fifth, two-fifths, three-fifths, four-fifths, or the whole of the current of a machine can at pleasure be sent to the distributor for transmission to the lantern; and further, the two machines can be coupled, and the full current from both be employed.

Engines.—Fig. 2, one-eighth full size. The machines are placed in the engine room, bolted down to concrete foundations, and are driven through a counter-shaft by belting from the engines. There are a pair of horizontal surface condensing steam engines, each with two cylinders of 9in. diameter and 18in. stroke, making 140 revolutions per minute, and each indicating 17·7-horse power with 40 lb. steam pressure above atmosphere and 11 lb. vacuum. To provide against accident or failure of water supply, they have been arranged so as to be capable of being worked either condensing or non-condensing. Either of them is sufficient to drive one machine, the other engine being idle; or the two can be used together for driving both machines in thick weather. The steam to both cylinders is regulated by an equilibrium throttle valve, which is controlled by a high-speed governor, adjusted for the engine to run at the normal speed of 140 revolutions per minute. Single in place of compound engines were adopted, because they are less complicated and better suited for the less skilled attendance of ordinary light-keepers. Probably also greater regularity in driving has thus been secured, which is, of course, a matter of the greatest importance in electric lighting, especially where, as in this case, there is only a single arc lamp in the circuit forming the resistance. The result has been eminently satisfactory; and the engines, which were built by Messrs. Umpherstone, of Leith, are a most excellent piece of work.

Boilers.—There are two steam boilers, of which only one is in use at a time, the other being spare. Each is 20ft. long, and 5ft. 6in. diameter, with one furnace flue 3ft. diameter and 8ft. long, having six cross Galloway water tubes. The shells are of best ⅜in. steel plates, with the longitudinal joints double rivetted; and they were tested up to 110 lb. per square inch, the working pressure being 40 lb. The feed is principally rain water collected from the roofs and the pavement of the court; but water can, if required, be taken from the small loch, which is also used for condensing purposes. The coal consumption is 1 cwt. per hour of lighting, which includes banking the fires during the day.

Conductors.—The current generated in the engine-room is conveyed to the lantern by leads, which consist of copper rods of 25 mm., or 1in. diameter, covered with a double waterproof wrapper. This is the first time that copper rods have been used for conducting the current for lighthouse illumination. They are constructed in 14ft. lengths, the joints being formed with a zigzag scarf screwed up tightly by gun-metal coupling-boxes with four bolts in each. They are carried by timber bearers, placed in a groove made for them in the side of a concrete wall running from the engine-room to the tower. The total distance to the lantern is 880ft. Several bends are introduced to allow for expansion and contraction due to changes of temperature. The loss in the leads was expected not to exceed one-sixth of the total energy generated; but it is considerably more than this, amounting to at least one-fifth. It is hoped, however, that an improvement will yet be made in this particular.

Lamps.—The lamps, of which there are three, one in use and two spare, are of the Serrin-Berjot type, with some modifications, notably the shunt or bye-pass, first introduced in the South Foreland experiments on the suggestion of Dr. Hopkinson, whereby a large percentage of the current goes direct to the lower carbon, and only an amount sufficient to regulate the carbons is passed through the lamp. This is a great improvement, and prevents injury to the lamp from heating. The weak point about it, in the lamps sent to the Isle of May, was that the contact between the lower carbon-holder and the bye-pass, being necessarily a sliding contact, was effected by copper-wire brushes, and these were found to wear out rapidly. On the suggestion of Mr. Munro, the engineer in charge of the station, a simple form of mercury contact has been substituted and works quite satisfactorily.

Carbons.—The carbons in use are 40 mm. or 1·6in. diameter, but if desired 50 mm. or 2in. carbons can be used when both machines are running. They are Siemens make, and have a soft central core of pure graphite, which has the effect of causing them to burn with greater regularity and steadiness than they otherwise would, and prevents a crater from forming and remaining at one side. The rate of consumption of the 40 mm. carbons is 1¼in. per hour, or 2in. including waste. The power of the arc is estimated at 12,000 to 16,000 candles, when one machine only is running.

Dioptric apparatus.—Figs. 3 and 4, half full size. The dioptric apparatus, which was manufactured from Messrs. Stevenson's designs by Messrs. Chance, of Birmingham, is of a novel description, the condensing principle being carried further than in any apparatus previously constructed. The principle consists of darkening certain sectors by diverting the light from them, and throwing it into the adjoining sectors so as to reinforce their light. Thus the power of the light is increased in proportion as the dark arc is increased. The light gives four flashes in quick succession every half minute; and during the bright periods the effect of this concentration of the rays is that the light radiating naturally from the focus is increased in power fifteen times in azimuth in addition to the vertical condensation, excepting, of course, the loss due to reflection and absorption. The apparatus which effects this result is a second-order fixed-light apparatus of 1400 mm. or 55in. diameter, which operates on the rays in the vertical plane. Outside of this there is a revolving cage of straight vertical prisms, extending the full height of the fixed apparatus, or 5½ft., and composed of two panels on opposite sides of the centre, each operating in the horizontal plane on 180 deg. of the light coming from the fixed apparatus, in such a way as to condense the whole 180 deg. into four flashes of 3 deg. each—that is, 45 deg. into 3 deg. with the proper intervals of darkness between them. This cage of glasswork is caused to make one complete revolution every minute round the fixed apparatus, thereby producing the characteristic of four flashes every half-minute. The fixed-light apparatus is not of the ordinary Fresnel section, but has the refracting portion confined to an angle of 10 deg., the upper and lower reflecting prisms being carried nearer to the focal plane. This design, although involving the loss of some light, facilitated the adoption of the late Mr. Thomas Stevenson's proposal of dipping lights in fog, so as to be able to direct the strongest part of the light to the horizon in clear weather, and in fog to a point only three to five miles distant. Such a change could be most easily produced by simply raising and lowering the level of the radiant in the apparatus; but there was a difficulty in doing so in an ordinary optical apparatus, inasmuch as, when the position of the radiant was altered, the rays from the reflecting prisms, above and below the refractor would be sent in an opposite direction to those coming from the refractor. This form of the fixed-light apparatus was also specially necessary at the time the apparatus was designed, because it was then intended, as already mentioned, to use a continuous-current machine with the positive carbon below; and consequently the strongest part of the light would have been dealt with by the upper reflecting prisms. By making the apparatus almost entirely of totally reflecting prisms, instead of refracting and reflecting combined, all the prisms act in the same way; so that by lowering the radiant the whole of the light from every part of the apparatus can be dipped simultaneously to any required extent, with the exception of a small piece in the centre, which is left a refractor, and which will send light to the horizon when the other part of the apparatus is dipped. In clear weather the three upper prisms send their light from ½ deg. above the horizon to 3 deg. below it; the rest of the upper prisms and all the lower ones send their light to the horizon, and the refracting portion from 3 deg. to 5 deg. below the horizon. The dipping of the light during fog has not yet been used, but as soon as the light-keepers, who, with the exception of the engineer, were the ordinary keepers in the service, and knew nothing of electric lighting, have become thoroughly familiar with their duties, it is intended to introduce it, and probably in the same way to employ a less powerful current, and, say, 25 mm., or 1in., carbons in very clear weather, while both machines with 50 mm., or 2in. carbons, will be used in very thick weather.

Lamp changing and revolving arrangements.—Fig. 3. Standing in the centre of the light room is a circular case, 5ft. 8in. diameter and 5ft. 4in. high, formed of cast iron pilasters filled in between with glazed doors. The top of this case carries the fixed-light apparatus, as well as a steel roller path 5ft. 10in. diameter, on which the carriage supporting the cage of vertical prisms travels on twelve steel rollers. The top of the case also serves as the service table, on which the electric lamp stands when in focus. Access to the interior of the apparatus and to the lamp is obtained from the inside of the case, through a trap in the top of it. Some difficulty was experienced in devising a suitable system of readily substituting one lamp for another, when it may be desired to change them, or in the event of the one in focus going wrong. The difficulty arose from the necessity of keeping the spare lamp out of the apparatus entirely, so as to prevent its interfering with the light emanating from the lamp in use, as the light shows all round the horizon. The change is accomplished by means of an arrangement of rails, and three turntables or shunt-tables, on which the lamps can be freely run, and which are placed on the service table. One of these is in the centre of the apparatus, and one is on a trap door, working vertically in guides and counterbalanced, in the manner of a hoist, whereby a lamp can be lowered from the level of the top of the

[1] Paper read at the Institution of Mechanical Engineers at Edinburgh.

THE ELECTRIC LIGHT ON THE ISLE OF MAY.

MESSRS. D. AND T. STEVENSON MM. INST. C.E. ENGINEERS.

(*For description see page* 158.)

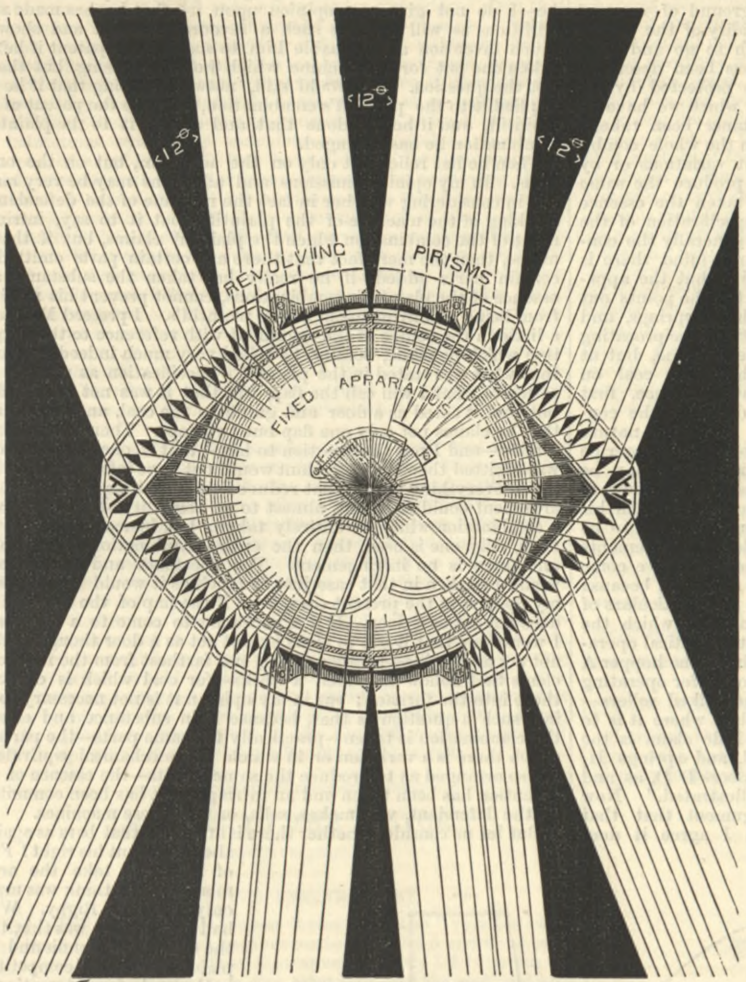


Fig. 3: HORIZONTAL SECTION THROUGH FOCAL PLANE.

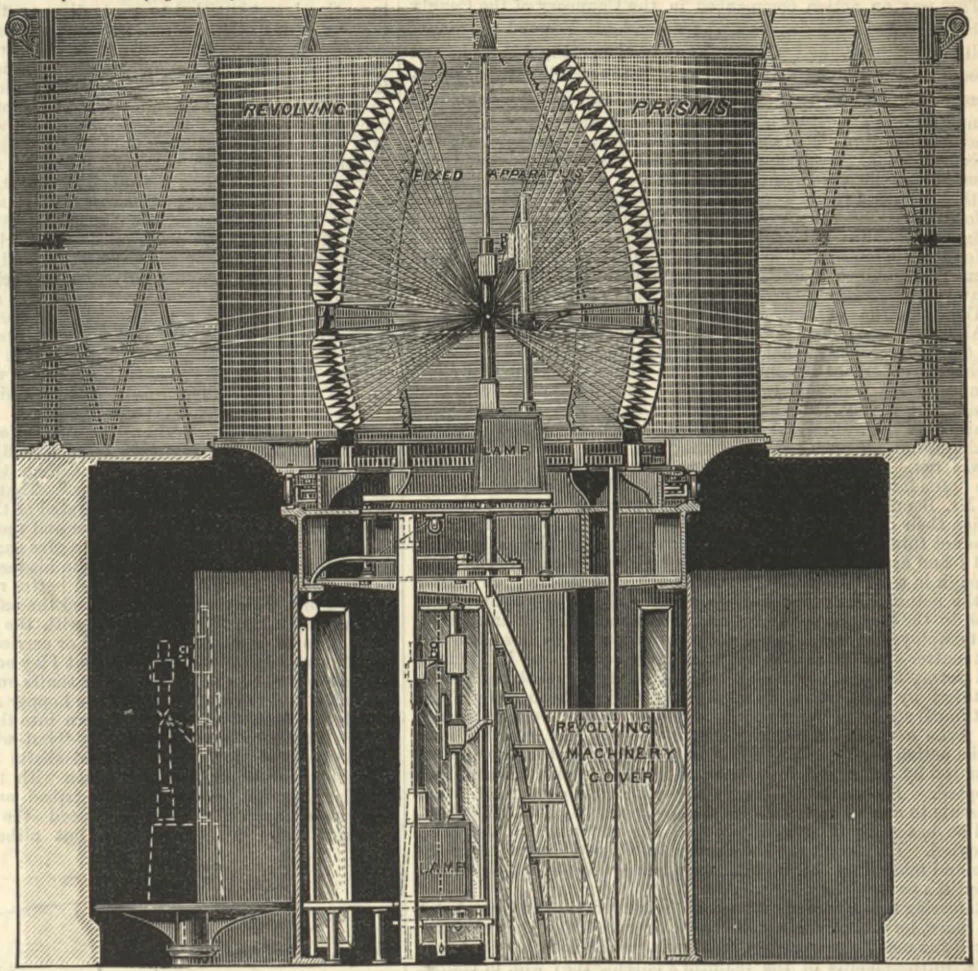


Fig. 4: VERTICAL SECTION THROUGH APPARATUS AND LANTERN.

case to the floor of the light room. Here the lamp is again received on rails, on which it can be conveniently run out of the case, to be re-carboned and adjusted. In this way a lamp can be raised from the floor of the light-room into the apparatus, the lamp in focus withdrawn on to one of the turntables and the fresh lamp run into focus, the original lamp shunted on to the hoist and lowered out of the apparatus, all in about eight seconds. A three-wick paraffine oil lamp is kept trimmed and ready for use, in case of a failure of the electric current, and it can be lighted and put in focus in about three minutes. Within the case, and placed at one side of it, is a train of wheel-work, actuated by a weight with a fall of 60ft. down the centre of the tower. This machine drives the revolving cage of vertical prisms by a shaft which passes up through the top of the case, with a pinion working in an internal wheel of 4ft. 10½in. diameter secured to the carriage of the cage. This machine is carefully boxed in, to prevent the dust from the incandescent carbons finding its way into the bearings, whereby great trouble has been caused at various lighthouses.

Power of light.—The resulting beam of light from this apparatus is about 3,000,000 candles when one machine is in use, and with both machines 6,000,000; that is, about 300 and 600 times more powerful than the old fixed oil light. When the three-wick oil lamp is put in the focus of this apparatus, the emergent beam is more powerful than the old fixed oil light with a four-wick lamp, which was 9446 candles. The light has been picked up and recognised by sailors at forty and fifty miles off, by the flashes illuminating the clouds overhead, although the geographical range of the light is only twenty-two miles. The engine-room is connected by telephone with the light-room; and the houses of the keepers are connected by air whistles or electric bells with either the light-room or the engine-room.

Men employed.—The establishment consists of an engineer, four keepers, and an occasional or auxiliary keeper. The engineer, who is responsible for the management of the station, does not take a regular watch, but visits the engine-room and light-room occasionally during the night. Two of the keepers attend to the light-room duty, and two have charge of the engines and boilers, relieving each other in regular watches. The auxiliary keeper does any odd duties, such as carting fuel, &c.; and in the event of any of the others being ill takes his place. Since the light was first exhibited, the machinery and electrical appliances have worked without a hitch, and recourse to the oil-lamp has been unnecessary. This is the more gratifying when it is remembered that the men in charge, with the exception of the engineer, were new to the work, and that the light was started at a period of the year when the hours of lighting were longest, namely sixteen hours.

Cost.—The new buildings, engines, electric machines lamps, &c., have cost £15,835; and the buildings, lanterns, &c., previously on the island, which have been utilised, may be valued at £6600. Thus the total cost of the installation may be taken at £22,435; and the cost of maintenance will not exceed £1050 per annum. These figures are very moderate, considering the great power of the light, and the isolated position of the lighthouse. To compare the cost of this installation with what it would have been if oil were the illuminant, there must be added to the above £6600 for buildings, a sum of £2925 for the cost of the apparatus and machine, &c., making a total of £9525, while the cost of maintenance would have been £330 per annum. Taking these figures, and adding to the maintenance 3½ per cent. on the original outlay, it is found that while the oil light would cost 3·49s. per hour, and 0·00017d. per candle-power per hour, the electric light costs 9·66s. per hour, or two and three-quarter times more, and 0·000038d. per candle-power, or less than one-quarter of what the oil light would cost per candle-power. This is taking the electric light power of one machine. Surprise has frequently been expressed by masters of vessels, and by residents on the neighbouring shores who live in view of the Isle of May light, that this light, which is so extremely brilliant in clear weather as to cast shadows at a distance of ten and fifteen miles, is so cut down by fog that some even go the length of believing the old oil-light was better in fog. All who have experience of the electric light are quite prepared for the first part of this statement, while the last, it need hardly be said, is a mistake, inasmuch as the electric arc has been proved, both by experiment in natural and artificial fog, and also by observations on existing lighthouse lighted by electricity, to be in all circumstances of weather the most penetrating. Every night at 12 o'clock the lightkeepers at St. Abbs Head, 22 miles distant, where there is a first-order flashing light and one of the most powerful oil-lights in the service, observe the Isle of May light, while the keepers there also observe the St. Abbs Head light. The result of the last five months' observations is that the Isle of May light is seen one-third oftener from St. Abb's Head than the St. Abb's Head light is seen from the Isle of May. It is perfectly true, however, that the superiority which is so apparent in clear and rainy weather is very much reduced in hazy weather, and practically disappears in very dense fog. Looking to this fact, and to the large first cost and annual maintenance, the author feels that the conclusion arrived at by the Trinity House is sound, that electricity should be used only for important landfall lights.

If, however, the most powerful light is desired independently of cost, then the electric arc has no rival. And if the further expense is to be incurred of introducing biform, triform, quadriform, or even double quadriform lights, then the electric light is better adapted than any other illuminant, because, on account of its focal compactness and other properties, it can be so dealt with by suitably designed dioptric apparatus that the whole light evolved is effectually utilised. This is not the case with the large gas or oil flames generally used in the multiform system, in which for this and other reasons a considerable loss of light is incurred. Moreover the coolness of the electric arc renders multiform lights really practicable with electricity, which can hardly be said to be the case either with gas or oil.

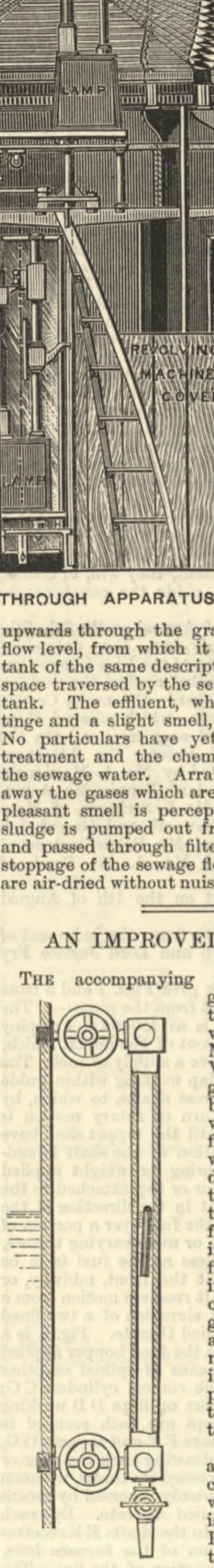
Hyper-radiant apparatus.—In the author's opinion, however, it is only in very exceptional cases indeed that electricity should be used; and he considers that a single oil or gas burner placed in the focus of a proportionately sized dioptric apparatus is sufficient for the generality of cases; and that any additional outlay which can be permitted should be expended in establishing a powerful sound signal to be used during fog when the light is obscured, and when for all practical purposes even the electric light itself would also be obscured. This is specially the case since the introduction, on Messrs. Stevenson's suggestion, of hyper-radiant apparatus suited for use with burners of large diameter. As the result of experiments made in Edinburgh in 1869, they pointed out that the effectiveness of the large Wigham burner was to a great extent lost in revolving apparatus, because much of the light was ex-focal. A year or two ago, when the Commissioners of Northern Lighthouses resolved to increase the size of the burners in some of their lights, an experimental lens of 1330 mm. or 52⅜in. focal distance, designed by their engineers, was constructed by Messrs. Barbier and Fenestre, and by the courtesy of the Trinity House was fully experimented upon at the South Foreland, on the termination of the experiments conducted there with electricity, gas, and oil. From experiments made by Sir James Douglass and the author, and from photometric observations by Mr. Harold Dixon, the expectations of Messrs. Stevenson were fully borne out, and the following conclusions seem warranted:—That a single burner, shown in a complete panel of a revolving apparatus of the hyper-radiant kind, would give a more powerful light than burners and ordinary Fresnel lenses, arranged as biform, and would be of equal power to triform; while the consumption of oil or gas would be one-half or one-third respectively. Moreover, all the disadvantages of superposed lenses, including excessive heat in the light-room, difficulty in the management of the burners, and obstruction of light by the necessary ventilating tubes, would be avoided. The result of the above experiments has so conclusively established the advantages of the hyper-radiant apparatus, that the American Lighthouse Board have since ordered a complete apparatus of this kind; while the Trinity House and the Irish Lighthouse Board have adopted this size of lens recently ordered by them on Mr. Wigham's biform principle.

THE SEWAGE WORKS OF HALLE.[1]

Professor Arnold, of Brunswick, has described these works—*Deutsche Vierteljahrsschrift für öffentliche Gesundheitspflege*, 1887, p. 83—which have been constructed to deal with the sewage, which includes both domestic and manufacturing waste water, on the system of Messrs. Müller and Nahnsen. They have been in operation since September 1st, 1886. They are adapted for the daily treatment of 3000 cubic metres, but at present are only receiving 900 cubic metres of sewage per diem. The sewage water, which enters the works from the main outfall, is divided into two streams, which are regulated by sluices. The amount of chemicals is apportioned in accordance with the volume of sewage to be dealt with, by means of revolving boxes, on the principle of overshot water-wheels, which rotate faster or slower as the quantity of sewage passing through the works varies, and add a proportional amount of precipitants. The suspended and floating impurities are subsequently removed by revolving gratings. The precipitated sewage then passes to the bottom of a circular tank, and flows upwards through the gradually accumulating sludge to the overflow level, from which it is conducted to the bottom of a second tank of the same description, through which it again ascends, the space traversed by the sewage being a rise of three metres in each tank. The effluent, which is fairly clear, but has a yellowish tinge and a slight smell, is then discharged into the river Saale. No particulars have yet been published respecting the cost of treatment and the chemical and bacteriological investigation of the sewage water. Arrangements are being made for conveying away the gases which are given off during the process, but no unpleasant smell is perceptible in the vicinity of the works. The sludge is pumped out from the funnel-shaped base of the tanks, and passed through filter presses, and this takes place without stoppage of the sewage flow. The semi-solid cakes from the press are air-dried without nuisance.

[1] Proc. Inst. Civ. Engineers.

AN IMPROVED WATER GAUGE FLOAT.



The accompanying illustration represents a glass water guage attached to a boiler, and within the gauge a float of novel design, which has recently been patented by Mr. Loudon Campbell, of Alexandria, Va. The float is made of dark blue glass, highly tempered to prevent its breaking, and is provided near each end with encircling rings forming projecting flanges. These rings serve as scrapers within the tube of the water gauge, during periods of ebullition and under the normal action of the boiler, scraping the froth and scum from the inner surface of the tube, and keeping it always in a bright and cleanly condition. The float thus indicates the height of water in the boiler in so plain a manner that it cannot fail to be observed by a casual glance, while it can be easily seen from a considerable distance. A spiral spring, not shown in the illustration, is placed in each end of the gauge tube to prevent breakage of the float when the tube is blown out and the float goes to the bottom.

This improvement is applicable to all classes of steam boilers, being especially desirable in gauges where the water used is muddy or impure. It is now being used by steamers on the Potomac River and by several manufacturing concerns.—*Scientific American.*

The Hotchkiss Guns.—Secretary Whitney has issued the following statement:—"The Department has finally closed a contract with the Hotchkiss Ordnance Company. A branch of their manufactory will be established in this country. Our secondary batteries have heretofore been made abroad. It marks another most important era in the reconstruction of the Navy. Mr. Hotchkiss was an American, and when he died, in 1884, every important European nation had a manufactory of Hotchkiss ordnance. England, France, Germany, Russia, and Italy each had one. By delaying the giving out of orders we have accumulated a large contract, and the investigations made by the representatives of the company have elicited the fact that with the superiority of machinery in use in this country the prices can be made the same for their arms made here as made abroad. We either had to prepare to manufacture ourselves or get them to come here. We cannot be dependent on another country for our war material. The machine guns have become an indispensable branch of any national armament. To illustrate their effectiveness, the six-pounder Hotchkiss rapid-fire gun is controlled by one man, aimed from the shoulder, and will discharge twenty-three six-pound shells per minute with a velocity that will penetrate two inches of steel plate at a thousand yards. They are especially necessary against torpedo boats and unarmoured ships, and to clear the exposed decks of ironclads. The company is now developing a 9-pounder and experimenting with a 33-pounder. With the Bethlehem Iron Company contract and this one executed, American shipbuilders will be able to build and arm warships entirely from American manufactories."

LEGAL INTELLIGENCE.

COURT OF APPEAL.

PROCTOR *v.* BENNIS AND OTHERS.

THIS was an action commenced in the Chancery of the County Palatine of Lancaster against the defendant, Edward Bennis, of Bolton, engineer, and Crosses and Winksworth, Limited, and Greenhalgh and Shaw, cotton spinners, both of Bolton, for infringement of Proctor's Letters Patent, No. 2047 of 1875, the defendant Bennis being charged with the manufacture and sale of infringing machines, and his co-defendants, Crosses and Winksworth, and Greenhalgh and Shaw being charged with the use of machines purchased from the defendant Bennis, alleged to be an infringement of the plaintiff Proctor's patent. The action was originally tried before the Vice-Chancellor of the County Palatine, who gave judgment against the defendant Bennis, but in favour of the defendants Crosses and Winksworth, and Greenhalgh, who were users of machines manufactured by the defendants Bennis and Shaw, on the ground of acquiescence by the plaintiff.

The VICE-CHANCELLOR, in the course of his judgment, said:—"Although therefore I assume for the purpose of this case, *but for that purpose only*, that the tappet action as described by the plaintiff as part of his invention was already described by Mr. Bennis in his provisional specification of 10th April, 1875, that would not in my judgment suffice to make out an anticipation against the plaintiff. But further, was Mr. Bennis's patent taking it altogether an anticipation of the plaintiff's? In my judgment it was not. On the whole therefore I come to the conclusion that the defendants have failed in making out the alleged anticipation by Mr. Bennis's patent, and that as to anticipation by prior publication their case altogether fails. Upon the question of prior user, I do not think that the defendants have supported their allegation, and I find as a matter of fact that there has been no prior user. Though in some respects the machinery adopted to give motion to the actual piece of mechanism which strikes the coal and sends it on to the furnace might be, and is in some sense different from that employed by the plaintiff, yet in my judgment the essential subject matter of the plaintiff's patent has been adopted by Mr. Bennis, and forms the main and substantial part of the machines manufactured by him. The radial, as contradistinguished from the rectilineal stroke of the piece of machinery which propels the coal, has been adopted, the lifting or throwing power given by such radial action has been adopted, and the effect of the flap or door actuated by the machinery described by the plaintiff has also been adopted. He—Bennis—has in my judgment done that which amounts to a mere colourable departure from the plaintiff's patent, and he has really taken and adopted the substance of the thing patented. He has, to use the expression of Lord Cairns, taken the pith and marrow of the invention, and has thereby infringed the plaintiff's patent."

Referring to the case of Crosses and Winksworth, and Greenhalgh and Shaw, he said: "I would, however, observe that if they continue to use the machines manufactured by the defendant, which I hold to be infringements of the plaintiff's patent, they will, of course, do so at their own peril, and will have to abide the consequences arising therefrom."

The case came before the High Court of Appeal on the 8th, 9th, 11th, 12th, 14th, and 15th days of July last, the defendant Bennis having appealed against the decision of the Vice-Chancellor, and the plaintiff Proctor having also appealed against the decision of the Vice-Chancellor's judgment—as regards the users, Crosses and Winksworth and Greenhalgh and Shaw—which relieved these defendants from liability on the ground of acquiescence. On the appeal there appeared for the plaintiff Proctor the Attorney-General and Mr. Moulton, Q.C., instructed by Mr. A. Macdonald Blair, of Manchester, and for the defendant Bennis, Mr. Aston, Q.C., and Mr. Bousfield, instructed by Mr. S. Stringer, of Manchester, and for Messrs. Crosses and Winksworth and Greenhalgh and Shaw, Mr. Rigby, Q.C., Mr. Clare, and Mr. Baker, instructed by Mr. T. H. Winder, of Bolton, and Mr. A. W. Read, of Manchester.

The Lords Justices delivered judgment on the 4th of August instant for the plaintiffs.

It will suffice if we give an extract or two from the judgment of Lord Justice Cotton, Lord Justice Bowen and Lord Justice Fry agreeing with him.

In order to make what follows clear, we give Figs. 1 and 3 from the plaintiff's specification, and an extract from the same:—"The construction and action of the apparatus is as follows:—I employ an ordinary feed hopper applied to the front of the boiler, which, by means of spiked or other rollers will give a supply of fuel. The fuel is received upon an inclined door or flap working within guide plates; the door or flap is secured to cross shafts, to which, by means of lever and tappets, a partial turn or rotary motion is given, drawing back the door or flap until the tappet shall have passed its throw, whereon the partial rotation of the shaft is suddenly reversed by means of a coiled spring or weight applied thereto. By such reversing action the door or flap attached to the shaft receives a rapid forward movement in the direction of the furnace bars, throwing and distributing the fuel over a portion of the fire. The tappet is provided with two or more varying throws, so that the spring will be coiled more or less as the fuel is to be alternately thrown on to the fire surface at the front, midway, or back of the fire surface. The tappet shaft receives motion from a worm and worm wheel. Fig. 1 is a front elevation of a two-flued boiler having my improved apparatus applied thereto. Fig. 3 is a section on the line A B of Fig. 1. At A is the feed hopper applied to the front of the boiler, which, by means of spiked or other rollers B B will give a supply of fuel to the conical cylinders C C; the fuel is received upon the inclined doors or flaps D D working within guide plates; the said doors or flaps are each secured to cross shafts E E, to which, by means of levers F F and tappets G G, a partial turn or rotary motion is given, drawing back the door or flap until the said tappets G G shall have passed its throw, whereon the partial rotation of the shaft E is suddenly reversed by means of a coiled spring H or a weight applied thereto. By such reversing action the door or flap attached to the shafts E E receives a rapid forward movement in the direction of the furnace bars, throwing and distributing the fuel over a portion of the fire. The tappet is provided with two or more varying throws, so that the spring will be coiled more or less as the fuel is to be alternately thrown on to the fire surface at the front, midway, or back of the fire surface. The tappet shafts J J receive their motion from worms K K and worm wheels K[1] K[1], on the shafts J J and L[1], which shaft L[1] is driven by the fast and loose pulleys M M. There is also on this shaft another worm and worm wheel N for operating the spiked rollers by means of the vertical shaft P, and on the shaft is an excentric and strap R, which operates the lever S, giving a rocking motion thereto, the upper end of the said lever being connected to the piston or ram T, giving to the latter a to-and-fro motion within the cylinders C C, whereby a positive and regular feed or quantity of fuel is pushed out of the cylinders alternately, and descending upon the double inclines *c c c c*, reaches the doors D D, ready to be propelled on the next action of the tappet springs and shafts. Having thus described the nature and particulars of this my said invention, together with the manner in which the same is to be or may be performed or carried into practical operation, I would have it understood that I lay no claim to the hopper A, nor to the spiked rollers, nor to the shafts and worms for operating the same; but what I do claim is the employment of the tappets G G, and shafts E E, and springs H when applied to and in connection with the doors D D, as and for the purpose herein fully described and illustrated."

Lord Justice COTTON said: Is there an infringement? The patent is good, the specification, in my opinion, is good, but is there an infringement? Now, as I have already stated the contention, and the only contention of the plaintiff, in this respect, is not that parts of his machinery have been taken for which he has a right to protection, but that his combination has been taken. It is obvious, and I need not go into it, that the defendant Bennis has not taken absolutely and exactly the combination which the plaintiff has patented. It is very seldom indeed, unless a man intends to contend boldly, and to hold to it, that the patented invention is not entitled to protection on the ground of want of novelty or any other ground impeaching the validity of the patent—it is very seldom that anyone is bold enough to go and take exactly the combination or machinery which has been described in the specification of a patentee, and which is protected by his patent if valid. But the question, to my mind, which we have to consider is this: Has the combination in substance been taken? Has the defendant, though not exactly taking in the whole combination which has been patented, taken by slight variations or by mechanical equivalents, the substance of it, to produce the same result by practically the same means? Has he taken the essence of it? Now one must a little bit look at the specification of the plaintiff. First of all, on page 3, he describes generally the construction and action of the apparatus, and to my mind there is that which shows this, not only what he is claiming, but the apparatus for which he is claiming it; that is to say, that he points out there this: that by a combination of tappets, shafts, springs, and flaps, so arranged that the flaps have an intermittent reciprocating radial action and with a force varying from time to time, but at regular intervals, he makes a machine which throws coal on to the furnace. That is described without reference, first of all, to the figures at page 3, where he describes the construction and action. Then he says, "such being the nature and object of this my invention, I will proceed to describe the same in detail, and in order that the invention may be fully understood I refer to drawings." That does not cut down to my mind what he had previously stated as the mode in which his invention is to be carried into effect and the result which is to be produced by it. But he is going to give examples and statements in detail to show how that is done in his machine. Then we come to his claim, and that I think I had better read in detail, because he says this, "Having thus described the nature and particulars of this my said invention, together with the manner in which the same is to be or may be performed or carried into practical operation, I would have it understood that I lay no claim to the hopper A nor to the spiked rollers nor to the shafts and worms for operating the same." I need not refer to the hopper A and spiked rollers—that is the feeding of the coal down into the place where it is to be acted upon by the flap or door—"but what I do claim is the employment of tappets G G and shafts E E, and springs H, when applied to and in connection with the doors D D, as and for the purpose herein fully described and illustrated." Now the ingenuity of counsel produced the argument that that did not claim a combination; but although I agree it does

FIG. 1

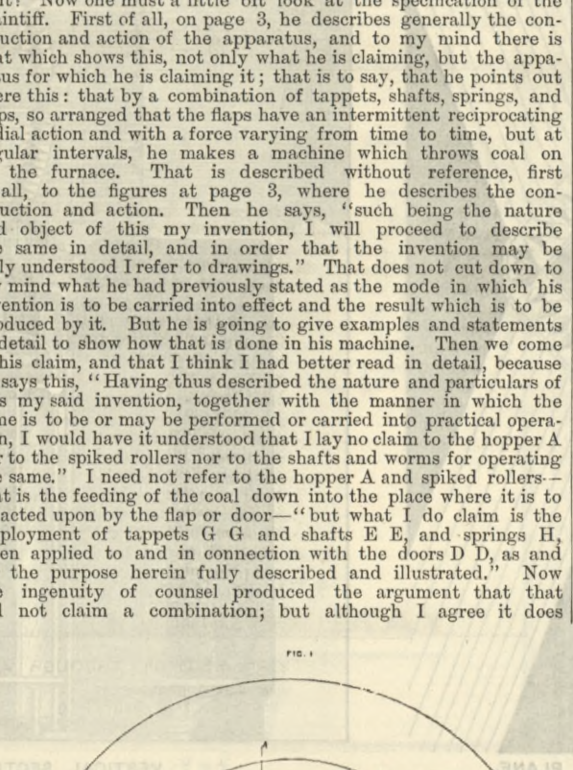
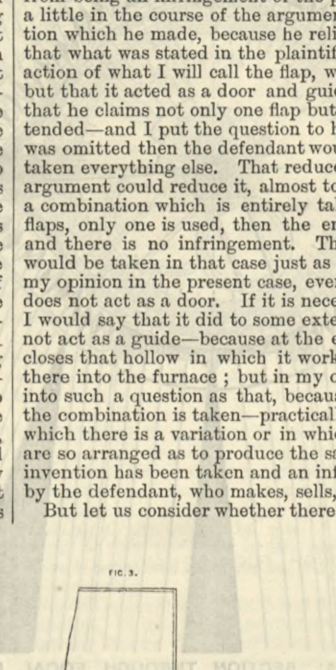


FIG. 3



PROCTOR'S FURNACE FEEDER

not contain the word "combination," what is here claimed to my mind is essentially a combination and nothing else. It is the employment of tappets, shafts, and springs in connection with doors D D as and for the purpose herein fully described and illustrated. We have seen what those purposes are. They are what I have already mentioned, but to say that a man who claims the use of certain mechanical means in connection with certain other things does not claim a combination, to my mind requires really no answer. Merely reading the words is a sufficient answer to it. A combination is the use of certain things in connection with others to produce a machine, and that is what is here claimed. He does not claim the tappets as his invention, or the shafts as his invention, or the springs as his invention, nor does he claim the doors as his invention, but he does claim what are called the doors, though in other parts I think they are called flaps in connection with these particular things I have mentioned. I have already stated what I consider, having regard to the previous part of his specification, are the purposes and objects for which he claims that combination. As appears from the latter part, the motion is communicated to these flaps by a reciprocating action given to a shaft to which the flap is fastened, and made part of the shaft, by means of springs, and by means of tappets which are worked so as to push back the spring and to wind it up in a particular way.

Now what has the defendant done? Of course if you first look at the machine you say at the first blush:—"Well, that is something different," and it does look a different machine, but one must consider this: whether in substance, although he has not taken the exact combination, he has merely substituted for the particular part, or various parts, of the plaintiff's specification ordinary mechanical equivalents for producing the same objects; and if he has done so, in my opinion, although he has not taken the exact combination—he has taken the essence of it; and therefore his machine sometimes would be called a colourable variation, or in plain terms, is an infringement of that which is protected by the plaintiff's patent. It is a colourable variation. I do not rely upon that so much as that it is an infringement; but a colourable variation, as I understand it, is where a man makes slight differences in the parts of his machine, although really he takes in substance those of the patentee, and gives a colour so as to suggest that he is not infringing the patented machine when he is really taking mere substitutes for the portions of the machine so as to get the same result for the same purpose.

Now let us look at what the variations are. It is quite true that the defendant has no shaft E which is mentioned as a portion of the combination. But what has he? He has this. He has at the end of an arm that which is the shovel, which pushes the coal in his machine on to the fire; and that flap at the end of that arm has a radial action, and an intermittent or reciprocating action. That flap, or the arm of that flap, is fixed to a shaft, the arm rotating on its own bearing.

Then what was very much relied on was this—that there are certain omissions in the defendant's machine of parts which there are in the plaintiff's combination; that there are certain things in the defendant's machine not found in the plaintiff's, producing a result which is not obtained in the plaintiff's machine. And it is said that that must prevent what has been done by the defendant from being considered as an infringement of the plaintiff's machine. If, in fact, the defendant has, by any additions to his machine, or by additional results from parts of his machine, made an improvement, that will not enable him to take the plaintiff's combination which he has protected without infringing the plaintiff's patent. It may be—I do not give any opinion upon it—that he has made such additions as will produce such a favourable result and show so much invention as to enable him to sustain any patent if he has taken one out for his machine which he is now using, but that is not the question. He would still, notwithstanding that if he has applied it to the plaintiff's combination, infringe the patent of the plaintiff, and if he has done that and added it to the plaintiff's combination he has infringed.

Then he has relied not only on the additions, but on the omissions. In my opinion omissions and additions may be very material in considering whether in fact the machine of the defendant is a taking of the machine of the plaintiff, that it to say, infringement of the combination which the plaintiff claims, but if that is not so, then the mere fact that there are certain parts omitted or certain parts added—if he really has taken the substance and essence of the plaintiff's combinations, cannot prevent his machine from being an infringement of the plaintiff's. I pressed Mr. Aston a little in the course of the argument with reference to the suggestion which he made, because he relied very much indeed on this—that what was stated in the plaintiff's specification as regards the action of what I will call the flap, was that it was not only a flap, but that it acted as a door and guide to the coal, and he said also that he claims not only one flap but two flaps. Therefore he contended—and I put the question to him—that if one of those doors was omitted then the defendant would not have infringed if he had taken everything else. That reduced the point, as I thought the argument could reduce it, almost to an absurdity—that if there is a combination which is entirely taken, but instead of using two flaps, only one is used, then the entire combination is not taken and there is no infringement. The substance and essence of it would be taken in that case just as much as it would be and is in my opinion in the present case, even if the flap of the defendant's does not act as a door. If it is necessary to come to a conclusion I would say that it did to some extent act as a door though it does not act as a guide—because at the end farthest from the furnace it closes that hollow in which it works—for coal which is collected there into the furnace; but in my opinion it is not necessary to go into such a question as that, because if in substance and essence the combination is taken—practically the same parts—the parts in which there is a variation or in which the mechanical equivalents are so arranged as to produce the same results—the essence of the invention has been taken and an infringement has been committed by the defendant, who makes, sells, or uses these machines.

But let us consider whether there is anything that bars as against the defendant his right? First of all I will take the argument which I think was urged only by Mr. Rigby. What had taken place was this, that the defendant Bennis and the plaintiff were rival competitors in the trade for automatic machines for feeding furnaces, and it was on the evidence that as regards at least some of the defendants who were using these machines, when it was known by the plaintiff that they were about to buy some of these furnace-feeding machines from Mr. Bennis, the plaintiff went to them and said, "Now do give mine a trial; you will find it a very much better machine." I have not got the exact words, and I am unwilling to refer to them unnecessarily, but that is the substance of it. Mr. Rigby said that was as much as to say to them, "Now just try and see which is the best machine, and then you may take whichever you think to be the best," and that that therefore was permission to them to use the machines made by Mr. Bennis, if, on trial, they were found to be better than the machines made by Mr. Proctor. In my opinion that is not the proper construction of that. Undoubtedly Mr. Proctor at that time had his patent, and he said that he considered that the machine which Bennis was then making, and which these defendants, Greenhalgh and Shaw and Crosses and Winkworths, were going to try, was an infringement. But, in my opinion, that does not amount to this, "You may use Bennis's if you think it better than mine," but only this, "Whatever other objections I may have to Bennis's machine, mine is the better one, and, without entering into any contest, if mine is better, you will not be so unwise as to have Bennis's"—that is all. He is a rival manufacturer, and in order to induce these people to take his machines, he goes and says, "Now try them, and you will find that mine is very much the better." He does not say so, but I think that implies this, "I cannot suppose that you persons who are engaged in trade will be so foolish, if you find mine is a better machine, to take that of my rival, whose machine turns out to be inferior to mine." In my opinion, that argument which was pressed on us very much by Mr. Rigby cannot prevail.

Then it is said that independently of that argument there had been a lying-by on the part of the plaintiff which would in a Court of Equity prevent him from obtaining any relief. I am not quite certain—it is a matter put in rather a different form as regards any action at common law—that his conduct amounted to a representation that Bennis's machine was in fact no infringement. Of course, if that were so—if there was a representation to that effect—he would be bound by that, and could not afterwards bring any action against those who acted on that representation and used Bennis's machines. But does the evidence come to that? I should like first to take the question whether there had been any lying-by—that is to say, any acquiescence in the proper sense of the word. In my opinion, that cannot be held to be so. The right of the patentee does not depend on the defendant having notice that what he is doing is an infringement. If what he is doing is in fact an infringement, even although the defendant acts in a way which the counsel for the defendant said was *bonâ fide* or honest, he will not be protected from an injunction by that. It does not depend upon notice. The old right of monopoly has been granted to the patentee, and in order to raise an equity, one must, as I understand, prove this as against the defendant, and I read the words of Lord Cranworth when expressing his opinion. I was going to give my own, but I will take his words. I am quoting from "Ramsden *v.* Dyson," in 1 English and Irish Appeals:—"If a stranger begins to build on my land, supposing it to be his own, and I perceiving his mistake abstain from setting him right, and leave him to persevere in his error, a Court of Equity will not allow me afterwards to assert my title to the land on which he expended money, on the supposition that the land was his own. It considers that when I saw the mistake into which he had fallen, it was my duty to be active, and to state my adverse title, and that it would be dishonest in me to remain wilfully passive on such an occasion, in order afterwards to profit by the mistake which I might have prevented." That lays down the principle that applied to the particular case there under discussion, where it was contended that the landowner had lost his right to recover the land and turn out those who were tenants from year to year, or tenants at will, because he had not objected to their building. It is necessary that the person who alleges this lying-by should have been acting in ignorance of the title of the other man; that the other man should have known that and not mentioned his own title. But, here, how is it? I do not find at all that any of these defendants state that they never knew anything about the plaintiff's patent. In my opinion, it must be taken that they did know it, although that is immaterial as regards the question as to whether relief generally should be granted as against the patentee. Even if they did not know it, why was the plaintiff to suppose that these persons who were buying these machines, and some of them at least attending at exhibitions where the machines were exhibited, should be ignorant of a patent which had been obtained for these machines which were most material for manufacturers who were using steam engines. I cannot find at all anything from which we ought to draw the conclusion that if they were ignorant of the patent of the plaintiff, he—the plaintiff—had reason to suppose that they were so. Why should he suppose that they were not acting in this way as they have been doing now, contending that whatever might be his patent, they would establish what they were doing was no infringement. In my opinion, the facts of this case do not in any way bring the conduct of the plaintiff into such a light as to require us or to enable us to hold that this action between himself and the defendants was such as to be a lying-by, so as to deprive himself by his silence with knowledge that the defendants were acting in ignorance of any title to relief which he otherwise would have had.

Then is there anything like a representation that what was done by Bennis in his machines was no infringement? It is true that the plaintiff never said that it was, as I understand, although he knew it. In my opinion mere silence—merely not giving notice to the defendants that what they were doing was an infringement—cannot reasonably be taken as any representation that what they were doing is not an infringement. It would be straining the actions of men and straining silence to hold that by not alleging "Now you are infringing my patent," a patentee could be held to this, that that amounted to a representation that what the parties were doing was not an infringement. In my opinion, therefore, it cannot be said here that on this latter part there was any evidence which would induce us to come to the conclusion that there was any estoppel against the plaintiff by a representation made by him to the effect relied on by the defendant. In my opinion, therefore, the appeal of the plaintiff ought to succeed, and the appeal of the defendant Bennis ought to fail.

LETTERS TO THE EDITOR.

(*Continued from page* 153.)

LOCOMOTIVE ENGINE BLAST.

Sir,—Following up my former letter upon the "variable blast-pipe" used on Stevenson's engines made in 1843-4-5 and 6, as bearing upon your leader in The Engineer for July 1st, wherein the two chief features named are the blast-pipe and the sectional area of the tubes not being under control as to the equal, or more equal, distribution of the heated gases passing through them.

A question was raised some forty years ago as to the chimney, whether a better result was obtained by the greater length of funnel when carried down in the smoke-box to the top of the upper row of tubes, or by merely placing it on the top of the smoke-box, the curve of which led the products of combustion to the bottom of the chimney, where the exhaust steam carried them forward. I see by your illustration that Mr. Appleby adopts the latter plan, though I assume that the greater length of the former ought to give greater suction.

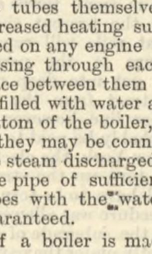
Of the plans tried for better utilising the heat passing through the tubes, the first that I remember was on a goods engine by Tayleur, of Warrington, Stephenson's patent, six wheels coupled, put on the London and Birmingham line in 1846, which in the hands of men used to the old four-wheeled Bury type could not keep steam, and no wonder, as they used intermittent feed, and ran with the blast-pipe closed or open, finding no difference. On Mr. Robert Stephenson being consulted he ordered a $\frac{5}{8}$in. round bar of iron to be placed in each of the tubes—$1\frac{5}{8}$in. outside diameter—and the smoke-box door to be locked. The result was evident, and as the man got more familiar with the engine he did not perceive that these bars were being gradually withdrawn, and when at last he awoke to the fact that none were left in the tubes, or had been for some days, he realised the situation.

The next suggestion may be found in your earlier pages, from one Moriarty, of Greenwich, being a strip of iron of the width of the internal diameter of the tube twisted into a spiral form and so detaining the air-current and causing it to rotate on its passage to the smoke-box. I never saw it tried or heard the result, which should have been successful in some degree.

The contraction for 12in. of the fire-box end of the tubes of the London and South-Western engines must have been with the view of strengthening the fire-box tube-plate, rather than of getting better results from the heat in the tubes.

The latest suggestion known to the writer is one which will hardly meet the views of the several schools of locomotive engineers, though entitled to fair consideration. It will involve the enlargement of the water spaces between the tubes, and perhaps of the tubes themselves also; while, on the other hand, it offers increased heating surface within less compass. The plan may be tried on any engine with 2in. tubes, or even less. It consists in passing through each tube an internal tube, leaving an annular space between them of $\frac{3}{16}$in. or $\frac{1}{4}$in. These internal tubes are to be filled with water and connected at the smoke-box end with the bottom of the boiler, and at the fire-box end with the crown plate; or they may be connected in the fire-box by elbows, in pairs, and the steam discharged into the steam space of the smoke-box end. One pipe of sufficient size at either end will connect the tier of tubes with the water and steam spaces, and circulation will be guaranteed.

If a boiler is made for such an arrangement, it may be found advisable to screw the $2\frac{1}{2}$in. tubes into the fire-box tube plate, and through it to receive a socket cap with the end slightly less than the inside diameter of the tube, thus forming a shield to protect the end of the tube and the screw from the flame, and also to hinder pieces of fuel as large as the size of the ring space from entering. As a further precaution, a nut on the water tube should be within 1in. of the end of the flue tube, to arrest cinders raised by the draught, which will keep this space clear of dust. The water tubes being of equal size throughout, and with easy curves, will be found to work perfectly clean, free from all deposit, which will be carried over and drawn to the place intended for it in a properly constructed boiler.



Since Mr. D. K. Clark published his experiments as to the blast, there have arisen new factors which have to be considered; for while he admitted the important action of the fire-door upon the vacuum as a damper, he did not anticipate the admission of air thence for combustion, hence his deductions being based on the air surface of the fire-grate with coke, will be modified under coal burning with deflectors and bridges, and free air admission. This has been a subject for discussion before in your columns, as to whether the gain may not be counterbalanced by injury to the fire-box; and during the inquiry as to the amended blast pipe, it may be well to consider whether it will not be desirable again to draw the air from the ash-pan, and use a divided grate at different levels, or inclined.

Whether the use of a contracted nozzle for the blast-pipe, more than one slightly "lipped," as shown by Mr. Clark at page 133 of "Railway Machinery," has any beneficial effect to counterbalance the back-pressure, should be carefully ascertained, as your suggestion for the annular steam nozzle is worth trial to obtain the best effect on the chimney; but I cannot help thinking that a space of 2ft. between the nozzle of the blast-pipe and the bottom of the chimney should be allowed for the steam escaping among the products of combustion to mix with them and expand before reaching the chimney, will be found to be of infinite value in attaining the end in view, and if my notes should tend to the improvement of the locomotive boiler, I shall be glad to have contributed to an end which has long been in my mind.

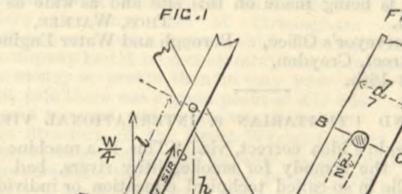
Among the explosions of locomotive boilers which I have noticed there seem to be two causes which must be remembered. One is that rupture of the shell has been caused in several cases by making the boiler a frame stay, thus throwing a strain from the frame upon the side or bottom of the boiler or fire-box. Five of one lot of six engines went from this cause, one on a curve, another while standing on a sharp crossing. The other cause is the neglect of proper circulation. Several photographs show that there has been an internal disturbance among the tubes at a short distance from the fire-box, as if the water space had been made up and the solid scale become heated, forming the centre of the explosion. I will, with your permission, at a later date call attention to a simple plan which will, I think, greatly assist in securing circulation, removing sediment, and so preventing the formation of scale, and so securing a larger amount of economy for this class of boiler. BOILER.

August 12th.

STRESSES IN A CAMP STOOL.

Sir,—With reference to the problem on the stresses in a camp stool, permit me to state that I am of opinion that "R. W. M. M." is somewhat in error—in principle—in his treatment of this problem on account of the direct longitudinal component stress having been treated as a variable instead of a constant or uniform force. I refer to the statement the cross section B C has to resist, also the crushing force $\frac{W h}{4 l}$ acting on the portion B K, and uniformly increasing from K to B—*vide* Figs. last issue—at which point it amounts to $\frac{W h}{4 l} \times \frac{2 d_1}{(d_1 + d_2)}$, whilst the strength modulus Z appears to have been $\frac{1}{6} b (d_1^2 - d_2^2)$ instead of $\frac{\frac{1}{6} b (d_1^3 - d_2^3)}{d_1}$.

I submit the following solution, which will be found mainly to agree with that of "R. W. M. M." excepting upon the points already mentioned.



W = weight on stool.
$\frac{W}{4}$ = vertical reaction on foot of one eg.
l = length of one leg.
c = half distance between feet of legs.
h = height of pin above ground.
b = thickness of one leg.
d_1 = breadth of one leg.
d_2 = diameter of pin hole.
f = modulus of rupture = 12,000 lb. for ash in compression (as previously given).

Then the maximum stress at section nearest point of support being f,

$$f = \frac{W}{4} \left\{ \frac{\cos. \theta \times l}{Z} + \frac{\sin. \theta}{A} \right\}$$

where A represents the area of cross section B C and $Z = \frac{\text{inertia}}{\frac{1}{2} d_1}$ = modulus of section or strength modulus = $\frac{31}{240}$,

$$\therefore f = \frac{W}{4} \left\{ \frac{1}{2} \times \frac{12}{1} \times \frac{240}{31} + \frac{5}{6} \times \frac{2}{1} \right\} = \frac{W}{4} \cdot \frac{4475}{93}$$

$$\therefore W = \frac{12{,}000 \times 93 \times 4}{4475} = 997 \text{ lb.}$$

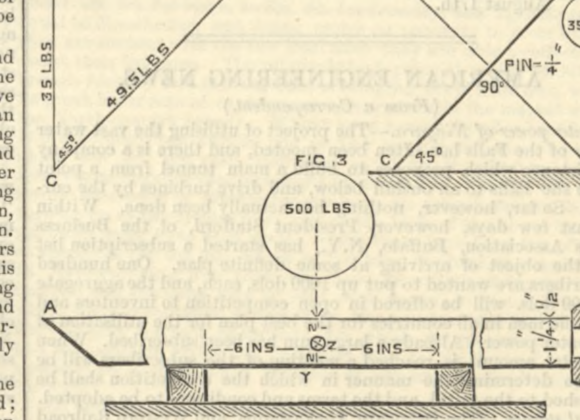
l = 12in., h = 10in., c = 6in., area cross section = $\frac{1}{2}$ square inch.

38, Playfair-road, Southsea, JAMES E. CAINE.
August 11th.

P.S.—I do not think the value of f should be taken so high as 12,000 lb.

Sir,—I beg to offer the following solution of stresses in camp-stool; and although the problem may puzzle a few more of your readers than "Puzzled," the stresses are really easily computed.

The data given by "Puzzled" in his letter of July 29th last are: weight carried = 140 lb.; material of legs, ash timber; scantling of legs, $1\frac{1}{4}$in. × $\frac{1}{2}$in.; diameter of hole for pin, $\frac{1}{4}$in.; length of leg = 2ft. Now, "Puzzled" should have given the "spread" of the canvas or carpet, *i.e.*, the length of the chord from "nip to nip," and the angle contained when the weight, 140 lb., is acting on canvas by the leg, with the ground or horizontal line.



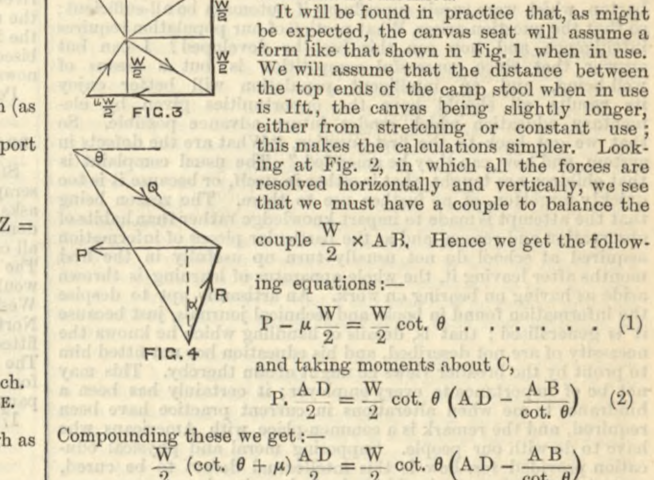
Let Fig. 1 represent a skeleton sketch of a camp stool, whose legs make an angle of 45 deg. with horizontal line. Let Fig. 3 represent any leg placed horizontally on bearings 12in. apart, and let Fig. 2 represent triangle of forces. First as to the transverse strength of any leg B C (Fig. 1) at section X Y (Fig. 3), we have $\frac{140}{4}$ = 35 lb., acting at B, Fig. 1, but opposed by tension of chord A B; consequently the leg B C is an inclined beam, supported at both ends, and loaded in the middle; the reaction at either end will be thus 35 lb., and the load at the fulcrum, or rim, will be 35 × 2 = 70 lb. Now, the ultimate cohesive strength of ash timber is given in text books at 12,000 lb. per square inch (?), and the length of the inclined beam B C must be represented by the chord A B = 12in. It may be conceded that the neutral axis of A B., Fig. 3, will coincide with the bottom of pin, that is, the fibres of wood above pin will be subjected to compression, and those below pin to tension. The area of section Z y = $\frac{1}{4}$ square inch, and the breaking strain therefore will be $\frac{12{,}000}{4}$ = 3000 lb.; we have $\frac{12}{2}$ = 6in. The length of half strain = length of long arm of lever, and, say, 1in. = length of short arm $\therefore \frac{1 \times 3000}{6}$ = 500 lb. = the breaking strain acting on section $x\,y$, and we have $\frac{500}{70}$ = 7·14, or a factor of safety of 7. The stress on the chord—carpet—will be 35 lb., as shown by triangle of forces—Fig. 2—and the strut stress through leg will be 49·5 lb. nearly.

In the case of leg making any other angle of, say, 60 deg. with the ground, to find the stress of the chord—*i.e.*, carpet—for one leg, we have sine 60 deg. : 35 lb. : : sine 30 deg. : 20·2 lb. stress on chord, and sine 60 deg. : : 35 lb. : secant 60 deg. to 40·4 = strut stress through leg.

Therefore the breaking strain of camp stool will be 2000 lb., as far as the transverse strains of legs are concerned. The total stress on the two pins will be 49·5 × 4 = 198 lb., and the total strain on canvas will be 35 × 4 = 140 lb. = weight given by hypothesis, that is, for the 45 deg. rake of leg. For the 60 deg. rake the total strain will be 20·2 × 4 = 80·8 lb. I consider 45 deg. rake the proper one for a camp stool, for if made at 60 deg., as suggested by your correspondents, the seat, if large enough, would be too high for the sitter, and if made with a less rake than 45 deg., the strains become excessive, as I have proved by experience. R. HARTLAND.

Cork, August 15th.

Sir,—Seeing that no less than three of your correspondents have attempted this problem, and all with different results, I send the



following solution. In the first place, the friction of the ground can scarcely be omitted from the calculations; and secondly, the angle of dip of the seat of the camp stool is an all-important factor, and must be calculated and not assumed.

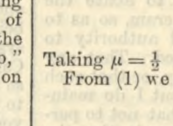


FIG.3

It will be found in practice that, as might be expected, the canvas seat will assume a form like that shown in Fig. 1 when in use. We will assume that the distance between the top ends of the camp stool when in use is 1ft., the canvas being slightly longer, either from stretching or constant use; this makes the calculations simpler. Looking at Fig. 2, in which all the forces are resolved horizontally and vertically, we see that we must have a couple to balance the couple $\frac{W}{2}$ × A B. Hence we get the following equations:—

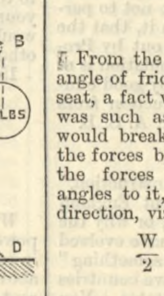


FIG.4

$$P - \mu \frac{W}{2} = \frac{W}{2} \cot. \theta \quad \ldots\ldots \quad (1)$$

and taking moments about C,

$$P . \frac{AD}{2} = \frac{W}{2} \cot. \theta \left(AD - \frac{AB}{\cot. \theta} \right) \quad (2)$$

Compounding these we get:—

$$\frac{W}{2} (\cot. \theta + \mu) \frac{AD}{2} = \frac{W}{2} \cot. \theta \left(AD - \frac{AB}{\cot. \theta} \right)$$

$$(\cot. \theta + \mu) \frac{AD}{2} = AD \cot. \theta - AB$$

$$\cot. \theta + \mu = 2 \cot. \theta - \frac{2}{\sqrt{3}}$$

$$\therefore \cot. \theta = \mu + \frac{2}{\sqrt{3}}$$

Taking $\mu = \frac{1}{2}$ $\qquad \cot. \theta = 1·655 \ldots.$

From (1) we get:—

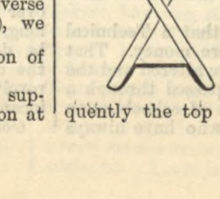
$$P = \frac{W}{2} (\cot. \theta + \mu) = 150·85 \text{ lb.}$$

From the last equation we see that P depends not only on the angle of friction, but also on the angle of dip of the ends of the seat, a fact which "Scrutator" notices when he says that if the dip was such as to give an angle whose tangent was $\frac{1}{6}$, the stool would break under a weight of 120 lb. Fig. 3 gives a diagram of the forces by graphical statics. Looking at Fig. 4, and resolving the forces at either extremity along the leg, and at right angles to it, we get two equal forces acting in the perpendicular direction, viz.:

$$\frac{W}{2} \cdot \frac{\sqrt{5}}{2} \cdot \sin. (30 + d) = \frac{W}{2} \cdot \frac{1}{\sin. \theta} \cdot \sin. (60 - \theta) = 65·31 \text{ lb.}$$

These forces acting at a distance of 12in. cause a bending moment at O of 783·72 inch-pounds. Now, as there are two legs, an inch square in section, to bear this bending moment, we have $b = 2$, and $d = 1$, in the following formula, and we may take S (the modulus of rupture) as 12,000

$$M = \frac{1}{6} S b d^2 = \frac{1}{3} S = 4000 \text{ inch-pounds.}$$



Hence the two legs which will bear a strain of 4000 inch-pounds, are subjected to a bending moment of only 783·72 inch-pounds, which means a factor of safety of over 5. If I remember rightly, none of the other solutions accounted for the fact of there being altogether four legs to the stool.

In considering the stool without a bolt, as constructed by "Common Mechanical Engineer," it should be remembered that as there are only two forces acting on each leg, these must be equal and opposite; consequently the top ends would rise till the canvas lay flat along

the legs for some distance, thus making it an exceedingly uncomfortable stool to sit upon. Also, this very tendency of the legs to rise causes the strain on the bolt pin, and makes the friction of the ground act in the opposite direction to which it would act in the case he has supposed. T. E. N.
August 16th.

TECHNICAL INSTRUCTION.

Sir,—Absent from town, I did not see my letter, with your editorial comment, till yesterday, when I had the advantage of reading in the same connection your leading article in the following number, with the argument of which I find myself in substantial agreement. For I expressly disdain the intention of pushing quack remedies for depression of trade, and I neither admit that we are beaten in the industrial race, nor that anything which can fairly be called technical education has contributed to such defeats as our commerce sustained. In speaking of the future of this country, I had in mind the general welfare of its inhabitants, and to this other means contribute besides those which confer commercial superiority. For instance, I would name the action of the plumbers and carpenters, commended by you in the same issue, as a fact which, though it has little bearing upon foreign competition, may greatly influence the future happiness of this nation. The mention of these two trades, of so great domestic importance, should suffice as evidence of the fact that, even if an automaton may meet the exigencies of competitive commerce, the supply of intelligent workmen is still of importance to Englishmen. Perhaps it does not follow that they need be educated at school, there being various ideals of education, and Mr. Tony Weller's view differing from that of Professor Huxley. But this fact remains, that it is the law of the land that every child shall go to school, and that being so, it is of more than theoretical interest that school education should be the best attainable. The predominant English form of education is that derived from the universities and so-called public schools, a system of considerable antiquity, originally intended for the clergy. I understand that it is a fact that in the simplified form obtaining in the Board Schools, it tends to disincline children from manual labour, by putting forward scholastic eminence as the ideal of life, and to which at least all school honours and prizes fall. The word Kindergarten is a somewhat laughable name, which I used as the readiest title of a method of teaching which I find admirably set forth by Professor Perry in the preface to his "Practical Mechanics," a book highly praised by your reviewer some two years since, from which I beg leave to quote as follows:—"I am inclined to believe that if, instead of forcing the workman to study like a schoolboy, we were to teach the boy as if he had already acquired some of the experience of the workman, and made it our business to give him this experience, we should do better than at present." For the theory implied in this passage abundant reasons can be produced; in practical fact, the best approach to an application of the method in elementary education that I am aware of is found in the Swedish Slöjd—a system of educational handwork most favourably reported on to the U.S.A. Government in 1885, and a shorter description of which appeared in the *Journal of Education*, February 1, 1887, since reprinted by Longmans in a volume entitled "Some National and Board School Reforms." A most important point is that in this and other cases where handbook teaching has been introduced the children are reported to do their other school work better than before.

Remembering what passed for science teaching at a public school, and the small amount of scientific thought as distinct from miscellaneous information resulting, I cannot wonder at your protest against its indiscriminate extension. On the other hand, you remark the possible value of real technical training, and have praised such efforts as those of the late Mr. Wm. Denny at Dumbarton, which were surely superfluous if automata be all-sufficient; so that the question arises, What portion of our population requires intelligence, and how can this best be developed? I can but answer that since successful competition is but a means of well-being, and an intelligent population will better enjoy its results, all should have the opportunities given by elementary education which render future advance possible. So that we get back to the first question, "What are the defects in system, and how can they be amended." The usual complaint is that children are taught what is either in itself, or because it is too quickly forgotten, of no further use to them. The reason being that the attempt is made to impart knowledge rather than habits of observation and reason, and as the particular pieces of information acquired at school do not usually turn up usefully in the first months after leaving it, the whole apparatus of learning is thrown aside as having no bearing on work. An artisan is apt to despise the information found in books and technical journals, just because it is generalised; that is, details of handling which he knows the necessity of are not described, and his education has not fitted him to profit by the broader views he might attain thereby. This may not be of importance to every employer; it certainly has been a hindrance to me when alterations in current practice have been required, and the remark is a common-place with Americans who have to do with our people. Supposing moral and physical education provided for, how is this intellectual defect to be cured, except by showing at school how book learning bears upon practice; which can only be done by setting boy or girl to work making something, and then getting them to use their common-sense in discovering the reason and the science of it.

Such a reform in our methods cannot be introduced on the instant, and what I would ask of Government is to abate the rigidity of their standards and payment-by-results cram, so as to leave room for an able master or a zealous local authority to experiment quietly and inexpensively if so disposed. That any such scheme will diminish our imports from Germany, or that such reduction is desirable, I am far from pretending, but I do maintain that our elementary education is not perfect, that not to perfect it is largely wasting the money already spent on it, that the direction in which it needs amending is that pointed out by Professor Perry. Further that the intelligence of the population is of the highest importance, and that it can be developed by good education I hold to be opinions warranted by a wide induction from observed facts. W. A. S. B.
Alresford, August 14th.

Sir,—With respect to your article on "Technical Instruction," I do not wholly agree with its tone. It is fairly evident England lacks something Germany and the United States have, or why the agitation generally current, and which now appears to have evolved the present Bill in the House of Commons. That "something" seems to be the practical instruction that both the above countries possess. Take any school text-book of the United States. You will find it very different from that of this country; much more a simple matter. We arrange our geometry instruction by the several books of Euclid, while the Americans get over the same ground with a fraction of the labour. The same with Germany.

As an ex-instructor of an engineering college abroad, I had to give in to the American methods, though I had been brought up on the usual plan of this country. The reason of all this is that education there has been of a classical tendency—old-world methods instead of the modern and more practical style. A boy, say, of the middle classes—the workmen may be left out of the question—those who will direct operations, are, therefore, without they are very clever, handicapped by Americans and Germans. Their life in an educational sense has been wasted. Board-schools teach the lower orders. What is wanted is an improvement in the next sphere above this. Yet what are the teachers of this class? Men who have been educated at antiquated colleges.

In one sense I support your opinion, viz., that a Technical Instruction Bill cannot do good by spending more money. That at present expended is sufficient if the plans were altered and the teachers be drawn more from those who have passed through a practical course. Why not appoint headmasters of schools more from the outside world, instead of from those who have always lived in a school? It is the routine and groove in which public institutions run in this country that detracts from their worth. A change is too long in coming about, the public departments always requiring more money to improve, instead of acting with that at their command already. An Engineer.

EDUCATION OF ENGINEERS.

Sir,—I have read with much interest the previous correspondence under the above heading, and now beg to subjoin my views on the subject, as I find they differ somewhat from any yet advanced.

Let it be supposed that rigid economy must be studied throughout, that the lad is resident in a town possessing a university, college, or other equivalent institution, and that he is to be a mechanical engineer, by which I mean one who shall efficiently fill in an engineering works any responsible post requiring a thorough knowledge of the profession, as, for example, that of chief draughtsman, works' manager, or principal.

Say the lad could only get an elementary education, and leaves school when fourteen, having, however, given special attention to mathematics and reached quadratic equations.

From fourteen to about fifteen let him have a few months each in the counting-house and various shops of an engineering establishment; next four or five years in the drawing-office, with opportunity to observe machinery in process of erection, the last year or two to be spent in the time and wages office and chief offices, so as to get an insight into the commercial part of the business, the preparation of estimates, &c. Throughout the apprenticeship, part of the spare time in the evenings to be devoted to the study of mathematics, physics, technical subjects, and one or two modern languages.

If our friend, when twenty-one, finds his intellectual thirst still unquenched, and has means for a three-years' course at Cambridge, or perseverance enough to work for a London degree in his evenings, so much the better. E. H. B.
August 17th.

CROYDON WATERWORKS.

Sir,—Being the engineer for the Addington Reservoir, allow me to make a further correction of the statement on page 67 of your journal. The dimensions are correctly given, but the total cost will not exceed £11,500. It is also only fair that an explanation should be given to the kind letter on page 107. The reservoir is being constructed entirely of concrete from gravel dug on its site. Trial holes were made all over the Corporation land, and suitable gravel for the concrete was found only between two deep parallel valleys, and the reservoir is being made on this site and as wide as the valleys will permit. Thos. Walker,
Engineer and Surveyor's Office, Borough and Water Engineer.
8, Katharine-street, Croydon,
August 16th.

COMMERCIAL AND UTILITARIAN *v.* INTERNATIONAL VIEWS.

Sir,—Were Ruskin's idea correct, viz., "This is a machine and devil-driven age," the remedy for smoke, filthy rivers, bad air, and trade would lie in so-called technical education or individual effort, and not in united action to make a sound beginning somewhere. Thus, without compulsion, factories, steamboats, and railway engines are not very likely to set the fashion of consuming their own smoke; nor is it to be expected private cooks, under existing circumstances, should demand better articles in the way of gas stoves and kitchen ranges than limited liability companies see their way to offer. So it would also seem to be with filthy rivers, bad air, and trade. A severe drought will scarcely induce the most energetic corporation to alter their ways—any more than the Postmaster-General can be persuaded to allow the public to bisect a penny stamp when they require two halfpenny ones for newspapers. H. A. T. S.
Peterborough, August 12th.

BRAKES ON THE LONDON AND NORTH-WESTERN RAILWAY.

Sir,—The gentleman who so kindly took the trouble to cut out a scrap from the *Evening Standard* and sent it to you for insertion asks for an explanation. The time bills show that it is the Caledonian Railway over which the trains run beyond Carlisle. This all can see. It is also a Caledonian engine that draws the coaches. The Caledonian Railway adopted the Westinghouse brake, and would not run the coaches fitted with the London and North-Western Railway brake only over their line. The London and North-Western Railway agreed to have the Westinghouse brake fitted to the West Coast Joint Stock in addition to their own. The Westinghouse Company's men fitted the brake. It was therefore not this time the London and North-Western Railway Company's brake that was in fault. Κριτής.
176, Nantwich-road Crewe, August 16th.

CONTINUOUS BRAKES.

Sir,—I see in your issue of the 12th inst. Mr. H. C. W. Borrie has favoured you with an extract from the *Evening Standard*, purporting to report a failure of the London and North-Western Railway "vacuum" brake. I trust you will allow me to point out that the train in question was one of the West Coast joint stock, and fitted with the vacuum and Westinghouse brakes, the former being used by the London and North-Western Railway on its own system as far as Carlisle, at this point the train is taken by the Caledonian Company's engine and controlled by the Westinghouse, so that any failure at Perth or north of Carlisle must be attributed to the Westinghouse brake and not the vacuum, as suggested by your correspondent. I do not think it likely that any sane man would suggest that the London and North-Western vacuum or any other continuous brake is immaculate, or that failure is impossible.
15, Walbrook, London, E.C., John E. Hopkinson.
August 17th.

AMERICAN ENGINEERING NEWS.

(*From a Correspondent.*)

Water power of Niagara.—The project of utilising the vast water power of the Falls has often been mooted, and there is a company in existence which proposes to build a main tunnel from a point above the Falls to an outfall below, and drive turbines by the current. So far, however, nothing has actually been done. Within the last few days, however, President Stafford, of the Business Men's Association, Buffalo, N.Y., has started a subscription list with the object of arriving at some definite plan. One hundred subscribers are wanted to put up 1000 dols. each, and the aggregate 100,000 dols. will be offered in open competition to inventors and scientific men in all countries for the best plan for the utilisation of the water power. Already a large sum has been subscribed. When the total amount is reached a meeting of the subscribers will be held to determine the manner in which the competition shall be published to the world, and the terms and conditions to be adopted.

Coal storage.—The Delaware, Lackawanna, and Western Railroad is building near Buffalo, N.Y., an immense coal trestle for storing the coal as it comes from the mines, leaving the cars ready for use. The total length of the trestle, including the inclined approaches, is about a mile, and the structure is 60ft. high. Its capacity is over 100,000 tons. The storage floor is 100ft. wide and 3000ft. long, and on it is a trestle 24ft. high, on which the cars are run to be dumped. A screen shed, 350ft. long and 50ft. high, adjoins the coal trestle, and there the coal is re-sorted in four sets of revolving screens. The buildings will be thoroughly lighted on the incandescent system.

Gold in Michigan.—The existence of small quantities of gold in the Lake Superior iron-mining region has been known for some years, but considerable excitement has recently been caused by the discovery of an outcrop of sugar quartz, rich with thin leaflets of gold, on the property of the Lake Superior Iron Company, near Ishpeming. The company sunk a shaft in the main, and at a depth of 20ft. the quartz had changed to ordinary white, hard quartz, with considerable gold. It is reported to be a true fissure vein, and has been traced for several miles east and west.

An irrigation scheme for Mexico.—American capitalists are negotiating with the Mexican Government for a concession for an irrigation scheme in the Yagin valley. The land is rich and productive, but is not under cultivation owing to lack of water. The canal will be 100ft. wide at top, 80ft. wide at the bottom, and 8ft. deep. About 1,500,000 dols. will be invested in the scheme, and there is a probability that the concession will be granted. The same syndicate is negotiating for irrigation canal schemes in Arizona.

River and harbour works.—The United States engineers in charge of rivers and harbours are sending in their annual reports to the Chief of Engineers, and submitting with them their estimates for the expenditure during the next fiscal year. About 450,000 dols. are estimated for the Delaware and Maryland district, and about 1,000,000 for Connecticut.

Inspecting engineers' watches.—The Chicago and North-Western Railroad Company has issued an order requiring superintendents, engineers, firemen, conductors, yard-masters, and train-despatchers to have their watches examined as to condition every three months, and a certificate of examination will be required. The order stipulates that all watches must be 15-jewelled, patent regulator, adjusted to heat and cold, and protected with the anti-magnetic shield. It has created some dissatisfaction, but it is a safe precaution. The plan is already adopted on the Pittsburgh, Cincinnati, and St. Louis Railroad; and the report of the official watch examiner shows that 95 watches were examined in July.

Hotchkiss guns for the Navy.—The Secretary of the Navy has made arrangements with the Hotchkiss Ordnance Company for the manufacture of Hotchkiss guns and ammunition on a large scale in this country. The Pratt and Whitney Company, of Hartford, Conn., will build the guns; and the Winchester Arms Company, of New Haven, Conn., will supply the ammunition. The Secretary has issued the following statement:—"The Department has finally closed a contract with the Hotchkiss Ordnance Company. A branch of the manufactory will be established in this country. Our secondary batteries have heretofore been made abroad. It marks another most important era in the construction of the Navy. Mr. Hotchkiss was an American, and when he died in 1884 every important European nation had a manufactory of Hotchkiss ordnance. England, France, Germany, Russia, and Italy each had one. By delaying the giving out of orders we have accumulated a large contract, and the investigations made by the representatives of the company have elicited the fact that with the superiority of machinery in use in this country the prices can be made the same for the arms made here as made abroad. We either had to prepare to manufacture ourselves or get them to come here. We cannot be dependent on another country for our war materials. The machine guns have become an indispensable branch of national armament. To illustrate their effectiveness, the six-pounder Hotchkiss rapid fire-gun is controlled by one man, aimed from the shoulder, and will discharge twenty-three 6 lb. shells per minute with a velocity that will penetrate 2in. of steel plate at 1000 yards. They are especially necessary against torpedo boats and unarmoured ships and to clear the exposed decks of ironclads. The company is now developing a nine-pounder and experimenting with a thirty-three pounder. With the Bethlehem Iron Company contract and this one executed, American shipbuilders will be able to build and arm warships entirely from American manufactories."

Pneumatic tubes to Europe.—A Connecticut man proposes to establish pneumatic communication with Europe, and has taken out patents on the details of the work. His scheme provides for two tubes with a continuous circulating current of air, and the speed attainable "may reach 1000 miles an hour." The tube lining and the exterior of the car would be of polished steel, with corrugated sides, and wheels carried in anti-friction bearings. This enterprise will probably languish for lack of funds, in spite of the inventor's claim that "there's millions in it."

An American-Chinese syndicate.—Once more Americans are looking to China for a field of operations. A Philadelphia syndicate has been granted a concession by the Chinese Government for a telephone system, with absolute control for fifty years. This is but the thin edge of the wedge, and Mr. Barber, the head of the syndicate, states that he declined to join the project if the telephone line was its only purpose. He outlines the plan as follows: To establish long and short distance telephone systems, build railroads, develope coal and iron fields, establish ironworks, rail mills, and locomotive works, and to introduce a banking system. The contemplated railroad system is about 2000 miles in extent, from Tien-Tsin to Shanghai, Nanking, and Canton. It is intended to get Chinese capital interested in the enterprise, in order to give confidence to the natives. Mr. Barber denies that Jay Gould is interested, as was reported.

Street railroad tracks.—It is probable that in a few years the groove-rail will be quite generally adopted, for city roads at any rate. The obvious defects of the centre-bearing and side-bearing rails, and the damage they cause, is slowly leading to a better form of track. The girder rail is gaining favour over the flat rail, and the grooved head will follow. The new West-End Railroad, Boston, Mass., will use an imported girder rail with grooved head. Street railroads are much more commonly used here in small towns and villages than in England, and in such cases the present cheap construction of cross-ties, stringers, and flat rails will remain the standard form. One important feature is the paving next the rail. At present it is allowed to get into deep ruts and holes, so that it would considerably detract from the advantages of a grooved rail. When laying a new line, however, on the improved plan, proper attention would probably be paid to the foundation and paving. On Fulton-street, New York, the electric railway company—previously mentioned—has torn up the street, laid its track, and relaid the paving. It will have to be torn up again for the conduit, and just why this procedure was allowed is not clear, there being no foundation except the subgrade of the street—the timbers being laid on the dirt directly under the paving sett, the paving has settled to an outrageous extent, leaving holes three and four inches deep, where the stringers are exposed, and already the rails are working loose by the street traffic, though no cars are yet run.

Waterworks.—There is a great and increasing demand for waterworks all over the country, and no town can hope to start a "boom" unless it can at least say that preparations are being made for water supply. The cities are improving their works, extending their systems, increasing their supply and purifying the same, filtering plants being now much in demand. But all over the country waterworks are being established, not only for towns of medium size, but also for villages and new towns. Sewerage and electric light systems often go hand-in-hand with waterworks. In Nebraska the supply is generally obtained from underground sources, and here, as in other parts of the West, wind engines are used to drive the pumps to a considerable extent—this for the small works, of course.

A new locomotive.—A new locomotive is now being built to run the "Flying Yankee" express on the Boston and Maine Railroad and Maine Central Railroad, which will be a novelty in the locomotive types of the country. It will have a single pair of driving wheels, and, to prevent slipping, it will be provided with the sand blast by compressed air, such as is used on the Caledonian Railway, Scotland, and which is being tried for ordinary engines on the Chicago, Burlington, and Quincy Railroad. The only modern locomotive in this country yet constructed with single drivers was one built some years ago by the Baldwin Locomotive Works to run the express trains on the Bound Brook route of the Philadelphia and Reading Railroad. It was purchased by the Eames Vacuum

Brake Company, and was subsequently sent to England and run on the Lancashire and Yorkshire Railway. No details of its performance were published, but it proved a failure, and this failure was widely announced as a failure of an American type of engine on an English railway, the fact being lost sight of that, being the only one of its kind built here, it was by no means representative of American locomotives. One feature in American locomotives that would bear alteration with advantage, for express trains at least, is the size of the drivers. There are probably none in use over 6ft. in diameter, and very few as large as that, the average being about 5ft. 6in. The details and performance of the new engine will be watched with much interest.

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

(*From our own Correspondent.*)

'CHANGE in Birmingham to-day—Thursday—and in Wolverhampton yesterday was slightly stronger, as the result of the announcements that better inquiries are being received from abroad. The United States are at present showing more disposition to operate than for a long time past. Some firms who have done nothing with America for two or three years are now in receipt of orders. The inquiries run chiefly upon black sheets for galvanising and working-up purposes, and upon superior bars. Baling hoops are also being required. Makers of commoner descriptions of finished iron are also doing rather more, and the works are starting earlier in the week than before. Vendors maintain that the prices of medium iron will become firmer, but buyers show no disposition to accept this opinion. At present prices are well maintained. Consumers decline to negotiate forward, and will operate only to meet pressing requirements. Marked bars remain at £7; medium sorts, £6 10s. to £6 2s. 6d.; merchant iron, £5 10s.; and common, £4 12s. 6d. to £4 15s.

Canadian inquiries are rather better for sheets, hoops, and bars, and in the next two months a good shipping business should be done.

Strips are experiencing more briskness, particularly the tack strip branch, which is busy. The tube strip makers anticipate a better demand during September, when there is always a large call from the wrought iron tube makers, who then invariably find an improved business for gas and other tubes. Prices of tube strip vary considerably, but £4 15s. to £5 may be taken as the average. Common hoops are £5 to £5 5s. for export sorts.

The orders placed of late in this district for wrought iron telegraph poles for India are understood to indicate the consumption of some 2000 tons or more of wide strip iron, rolled for this special purpose. Before being sent away the poles are galvanised.

Sufficient enquiries are still being received from the merchants and galvanisers to enable the sheet mills to be kept in full operation, and some makers are so well booked that any further acceptance of orders for prompt delivery is accompanied by a strong demand for higher prices. Enquiries are being received largely from Australia, Canada, and Russia, and there is a fair demand from India. Prices are well maintained on the basis of £6 to £6 2s. 6d. for singles, £6 5s. to £6 7s. 6d. for doubles, and £7 to £7 7s. 6d. for lattens.

Messrs. Morewood and Co., Birmingham, quote black sheets for 20 b.g., 21 to 24 b.g., 25 and 26 b.g., and 28 b.g. respectively; ordinary sizes, "Woodford" brand, £7, £8 10s., £10, and £10 10s.; close annealed, ordinary sizes, "Woodford Crown," £9 10s., £11, £12 10s., and £13; "Woodford best," £11, £12 10s., £14, and £14 10s.; "Woodford best, best," £12 10s., £14, £15 10s., and £16; "Woodford best, best, best," £14 10s., £16, £17 10s., £18; "Woodford charcoal," £16, £17 10s., £19, and £19 10s. Mild steel sheets, by Siemens-Martin process, close annealed, £13, £14 10s., £16, and £16 10s.

Galvanised corrugated sheet makers are doing a big trade, and last month was another heavy one as regards shipments. The total, according to private returns furnished by the Board of Trade to the Galvanised Iron Trade Association, was 12,094 tons, against 8029 tons shipped in July last year—an increase of 4165 tons. Prices are strong, and some large makers state that they are up 7s. 6d. per ton as compared with a month ago, and that with an ever-increasing demand they seem likely to go much higher. It cannot be said, however, that all makers are getting the full advance here indicated, and £10 2s. 6d. to £10 5s. per ton delivered Liverpool is an average quotation.

Abundance of confidence is manifested by the steel makers in the position of their industry. Local manufacturers report a more vigorous demand for their metal in all sections than they can supply, and the orders upon the books represent plenty of employment up to the end of the year. Sellers of steel imported from other districts are also doing well, and announce a steadily-growing demand, for steel sheets in particular. Siemens-Martin steel sheets for stamping purposes of local make are this week quoted from £9 to £9 10s. and on to £10 per ton, according to temper.

The supplies of steel scrap upon the market are scarce, since Welsh steel masters now find it more profitable to use up their own rolling mill scrap as a mixture with the pig iron charged into the Siemens-Martin furnaces than to sell it to outside buyers. The highest price that can be got up here is about 44s. per ton, which leaves 36s. per ton to South Wales. Makers there declare that so long as they can secure supplies at 42s. per ton, it pays better to make use of it in the Siemens-Martin process than to sell it. This question of the price at which steel scrap can be secured is becoming an increasingly important one to the steel makers. They state that the prices which they can afford to accept must depend largely upon the figure which from time to time scrap is commanding in the market.

The manufacture of basic manure from slag at the works of the Staffordshire Steel and Ingot Iron Company is proving a complete success. The company is producing rather over 100 tons per week, and so excellent is the demand from the London merchants, who have contracted to take the fertiliser, that the company reports that could it supply the demand it might have orders upon its books at the present time for 2000 tons ahead. The company has determined to at once double its production, and the contractor has been called upon to provide the necessary increased grinding plant. The price at which the new fertiliser is sold to agriculturists is somewhere between 30s. and 40s. per ton.

The pig iron trade is unchanged as regards prices, but there has been a slight accession of orders in consequence of consumers of Midland pig being compelled to place the contracts which they have long delayed in the hope of the market taking a turn in their favour. New orders for South Staffordshire forge iron are somewhat scarce owing to the keen competition of Midland producers. The largest makers of common and medium iron, however, report that they have a reserve of orders which will last some time. Forge iron of all-mine quality is quoted 50s. to 52s. 6d., and foundry numbers command the usual extras. Medium pigs are in moderate demand at 40s., and common at 28s. 6d. to 31s. 3d.

A new economy in finished iron and steel manufacture is just now being introduced into this district which has about it points of much recommendation. The new process consists in the substitution for the bottoms of mill and other reheating furnaces of basic steel slag instead of sand or mine, which up to the present has been mostly employed. The change is being carried out under a patent taken out jointly by Mr. A. E. Tucker, of Smethwick, near Birmingham, ironworks chemist, and Mr. F. W. Harbord, resident chemist at the works of the Staffordshire Steel and Ingot Iron Company, Bilston. The new bottom is made as follows:—The old sand or mine bottom is cut out to a depth of 8in. or 10in., and the basic slag in 2in. cubes is put in its place to a depth of 6in. or 7in. Over this is spread some finely-ground slag, care being taken to give a good fall in order that the cinder may run freely off. The furnace is then raised to its full heat to glaze the surface, when the bottom is ready for charging. Thus made the bottom requires very little attention. The advantages claimed for the new invention, which I have inspected, are—(1) a decrease in furnace waste of 2½ per cent. on the iron heated; (2) the production of a flue cinder which forms an excellent fettling for the puddling furnace, and which is in every way equal to the best ball tap; (3) improvement in the surface of bars, plates, sheets, and other sections rolled from the bottom; and (4) reduced cost for repairing and fettling.

The saving of 2½ per cent. is an important matter, being equal to from £7 to £10, according to its quality, on every 100 tons of iron reheated. This saving is due to the inert nature of the slag which does not flux away the scale from the bottoms of piles, &c. The bottom is quite free from silica, and thus the cinder formed consists of melted scale, which is an excellent fettling for the puddler. At steelworks where there are no puddling furnaces the cinder can be readily sold at 15s. per ton, instead of at 5s. or 6s., the amount now obteined for the flux from sand bottoms. The following is the analysis of the flue cinder obtained: Peroxide of iron, 20·00; protoxide, 69·02; silica, 4·35; lime, 3·80; magnesia, 0·20; oxide of magnesia, 0·80; sulphur, 0·04; phos. acid, 2·06; total, 100·27. Oxide of iron, equal to metallic iron, 66·97 per cent.; phosphoric acid, equal to phosphorus, 0·915.

Sixteen firms in Staffordshire, among whom are the Earl of Dudley, the Staffordshire Steel and Ingot Iron Co., the Patent Shaft and Axletree Co., N. Hingley and Co., and the Patent Nut and Bolt Co., have adopted, in some cases exclusively, the new bottom. In Glasgow and South Wales also iron and steel masters are introducing it into their works.

The North Staffordshire finished iron works are receiving shipping orders with a little more freedom, but the demand from home buyers is unusually bad. Galvanising plates and bridge girders are going to the colonies. Small sections of ordinary merchant iron are in limited call. Prices are nominal at £5 10s. to £6 for medium plates; £5s. 5s. to £6 2s. 6d. for angles; £5 10s. to £6 10s. for tees; and £5 5s. to £5 15s. for hoops.

The rivet makers at Blackheath contemplate forming a union which shall enable them to resist an innovation which they allege is being attempted by the masters. Some employers, it is said, insist upon the men paying the carriage, which is equivalent to a reduction ranging from 5 to 12½ per cent.

Only about three-fourths of the chain makers in the Cradley Heath district are said to be at work, and these even are on short time. They are making earnest efforts to complete arrangements for establishing the Co-operative Society, which it is expected will be consummated very shortly.

At the annual meeting of shareholders of the Sandwell Park Colliery Company, held at Birmingham on Tuesday, the directors presented a report which showed that during the year the company had done considerably more business and had earned more money in profits than in any year since 1881-82. On the credit side there was a gross profit of £17,646. A dividend at the rate of 5 per cent. per annum was declared.

The directors of the Great Wyrley Colliery Company, whose shareholders are summoned to meet in Birmingham, congratulate the owners upon the result of the past half-year's working. A net balance of profit is shown of £925, as compared with £1389 in the corresponding period of 1886. The directors recommend, in accordance with previous policy, that £500 be transferred to the credit of the Depreciation Fund, £250 to the Debenture Redemption Fund, and that £175 should be carried forward.

The death is announced of Mr. W. Fisher, of the firm of Plant and Fisher, Dudley Port Ironworks. Mr. Fisher was about fifty years of age.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester.—Business in the iron trade of this district continues to drag on slowly without improvement. A generally steady tone is maintained as far as prices are concerned, but this is not backed up by any weight of buying, and is indicative rather of the fact that makers cannot afford to take lower prices than that the market is really strong. Prices, it is true, have been—and not very long ago—lower than they are at present, but "living upon their losses" is not a method of carrying on business which can be continued indefinitely by ironmasters, and a very general stand is now evidently being made against the excessively low prices at which business was being done recently. Makers declare that they are better without the business than accept the offers which buyers in some instances put forward; and although there is but little actually being done, there is a general indifference about booking orders at anything under what may be termed the present current rates. This applies to both common pig iron and hematites. In finished iron there is also a stronger tone, but this is being supported by an increased weight of business which has come forward recently, chiefly for shipment. The general indications of the market at present are that, if from no other reason than the absolute necessities of the position in which makers are placed, prices are not likely to get any lower; but, on the other hand, there is nothing in the immediate future which is calculated to place makers in any really stronger position.

The iron market at Manchester on Tuesday was moderately attended, but there was only a slow business doing. The pig iron trade remains generally in an inanimate condition, and what there is doing is chiefly in foundry brands of Lincolnshire, which are just now the cheapest iron in this market, and moderate sales have been made at about 37s. 6d., less 2½, delivered equal to Manchester, with forge qualities quoted at 6d. to 1s. per ton less. These are, however, the very lowest figures that makers will accept, and offers at a trifle less have been declined. Lancashire makers, who are pretty well sold for their present very limited output, still hold out for figures very considerably above those at which district brands can be bought, their quoted rates remaining nominally at about 38s. 6d. for forge, to 39s. 6d. for foundry, less 2½, delivered equal to Manchester, and, being under no necessity to press sales, they are content with the few local sales they are able to effect at about their list rates. The relatively high price at which Middlesbrough foundry iron is being held is bringing Derbyshire iron, with its much lower rate of carriage, as a competitor in the market with the North-country brands. Whilst good named foundry brands of Middlesbrough can only in one or two exceptional cases be got under 43s. 4d. net cash, delivered equal to Manchester, good Derbyshire foundry can be bought at about 40s., less 2½, with the results that users of Middlesbrough have, in some instances, been turning on to Derbyshire iron, and on the basis of the above figure moderate sales have been made; whilst there have been fair offers at about 6d. per ton less, which sellers have declined to entertain. In Middlesbrough iron there has been very little doing in this market, and the same may be said with regard to Scotch iron, in which there is continual underselling, the constant fluctuations in the Glasgow warrant quotations, for which no reasonable cause can be assigned, giving an unsettled tone to the market, which operates as a check upon business of any importance being put through.

The business doing in hematites continues very slow, most of the large users being well covered for the present, but quoted rates remain firm on the basis of 53s. to 53s. 6d., less 2½ per cent., for good No. 3 foundry qualities delivered into the Manchester district.

In the manufactured iron trade there has been more business stirring, not so much on account of the home trade, which continues very dull as for shipment, the Indian and Australian markets being at present the principal customers. Bars have been moving away more freely and prices are steadier. It would be difficult now to place orders for anything like good qualities at under £4 17s. 6d. per ton, and for some of the best South Staffordshire qualities makers hold to £5 per ton for delivery into the Manchester district. Hoops are firm at £5 5s., and sheets at £6 5s. to £6 10s. per ton delivered into the Manchester district.

Although it can scarcely be said that there is any really substantial improvement in the condition of the engineering branches of industry, there seems to be a better feeling prevailing, and there are more inquiries stirring, which result in works here and there getting better off for orders. Boilermakers and machine tool makers seem to be the best off for work, and stationary engine builders are moderately employed; but apart from these branches, trade is only in an indifferent condition. Machinists in some instances have a fair amount of work in hand, but this is running off without being replaced. Locomotive builders are working on with the orders they have got with but little new work in prospect, and the general engineering branches of trade are but very poorly employed. Apart from a few concerns chiefly engaged in specialities, there are not many works that could not do a very great deal more than they have at present in hand, and this, of course, leads to a continued keen competition for any orders that are to be got, which of necessity places engineering firms who have to secure work in the position of having to take it at excessively low prices.

Messrs. A. and J. Dempster, of Manchester, have secured an order for the construction and erection of an iron retort-house roof for the Toronto Gas Company, Canada. This roof, which will be made from a special design of their own, will be 306ft. long and have a span of 76ft. They have also received an order for the construction of reservoir water towers and girders for the Buxton Waterworks. The firm have on hand an important contract for the Bolton Gasworks, consisting of an erection of large condensers, in which there are twelve columns so arranged that they can form one condenser, or by means of a series of valves each three columns can be worked as a separate condenser. Messrs. Dempster are finishing for the Kidderminster Gasworks two large gasholders of the telescopic type, each having a capacity of 150,000 cubic feet; and they have just finished erecting for the Ashton Gas Company a set of large purifiers 35ft. by 25ft., with strong wrought iron roof to cover them.

As I anticipated, the efforts which have been put forward during the past week to bring about a settlement of the strike in the Bolton engineering trade have altogether failed, the men declining to accept arbitration unless it is to be carried out on their own terms. The strike has now lasted over a period of more than three months, and the difficulties in the way of an agreement between the employers and their workmen have only increased. The Bolton masters are receiving the fullest support of the associated employers throughout the kingdom, and in accordance with a resolution passed at the annual meeting of the association held recently in Manchester, meetings of the various district branches are being arranged to organise such further assistance and co-operation as may be required to carry on the struggle. The men, on the other hand, are still well supplied with funds, and are determined to hold out. The only termination of the strike which is at present in prospect is that either one side or the other will have to be thoroughly beaten. The employers are slowly filling their shops with men, and they would have no difficulty in carrying on their works altogether independent of the men who have gone out on strike, were it not that the persistent intimidation employed against workmen coming into the town deters large numbers of men who would gladly accept the employment offered them.

A meeting of the Manchester Association of Engineers was held on Saturday, and a vote of condolence with the relatives of the late Mr. E. Fletcher, the last surviving member of the firm of Messrs. Collier and Co., engineers, Salford, who died recently, was unanimously passed. With the exception of the nomination of several gentlemen as members, the remaining business before the meeting was purely of a formal character.

Now that the financial portion of the Manchester Ship Canal project has been carried through, and the Company has entered into possession of the Bridgewater Navigation Company's property, the question which one hears repeatedly asked is,—When will the actual operations for the construction of the ship canal be formally commenced? There is naturally an impatience to see something commenced, but there is, of course, a good deal of preliminary work to be done before the actual construction of the canal can be really begun. Preparations are, however, being made by the contractors, who have to complete the work in four years, and there will be no unnecessary delay. The formal cutting of the first sod is being looked forward to by many as an imposing ceremony, and efforts have been made to induce the Queen to undertake this duty, but so far, I understand without success. It will no doubt be a great disappointment if there is no public ceremony as an inauguration of the work; but from what I can hear it is more than probable that it will be quietly commenced, with as little demonstration as possible.

With the exception that there has perhaps been a little more inquiry for house-fire qualities of fuel, the general condition of the coal trade remains unchanged. Pits continue working barely four days a week, with stocks accumulating; and although there is, perhaps, not quite so much pressure to sell, prices remain extremely low. All descriptions of round coal are bad to sell, and the very limited supplies of engine fuel only move off moderately. The average prices at the pit mouth remain at 8s. to 8s. 6d. for best coals; 6s. 6d. to 7s., seconds; 4s. 9d. to 5s. 6d., common coals; 4s. 6d. to 4s. 9d., burgy; 3s. 6d. to 3s. 9d., good slack; and 2s. 6d. to 3s. per ton, common sorts.

For shipment there is only a moderate demand, with very low prices taken; ordinary qualities of steam coal averaging 6s. 6d. to 6s. 9d. per ton delivered at the high level, Liverpool, or the Garston Docks.

Barrow.—There is a considerable amount of activity to notice in all the important branches of local industries, excepting that of shipbuilding and engineering. There has been a scarcity of orders in this department of trade for some months past, and although there are indications of a better state of things in the early future, there is not much work in hand at the moment to provide employment either for shipbuilders or engineers. Some inquiries are to hand for large steamers, but competition is still very keen. At the Whitehaven shipyard, which has been practically closed for some months, a new order has been booked for a steamer of about 1000 tons, which will bring about new life in the yard, and, it is believed, will be the forerunner of other orders which are expected to be placed here. At Barrow, however, no new contracts have been placed. The Barrow Shipbuilding Company is employing very few men in the erecting department, and the stocks will very nearly be empty when a launch takes place on Saturday. The yard of Mr. Caird's, at Barrow, is still closed for want of orders, and next to nothing is doing at the shipbuilding yards of Messrs. Ashburners' and the Furness Shipbuilding Company. In the iron trade a very full demand is experienced for Bessemer qualities of pig, and orders are largely held all round. The output is fairly well maintained, although in some instances, owing to the drought, makers are compelled to damp down furnaces for a day or two at a time. This is not the case in Barrow, but in the district the output has been restricted owing to this cause. There is a desire on the part of buyers to place a large number of orders for pig iron at current prices, as the opinion is gaining ground that large parcels of iron will be required in the immediate future, not only by steelmakers, but for general purposes. Prices cannot be quoted higher than of late, and makers are as fully determined not to sell in great bulk until the orders on hand are more nearly disposed of, or until better prices are secured than 44s. 3d. per ton, net f.o.b., for parcels of mixed Bessemer iron, which is about the average value of recent sales. Makers, however, still quote 45s. 6d. per ton, and those who are most favourably situated for orders are refusing sales at a less figure. In the steel trade the demand is nothing short of extraordinary. Makers are busy in almost every department, but in the rail trade there is an especially active market. The demand for rails is very full indeed, and makers are well stocked with orders. Inquiries are to hand from all quarters, and in some cases a very extraordinary weight of rails is required. Prices show no variation. There is a good demand for bars and billets, as well as for slabs and blooms. Arrangements are in progress for doing a large trade in shipbuilding steel, the demand for which is expected shortly to develope. Finished iron is still a very quiet business. Iron ore is in very good demand, but the market is more brisk for the superior classes of ore than for ordinary qualities. There is some talk of a new company being formed at Barrow for the manufacture of wood pulp for paper manufacture, and the arrangements for opening up a large cattle trade with America are reported to be progressing very satisfactorily.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

THE railway strike has ended, as I anticipated last week it would end, in the surrender of the men. They never had a chance, so long as neighbouring companies drafted their drivers and firemen to the assistance of the Midland, and this was done to an extent which the men themselves could never have thought of. Other railway companies were in a measure bound to help their Midland brother, for the latter were fighting their battle. Had the Midland men been able to carry their point, the struggle would have extended to the other lines, where drivers and firemen are working on precisely the same terms as the Midland men struck against. The shareholders' meeting at Derby on the 12th broke the back of the strike. Hope was entertained by the men that the general body of the shareholders sympathised with them, and that the sympathy would find expression before the board of directors. Never was hope more completely falsified. Only one shareholder ventured to express doubt of the wisdom of the directors' policy, and the few remarks he made were received with the greatest impatience—so much so, that the chairman was obliged to put it to the meeting whether they wished to hear him, and the answer was in the negative. Financially, the Midland, during the week the strike lasted, lost at the rate of £2500 a day. If the question had been merely a financial one, the policy of throwing away £2500 a day to save £950 a year would have been questionable, but the Midland directorate regarded it as one of "discipline," which is quite another matter. Many good drivers and firemen are unavoidably thrown out of situations, their places having been filled up during the strike by strangers. These men the company feel in honour-bound to retain in their service, as it was by their aid they were enabled to tide over the difficulty. The men were loyal to them, and they must be loyal to the men. At the same time there is a strong feeling that the company, now that they have won, should be as magnanimous as possible. This strike differs from almost every other strike seen in this district. Though the issues were the same, there has been no threatening or intimidation. The men have seen "foreigners" occupy their places without the slightest approach to violence or even the indication of it, and such has not been the usual course in this locality. Of the general conduct of the men it is impossible to speak too highly, but in the hour of victory the Midland directorate will do well to remember that, although the struggle was a severe one, they contended with self-respecting men who had no thought of striking beneath the belt by resorting to terrorism, which their calling would have made a particularly powerful factor in the fight.

The "Maxim" gun, a ferocious little spitfire, which I had the privilege of witnessing being tried here, is being produced in 3-pounder size. It is a most effective weapon. The Martini-Henry size must be especially effective when used at the mastheads of ships. It requires a quick, sharp touch on the button to discharge single bullets. Try as I would, the cartridges came out in volleys, and literally riddled the targets against the bank of an old colliery. Attached to infantry regiments on expeditions like that of the Soudan Campaign, the "Maxim" gun must be invaluable. The Chinese and French Governments are having several of them. This is the gun, in the smaller bore, which Mr. H. M. Stanley has taken with him in his expedition for the relief of Emin Bey.

An order for 150 steel projectiles, for our own Government, has just been completed in Sheffield. They are 33in. long, and are for 9·2in. guns. It is expected that heavy requirements on this account will shortly be placed in Sheffield.

Several trial sinkings have recently been made in South Yorkshire with the view of finding whether the Silkstone seam extends under the Barnsley seam. The results have been disappointing. In most cases the seam has been found, but too thin to be workable. This was notably the case at Aldwarke Main Colliery, near Rotherham, after sinking to the depth of over 500 yards, and at Wombwell Main Colliery, a depth of 600 yards. A short distance from Wombwell the Silkstone seam was found under conditions which led to the sinkings which have now proved so discouraging.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

BUT little business was done in Cleveland pig iron last week, and this week there is considerable disorganisation throughout the district owing to Stockton Races. At the market held at Middlesbrough on Tuesday last the attendance was scarcely up to the average, and few transactions took place. The tone was, however, no worse than on the previous market day. Merchants continue to quote 34s. 4½d. per ton for prompt delivery of No. 3 g.m.b., and and it is not easy to buy at less. Neither can large quantities be bought at that figure, sellers being just now very wary. They expect to do better when foreign consumers come into the market to purchase their winter supplies. Makers are not in pressing need of orders, and will not entertain any offer at less than 35s. per ton. Forge iron is plentiful, the market value varying from 32s. 3d. to 33s. per ton.

Stevenson, Jaques, and Co.'s current quotations are:—"Acklam hematite," (mixed nos.), 45s. per ton; "Acklam Yorkshire," (Cleveland) No. 3, 35s. per ton; "Acklam basic," 36s. per ton; refined iron, 48s. to 63s. per ton, net cash at furnaces.

Warrants are somewhat firmer than a week ago. Sellers now demand 34s. 6d. per ton, but very few sales are reported. At Glasgow, business was done on Tuesday last at 34s. 4½d. cash. Last week 34s. 2d. was all which could be obtained.

The stock of pig iron in Messrs. Connal and Co.'s Middlesbrough store continues to decrease. On Monday last the quantity held was 333,507 tons, which represents a reduction of 976 tons during the week.

Pig iron shipments from Middlesbrough have somewhat improved, but they are still behind those for June and July. Up to Monday night 32,147 tons had left the port, as against 33,650 tons during the corresponding portion of July, and 33,326 tons during that of June.

Most of the finished ironworks in Stockton and Middlesbrough are closed for the week. Manufacturers have adopted this course with less regret than usual, inasmuch as their order books are by no means full, and inquiries are scarce. Quotations remain unaltered.

The opening of the new municipal buildings of the borough of Middlesbrough, on the 9th inst., by a public dinner, was made the occasion for a discussion of the present position and future prospects of the trade of the Cleveland district. Mr. Belk, solicitor, in proposing the town and trade of Middlesbrough, thought that a great difference for the better had become discernible since a year and a-half ago. Pig iron last summer was selling at only 29s. 6d. per ton, whilst to-day the price is 5s. higher. Steel rails had, he said, risen in value from £3 10s. per ton a year ago to £4 5s. per ton now. Pig iron stocks had decreased more than 100,000 tons, which was a great matter for congratulation. A few years ago the exports from Middlesbrough consisted mainly of pig iron, whereas now ships of the largest size were sailing from the port to India, China, Japan, and the Colonies, laden not only with local manufactures, but with those of various other inland districts. During the first half of the present year, 255,000 tons had been shipped to India alone. Trade with Canada was also on the increase, large contracts having been recently made with the Dominion. A valuable order had been secured from China by Messrs. Bolckow, Vaughan, and Co., notwithstanding the competition of Germany. He anticipated a great future trade with that country as the result of the footing they had now obtained. In replying to this toast, Mr. Hanson, of the firm of B. Samuelson and Co., said that he also believed that trade was improving. House-building was again proceeding, and the new houses were occupied as soon as ever ready. The completion of the grand building in which they were assembled was a proof of the confidence of the people of the town in their future destiny. The iron trade, however, was suffering, and had been suffering for several years, from the continual substitution of steel for iron in the various processes and applications of industry. He believed that the basic process, which, if thoroughly successful, would so much benefit the district, was becoming better understood, and whilst the quality obtained thereby was improving, the prejudice against it was being gradually overcome. There was every reason to believe that as good steel for shipbuilding could be made in this way out of Cleveland ore, as out of Spanish ore by the Siemens-Martin process. The further progress of Middlesbrough depended, in his opinion, very much upon the capital and energy which might be expended in this new direction. The steel works in the immediate neighbourhood of Middlesbrough were now very fully occupied, and had difficulty in taking more orders. The one great need of the district was further mills for the manufacture of the best steel plates, angles, and other sections for which steel was being so largely used. He hoped that capitalists and men of energy would come from other districts to Middlesbrough to supply this want, and he believed they would find that steel could be made there more cheaply than anywhere else. It had been said that trade from the Tees-side town had been allowed to languish and decay for want of export facilities. He did not think that was true. Steamers of 4000 and 5000 tons were sailing from Middlesbrough every week to India, China, and Japan, markets which constituted the great future hope of their trade. That this was possible was mainly due to the Tees Conservancy Commissioners, who deserved great credit for the enormous improvements they had effected in the navigable properties of the river.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

THE Glasgow pig iron warrant market has been depressed this week. Reaching the highest point for a considerable time on Monday forenoon—42s. 10½d. cash—the price, which had been steadily advancing for upwards of a week, gave way, and the feeling of the market has since been less firm. The decline in prices is attributed to disappointment on account of the shipments of pigs in the past week turning out less satisfactorily than was anticipated. They were officially returned at 7000 tons, as compared with 7532 in the same week of 1886. But although the shipments are small, ironmasters state that orders are coming to hand in a fairly regular way. The American demand is maintained, the quantities ordered not being large, but numerous, and the total shipments to the States for the present year to date are 42,500, against 25,831 tons in the same time last year.

The current prices of makers' iron are as follows:—Gartsherrie, f.o.b. at Glasgow, per ton, No. 1, 48s. 6d.; No. 3, 44s.; Coltness, 53s. 6d. and 44s. 6d.; Langloan, 50s. and 46s.; Summerlee, 51s. 6d. and 43s.; Calder, 49s. and 42s. 6d.; Carnbroe, 44s. and 40s.; Clyde, 46s. 6d. and 41s. 6d.; Monkland, 43s. 3d. and 39s. 3d.; Govan at Broomielaw, 43s. 3d. and 39s. 3d.; Shotts at Leith, 49s. and 45s. 6d.; Carron at Grangemouth, 52s. and 44s. 6d.; Glengarnock at Ardrossan, 49s. and 43s.; Eglinton, 43s. and 39s.; Dalmellington, 44s. and 40s. 6d.

Malleable iron continues very steady, and at the moment there is a healthier appearance. Makers are getting their old prices for merchant bars more freely, while the demand for unbranded iron for the Indian market continues, and the manufacturers report an advance of 1s. per ton on the former price.

Among the papers to be read at the approaching meeting of the Iron and Steel Institute at Manchester is one by Mr. J. W. Wailes, of the Patent Shaft and Axletree Company, of Wednesbury, "On the Basic Open Hearth Process." There is reason to believe that this paper will show that the problem of how to produce basic steel in the open furnace has been successfully solved. This has been done by Mr. James Riley, manager of the Steel Company of Scotland, and it is understood that the furnace arranged by Mr. Wailes in accordance with Mr. Riley's scheme has given very good results.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

AN event of the greatest significance to the coal trade of North Wales has just taken place in the lowering of the first cylinder for the bridge that is to span the Dee. The North-Wales collieries are equal to an output of three million tons annually, and this will be brought into direct contact with the great markets of the Mersey and the salt districts of Cheshire. By a short line, joining the Cambrian Railway at Ellesmere, the bridge will also be linked to the Swansea and Merthyr coal districts, and afford a new field for the energetic management of the Cambrian. I note that the bridge, when completed, will exceed the span of every other bridge over a navigable river in the United Kingdom. The width is 480ft., and the large swing opening will give a free passage, 140ft. in width, to vessels. The moving power—hydraulic—under a pressure of 700 lb. to the inch, will open and close the bridge in 40 sec.

Next week will witness the eventful opening of the Bute Extension—the Roath Dock. The ceremony will take place on the 24th. From that date Cardiff will possess the following dock acreage:—West Dock, 18½ acres; East Dock, 46¼; Roath Basin, 12; Roath Dock, 38; timber floats, 12.

The returns now completed up to the end of June show very satisfactorily for the coal trade at Cardiff.

The coal trade during the last week has been more encouraging, and prices continue firm. Best steam is quoted at 9s. 3d. to 9s. 6d.; Rhondda, 8s. to 8s. 3d.; second steam, 8s. to 8s. 3d.; small steam, 4s. to 4s. 3d. House coal trade is very dull. I am glad to note that Mr. Beddoe has won a good addition of Mynyddyslwyn to his coalfield. This will tell when the winter season sets in.

The great subject of discussion and of complaint at the ironworks is the drought. Up to Wednesday there has been no rain of any appreciable quantity for five months, and the last month has shown a less rainfall than in any. Owing to this some of the works have been going from bad to worse, and Dowlais in particular may be said to have arrived at the last state next to a total stoppage. Some blast furnaces are going, and the mass of the workmen are being utilised in labour work, preparing ponds, &c., for additional supply. The partial stoppage of the last six weeks means that £20,000 has been kept out of circulation in the district. Present wages are from 10s. a week only, but even this entails a heavy loss on Lord Wimborne and others, the proprietors.

A valued correspondent corrects my reference to the water power at Cyfarthfa. I instanced the large fishpond as the work of a London engineer. This was not so. Mr. Barlow, the engineer in question, may have been consulted, but the pond, the whole of the watercourse in connection with the works arrangement, inflow and outflow in fact, the scheme which at the time was a feat in hydraulic engineering, was that of the chief engineer of the works, Mr. William Williams, grandfather of Mr. William Williams, the late engineer of Cyfarthfa, but who has long since retired into private life. The great work which attested the genius of the grandfather was thoroughly completed and puddled by the grandson.

The late drought has made this pond of inestimable benefit to Cyfarthfa, and the works are at full drive, and have been for some time. The coke ovens are being pressed on without an hour's delay.

The Home Secretary is showing commendable ability and tact in the passing of the Coal Mines Bill, and I hear expressions of satisfaction on all sides. The movement to have Welsh-speaking inspectors was an absurd one, and the compromise all that could be expected. The Board-school children are now getting into working age, and are fairly ignorant of Welsh altogether. Given two men of equal capacity, generally and technically, and one only of the two conversant with Welsh, then by all means appoint the Welshman. This is the most that can be expected, Sir H. H. Vivian, with whom I sorry to differ, notwithstanding.

The tin-plate trade is firm, and prevailing circumstances, such as increased demand, greater difficulty on account of short supply, of water to meet it, point to a speedy advance. During July Swansea sent away 657,000 boxes, value £419,313, or an increase over July, 1886, of 113,000 boxes. Quotations are I C cokes iron, 13s. to 13s. 3d.; Bessemer steel, 13s. 3d. to 13s. 6d.; Siemens coke coating, 13s. 9d. to 14s. 3d.; charcoal, 15s. 6d. upwards; ternes, 26s. 6d. to 28s. per double box.

Swansea Exchange was well attended by London and Liverpool buyers this week. Prevailing quotations:—Pig iron, Glasgow warrants from 42s. 5½d.; closing price, 42s. 7d.; hematite, 44s. 3d.; Middlesbrough, No. 3, 34s. 6d.; Swansea Bessemer, 48s.; Cwmavon, 48s.; Bessemer steel blooms, £4 5s.; bars, £4 15s.; Siemens bars, £5 2s. 6d.

It was reported at the Exchange that the Swansea blast furnaces are to be taken over by a Whitehaven company, and great extensions are in contemplation.

Merthyr Wireworks are being adapted to steel make.

NOTES FROM GERMANY.

(*From our own Correspondent.*)

FROM day to day the Rhenish-Westphalian iron market assumes a more cheerful aspect, and nearly in every branch is the tone a firm one, the demand is everywhere active, and the prices have a rising tendency. The progressive improved condition of the American market has begun to tell favourably here, the first branch to be agreeably affected being that of wire rods. Siegener iron ores have again risen a trifle in price, and of late the demand has been very brisk. The quotations are from M. 8·30 up to 11·80 for calcined steel stone. Luxemburg ores, on the contrary, have declined a little, which is strange, because the last of the great smelting works has just now joined the combination, and crude iron, in consequence, was advanced by 1f. p.t. The consumption of pig iron has latterly decidedly increased, particularly of forge sorts. Consequently prices are firm and rising. Stocks scarcely increased at all in the month of June, while some works are sold forward till December next. Spiegel and steel-iron are again in request for export, and somewhat higher prices have been accorded by buyers for it. Foundry iron is unchanged in demand and price, while Bessemer and basic are in great request, especially the former. Spiegel of 10 to 12 p.c. Mn. is noted at M. 50 to 51; steel iron, 44; best forge brands, 44 to 45·50; Bessemer, 50 to 51, paid; Luxemburg, 34 to 34·50; and foundry, 49 to 55 p.t. on trucks at works station. The rolling mills are all well and satisfactorily employed, especially in bars and sectional sorts, and the prices obtained leave a profit with which masters are satisfied as things go. Orders are not so numerous as before the Sales Syndicate came into operation, but that is attributable to such large lots having been placed anticipatory of this circumstance. The Saar group of rolling mills—the chief girder rollers on the Continent—refuse to join the three other syndicates of Berlin or Silesia, Hanover or Middle Germany and Dortmund, or the Westphalian group, but it is willing to come to some sort of arrangement to regulate base prices. In boiler and thick plates the works are sufficiently supplied with specifications, and the thin sheet mills are specially busy, so there was no difficulty in moving up the ground price to M. 135 p.t., the less so as a new convention for all the Siegerland and Westphalian mills has been agreed upon. These conventions, which really only can be called makeshifts till better times come round again, still seem the only means available to prevent ruinous underselling, so now one is on the carpet for wire rods. However, so far it is certain that the wrought iron sales bureaux have led to an advance in crude iron, and this, added to the anticipated large demand for wire rods from America, where they have gone up in price, is certainly favourable to the formation of such a syndicate, and, in fact, rods have gone up a trifle already in anticipation. The steel works have plenty of orders for some time to come, but for the most part more on the smaller railway requisites than on rails, for not many new tenders for the latter have been issued lately. The wagon trade is unchanged and dull, and only a small order for the State at Strasburg has been lately given out. The foundries, machine shops, and construction works are in many cases vere well off for work. Last month brought the brass founders very numerous orders for inland and abroad, so that many foundries are quite fully occupied for three months to come, and others are flooded with orders, and this in spite of Russia and Austria, through the new high tariffs, being closed to this country. In several cases higher prices have been realised than were last noted.

The current iron and steel prices are, for merchant bars M. 115, base price; rolled girders, 113 and higher; hoops, 110 to 116; steel billets, 112 to 125; boiler plates, 5½ mm. and above, 150; heavier sorts, 155 to 160; sheets, 135; iron wire rods, 109 and higher; steel ditto, 108; drawn iron wire, 127·50; steel ditto, 125 and higher; steel rails, 110 to 120; and light steel ditto, 110 p.t.

If there be any foundation for what the leading journal here for iron and steel interests asserts, namely, that the users of iron in Japan, China, India, and South America are beginning to find out that German bar iron is of better quality than that now nearly exclusively imported from England, and that the people of those countries will in future apply to Germany for their requirements, it behoves English makers and shippers to be on the alert, and only send out best qualities, for in that case these people, in working up the iron, will soon learn that it is far more uniform in quality and more agreeable to work than that made here, and will produce less waste, besides being unquestionably rolled and more pleasing to the eye, and price for price, no doubt England need not fear the competition as to quality.

The Belgian iron market continues very firm, but merchant iron is not in such brisk request as it was, and therefore it has been settled not at present to raise the official notations; but this is not the case with plates, as the prices are already enhanced, and buyers, accepting the situation, pay them without murmuring. Pig iron is very firm, and most works have sold their output up to the end of the year. The steel works are fully occupied, but on small parcels, as lately no large contracts have been closed. The prices of rails are depressed wherever competition arises. With the exception of the wagon factories, all other constructive works and shops are well situated.

The French iron market is still without life, demand is absent, and the prices make no attempt at rising. Girders, however, go off well, and stocks at Paris are almost exhausted; nevertheless, no higher prices than 125f. for them, and 135 for merchant bars can be achieved. The most favourable that can be said, is that prices have become a trifle firmer. Old rails cost 80f. p.t.; coke iron, 135.; mixed sorts, 145; foundry pig, 63 to 67·50; wire rods, 145 to 150. These prices are in the Haute-Marne district, where the works are still slack of orders. The coal trade is dull.

A rather original part of the ovation which has been offered to the Queen of Spain at Bilbao, during her progress in the Asturias, was a pyramid of iron ore, containing 10,000 tons, which represents the daily quantity shipped abroad from that port.

NEW COMPANIES.

The following companies have just been registered:—

Sewage Incineration Company, Limited.

Upon terms of an agreement of the 5th ult., this company proposes to purchase from Richard de Soldenhoff, of Cardiff, the letters patent No. 2721, dated 24th February, 1886, granted for improvements in furnaces for the desiccation, incineration, and carbonisation of precipitants or solids, resulting from sludge, and other substances liable to putrify, also the letters patent Nos. 12,259 and 7482, dated respectively the 27th September, 1886, and 23rd May, 1887, also for treatment of sewage and substances arising therefrom. The company was registered on the 4th inst., with a capital of £100,000, in £5 shares. The purchase consideration is £150 cash, and one-fifth of the first and subsequent issue of share capital. The company will also pay Messrs. Elers, Barrett, and Wills, of Vauxhall, the sum of £1000 for expenses in relation to certain experiments carried on by them at Leyton. The first issue is not to be less than £5000 of nominal capital. The subscribers are:—

	Shares.
*R. de Soldenhoff, Cardiff, engineer	1
*G. F. Wills, Crewkerne, surgeon	250
*H. Barrett, Menival, North Dulwich, merchant	250
*C. G. Elers, 87, Wandsworth-road	250
C. G. Elers, 6, Kensington-court	1
J. A. Archer, Waverley, Lordship-lane, S.E., merchant	250
H. G. Barrett, Menival, North Dulwich, merchant	1

The number of directors is not to be less than three, nor more than seven; qualification, 100 shares; the first are the subscribers denoted by an asterisk. Mr. R. de Soldenhoff is appointed managing director, and as remuneration for his services he will be entitled to £7 per annum per furnace if the number shall exceed 100 furnaces, and £5 per furnace if the number exceeds 200. The remuneration of the other directors will be 10 per cent. on the ascertained net annual profits.

Carter, Paterson, and Company, Limited.

This is the conversion to a company of the business of Carter, Paterson, and Co., general carriers and forwarding agents, of 128, Goswell-road. It was constituted by articles of association on the 15th ult., and registered as a limited company on the 8th inst., with a capital of £250,000, in 2500 shares of £100. 1362 shares are taken up, and are fully paid. The following is a list of the shareholders:—

	Shares.
*Walter Carter, 128, Goswell-road, general carrier and forwarding agent	388
*James Paterson, 128, Goswell-road, general carrier and forwarding agent	582
*Robert Paterson, 128, Goswell-road, general carrier and forwarding agent	388
J. J. Paterson, 128, Goswell-road, assistant manager	1
H. R. Paterson, 128, Goswell-road, accountant	1
H. W. Allen, 128, Goswell-road, traffic manager	1
Wm. Martin, 128, Goswell-road, veterinary surgeon	1

The number of directors is not to be less than three, nor more than seven; qualification, £2500 in shares or stock; the first three subscribers are directors. Each director will be entitled to an attendance fee not exceeding £1 1s. per meeting, and to such further remuneration as the company in general meeting may determine. Messrs. James Paterson and Robert Paterson are appointed managing directors at salaries of £3000 per annum and £2000 per annum respectively.

Chamberlain Explosive Syndicate, Limited.

This syndicate was registered on the 6th inst., with a capital of £1000, in £20 shares, to acquire certain inventions referred to in an unregistered agreement of the 5th inst., between Wm. Tyler Chamberlain and F. G. Hewitt. The subscribers are:—

	Shares.
W. T. Chamberlain, Tranter's Hotel, Bridgewater-square, E.C.	1
*G. Withers, Warnford-court, E.C.	1
T. G. Hewitt, 89, Cambridge-gardens, W.	1
E. Farman, 39, King-street, Cheapside, solicitor	1
H. M. Hewitt, 39, King-street, Cheapside, solicitor	1
G. A. Grindle, 19, Great Winchester-street, electrical engineer	1
T. Pinks, 152, Spa-terrace, S.E., clerk	1

The number of directors is not to be less than three, nor more than five; Mr. George Withers is appointed a director, and may appoint two other shareholders; qualification, £20 in shares or stock; remuneration, £100 per annum.

Del Norte Gold Mining Company, Limited.

On the 5th inst. this company was registered, with a capital of £660,000, in £1 shares, to carry on mining operations in the United States of America, and for such purpose to enter into an agreement with the Little Annie Gold Mining Company. The subscribers are:—

	Shares.
*M. M. Moore, 6, Lombard-street, merchant	1
*William Lloyd, C.E., 19, Finchley-road, N.W.	1
*Peter Penn Gaskell, J.P., 31a, South-street, Park-lane	1
J. H. Maughan, 83, Lombard-street, banker	1
G. L. Outram Davidson, 11, Sydney-place, Onslow-square, merchant	1
G. T. West, 83, Lombard-street, clerk	1
C. B. Brodie, 4, Queen Anne-grove, Bedford Park, merchant	1

The number of directors is not to be less than three, nor more than ten; qualification, £250 in shares or stock; the first are Sir Samuel Canning, C.E., and the first three subscribers; remuneration, £250 per annum each, and £150 additional for the chairman.

J. C. and J. Field, Limited.

This is the conversion to a company of the business of wax bleaching, stearine making, ozokerit refining, and the making of candles, soaps, sealing wax, &c., carried on at Upper Marsh, Lambeth, at Wellington-road, Battersea, at Bermondsey New-road, and at West Molesey, by J. C. and J. Field. It was registered on the 10th inst., with a capital of £200,000, in £10 shares, with the following as first subscribers:—

	Shares.
*H. E. Hunt, C.E., 1, Hyde Park-gate	500
J. E. Bentley, 9, Beaumont-crescent, West Kensington	500
A. L. Alderson Woodhouse, Surbiton	500
H. G. Barnard, M.A., 167, Westminster Bridge-road	400
Mrs. Augusta Annie Field, 5, Edge-hill, Wimbledon	500
F. J. Williams, County-grove, Camberwell	200
*P. Bicknel, 89, Newington Butts, merchant	500
*G. Maule, 154, Albany-street, merchant	500
E. C. Nicholson, Carlton House, Herne Hill	200
Mrs. E. Nicholson, Heathcroft, Wandsworth Common	300

The number of directors is not to be less than three, nor more than seven; the first are the subscribers denoted by an asterisk and E. J. Stephens and C. Leopold Field, of 15, Upper Marsh, Lambeth, who are appointed managing directors at a salary of £750 per annum each; remuneration of the other directors, £700 per annum; qualification, 100 ordinary shares.

Automatic Gas Machine Company, Limited.

On the 10th inst. this company was registered, with a capital of £6500, in £5 shares, to light streets, buildings, ships, railways, tramways, and other places, by means of automatic and other gas machines, or similar agency, and for such purposes to carry into effect an agreement of the 8th inst. with Hy. Brinsley Sheridan and Edward Rawlings, of 3, Victoria-street, S.W., for the purchase of their patent rights in respect to an invention for improvements in apparatus for the manufacture of gas. The purchase consideration is £1000 cash and 700 fully-paid shares. The subscribers are:—

	Shares.
*Hy. Barrett, 87, Wandsworth-road, merchant	1
R. H. Harland, 37, Lombard-street, analytical chemist	1
J. S. Pirrie, 2, Victoria-mansions, consulting engineer	1
C. G. Elers, 87, Wandsworth-road, merchant	1
*J. B. Marten, Victoria-mansions, merchant	1
*J. Macteur, F.C.S., 2, Victoria-mansions, chemical expert	1
*Edward Rawlings, 3, Victoria-street, S.W., surveyor	1

The number of directors is not to be less than three, nor more than seven; the first are the subscribers denoted by an asterisk; remuneration, 10 per cent. per annum of the net profits.

Basic Phosphate Company, Limited.

This company proposes to trade as crushers of slag and other minerals and materials, manufacturers of chemical and other manures, mortar cement, fettling material, and iron and steel. It was registered on the 12th inst., with a capital of £10,000, in £50 shares. An unregistered agreement of the 1st inst. between the Carlton Iron Company, Limited, of the first part, Walter Morison of the second part, and Wm. Barclay Peat of the third part, will be adopted. The subscribers are:—

	Shares.
*T. Kirk, Preston-on-Tees, *viâ* Darlington, ironmaster	1
W. Gowan, Whitehaven, timber merchant	1
*R. Morris, Doncaster, manufacturing chemist	1
W. R. Morris, Doncaster, manufacturing chemist	1
*W. Morrison, Leeds, landed proprietor	1
*E. W. Swan, Middlesbrough, iron merchant	1
A. A. Swan, Middlesbrough, iron merchant	1

The number of directors is not to be less than three, nor more than five; the first are the subscribers denoted by an asterisk. The company in general meeting will determine remuneration.

Cordoba Central Railways Company, Limited.

This company was registered on the 11th inst., with a capital of £600,000, in £20 shares, to construct a railway in the province of Cordoba, in the Argentine Republic, in conformity with a Government concession, dated November 3rd, 1885, and for the purpose of acquiring the rights of the concessionaire—subject to certain reservation—to enter into a contract with Messrs. John G. Meiggs, Son, and Co., contractors. The subscribers are:—

	Pref. Shares.
Sir Gabriel Goldney, Bart., 27, South-street, Park-lane	50
P. Norman, 12, Harrington-gardens, South Kensington	50
T. Wood, 2, Maudwell-road, Portman-square	50
C E. Gunther, 9, Fenchurch-avenue, merchant	50
Sir G. Russell, Bart., M.P., Reading	50
J. H. Duncan, 4, Coleman-street, chartered accountant	1
J. J. Hamilton, 12, The Avenue, Brondesbury	1

The number of directors is not to be less than three, nor more than seven; qualification, £1000 of share capital; the subscribers are to nominate the first; remuneration, £1400 per annum, with an additional £200 in the event of there being more than six directors.

Schanschieff Electric Battery Company, Limited.

This company was registered on the 10th inst., with a capital of £25,000, in £250 shares, to purchase, upon terms of an agreement of the 8th inst., between Alexander Schanschieff, David Marks, and Sidney Cronin, of the first, second, and third parts respectively, certain letters patent for the United Kingdom granted for improvements in galvanic batteries, and in saline and other preparations for use in connection therewith; and for improvements in miners' safety lamps, and with galvanic batteries therefor; and for an invention for enabling miners to detect the presence of fire-damp. The company further proposes to acquire patent rights for certain of the said inventions granted for foreign countries and the East Indies. The subscribers are:—

	Shares.
David Marks, 4, Cornwall-mansions, South Kensington	1
L. H. Samuell, Bushey, Herts	1
T. N. Oakey, 2, Copthall-buildings, E.C.	1
S. Hoffming, 102, Fore-street, merchant	1
S. de Lissa, 18, Queen Victoria-street, merchant	1
H. A. Trower, Goring-on-Thames, merchant	1
H. Eskell-Paget, 58, Ludgate-hill, surgeon dentist	1

Messrs. David Marks and Alex. Schanschieff are the first directors; qualification, one share. The company in general meeting will determine remuneration.

THE PATENT JOURNAL.

Condensed from the Journal of the Commissioners of Patents.

Application for Letters Patent.

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

9th August, 1887.

10,881. Moulds, R. Warwick, Plaistow.
10,882. Crushing Mill, G. J. Atkins, London.
10,883. India-rubber Soles for Boots, M. Frankenburg, Leicester.
10,884. Sectional Horseshoes, J. E. and E. W. Bingham, London.
10,885. Long Fillings for Cigars, O. Hammerstein, London.
10,886. Gas and Coal Range, &c., H. C. Turner, London.
10,887. Cutting Files, G. King, Keighley.
10,888. Ejector Mechanism, W. H. Brighton, Birmingham.
10,889. Stopping Rollers of Spinning Machines, G. H. Holden, Manchester.
10,890. Beverage, T. Needham, Halifax.
10,891. Carding Machines, J. Tattersall, jun., Pendleton.
10,892. Anti-poison Stopper, T. C. Lovewell and J. Yonge, Brighton.
10,893. Separating Iron from other Substances, M. H. Smith, Halifax.
10,894. Weft Brake for Looms, &c., E. Fielden, Manchester.
10,895. Stays for Hinged Window-sashes, I. H. Anderson, Glasgow.
10,896. Mounting Bodies of Vehicles, W. A. Colclough, London.
10,897. Gas Motors, A. J. Boult.—(*P. J. McMahon, United States.*)
10,898. Cement for Asphalte Walks, &c., E. Keirby, London.
10,899. Lock, H. Agar, London.
10,900. Soda, J. B. Thompson, London.
10,901. Steam Washing-machine, S. Hardley, New Zealand.
10,902. Locks, E. E. Deacon, London.
10,903. Floating Anchors, J. Waters, London.
10,904. Disposal of Sewage, A. H. Curling and J. Dunbar, London.
10,905. Channel Torpedoes, H. Echberg, London.
10,906. Spring Wheels, R. Edwards, London.
10,907. Covered Buttons, G. Heidman, E. Höttges, and C. Egen, London.
10,908. Pumping, &c., Apparatus, S. Seccombe, London.
10,909. Cash Carriers, H. J. Haddan.—(*L. G. Bostedo, United States.*)
10,910. Attachments for Ploughs, H. J. Haddan.—(*J. Oliver, United States.*)
10,911. Securing Rails in their Chairs, F. Moore, London.
10,912. Removing Snow in Public Places, H. John, London.
10,913. Permanent Way of Railways, J. R. McCartey, London.
19,914. Umbrella Frames, F. A. Ellis, London.
10,915. Drying Fruit, H. H. Lake.—(*H. C. Andrews, United States.*)
10,916. Chronometer Escapements, P. T. A. Rodeck, London.
10,917. Drying Fruit, H. H. Lake.—(*T. C. Oakman, United States.*)
10,918. Refining Copper Regulus, F. W. Dähne, London.
10,919. Plates for Secondary Batteries, E. Jones, London.
10,920. Measuring Water and other Fluids, R. H. Twigg, London.
10,921. Curtain Ring Clip Suspender, F. Moore, London.
10,922. Igniting Fuses, C. Roth, London.
10,923. Horseshoes, C. J. Jutson and F. A. Poupard, London.
10,924. Surgical Water Bandages, H. W., C. F., and J. Sitwell, Richmond, U.S.
10,925. Water-closets, A. R. von Fuchs-Bánrét, London.
10,926. Lining, Painting, or Coating Tanks, &c., P. Molyneux, London.
10,927. Starting Vehicles, J. A. Ahlin, London.

10th August 1887.

10,928. Absorbso Square, V. Bailey, London.
10,929. Acme Tilter, T. Hemingway, Leeds.
10,930. Clock Indicator for Measuring, P. Brimelow,
10,931. Drying Cylinder, W. Hutchinson, Weaste.
10,932. Mounting of Under Carriages for Gigs, &c., J. Williams, Wigan.
10,933. Insulating Electric Currents, D. S. Robertshaw and R. F. Sunderland, Halifax.
10,934. Gas Burners, W. W. Warrington, Glasgow.
10,935. Automatic Indicators or Alarms, F. C. Lynde, Manchester.
10,936. Drilling Boiler Rings, S. Dixon, Manchester.
10,937. Automatic Self-adjusting Soft Inodorous India-rubber Pad for the Relief of Hernia, F. H. Gurney, London.
10,938. Rack Pulley, W. J. Oakes, Aston.
10,939. Splices of Leather Belting, J. K. Tullis and W. R. Malcolm, Glasgow.
10,940. Lamps for Gas Brackets, J. Everard, Birmingham.
10,941. Oiling Fly-wheel Necks, &c., of Steam Engines, W. Crossley, London.
10,942. Treating Sewage, H. C. Bull and Co., and H. C. Bull, London.
10,943. Heating Railway Carriages, &c., H. Cornes, London.
10,944. Bolts, Latches, N. G. Kimberley, London.
10,945. Mathematical Instruments, R. H. and G. W. B. Edwards, London.
10,946. Preparing Fabric to Receive Embroidery, J. Hammett, London.
10,947. Perforating Attachments for Type Writers, A. Hamburg, London.
10,948. Preservation of Fruit, W. F. Reid, London.
10,949. Heating Water for Baths, G. Brey and E. Willame, London.
10,950. Closing Doors and Preventing Slamming, J. H. Bean and W. Gaines, London.
10,951. Driving Tools for Screw Nails, &c., J. E. Commerell and J. Rock, London.
10,952. Dynamo-electric Machines, L. Anspach and L. Gerard, London.
10,953. Stand for Tooth Brush, &c., F. W. Warrick, London.
10,954. Producing Currents of Air, A. J. Boult.—(*F. Bisson, France.*)
10,955. Obtaining Ammonia, &c., L. Mond, London.
10,956. Automatic Fire Extinguishers, T. Witter, Liverpool.
10,957. Treating Solids by Gases, L. Mond, London.
10,958. Draught Bungs for Beer Kegs, T. N. Curtis, E. W. Hatch, M. B. Burns, and J. P. Turnbull, London.
10,959. Table for Card Playing, G. Colditz, London.
10,960. Connection with Direct-acting Steam Pumps, J. Ross and A. Telfer, Newcastle-on-Tyne.
10,961. Knitting Machines, J. H. Stott and A. Grimshaw, Manchester.
10,962. Automatically Displaying Advertisements, C. E. Meredith, London.
10,963. Measurement of Electric-motive Force and Power, J. A. Fleming and C. H. Gimingham, London.
10,964. Sewing Machines, S. A. Rosenthal, London.
10,965. Steam Boiler and other Furnaces, B. Finch, London.
10,966. Treatment of Hydrochlorate of Ammonia, T. Schloesing, London.
10,967. Power-gear for Glaziers' Lead Drawing Vices, F. Knoeferl, London.
16,968. Portable Cranes, P. Alrig, London.
10,969. Roofing Tiles, W. S. Akerman, London.
10,970. Reproducing Sounds, W. S. Simpson and W. S. Oliver, London.
10,971. Holdfast Egg Tongs, J. T. B. Bennett, Lozells.

11th August, 1887.

10,972. Burning Oil for Heating Purposes, J. W. Newall, London.
10,973. Iron Heels, &c., S. Pooley, jun., Norwich.
10,974. Revolvers, A. Arbenz.—(*Messrs. Pirlot and Fresart, Belgium.*)
10,975. Adjustable Couches, I. Chorlton and G. L. Scott, Manchester.
10,976. Furnaces or Heating Apparatus, J. B. Hannay, Glasgow.
10,977. Finishing Woven Fabric, G. Urbain, Manchester.
10,978. Valves or Taps, S. Bennett and R. G. Brooke, Manchester.
10,979. Separating Silk, &c., from Wool, W. Marriott, London.
10,980. Canopies of Stove Grates, C. H. Perrot and A. Habershon, Rotherham, and C. Richmond, Masbrough.
10,981. Armour for Ships, &c., J. H. Lamprey, London.
10,982. Water Heater, B. R. Phillipson, Dublin.
10,983. Frames of Mattresses, S. Wilkes and S. H. Wilkes, Birmingham.
10,984. Metallic Fire Tongs, G. Smart and J. S. Parker, Birmingham.
10,985. Fog Signals, J. Lorraine, London.
10,986. Mechanical Figures for the Delivery of Goods, J. Maxfield, London.
10,987. Ready Reckoning Apparatus, J. Maxfield, London.
10,988. Covered Buttons, G. Heidmann, E. Höttges, and C. Egen, London.
10,989. Screw Stoppers for Bottles, H. Barrett and J. J. Varley, London.
10,990. Bolts, F. Henson, London.
10,991. Heads and Lids for Caustic Drums, &c., J. H. Plant, Liverpool.
10,992. Treatment of Cotton Seed, W. H. Stead, Liverpool.
10,993. Lubricant, W. M. Simpson.—(*Roberts, Simpson, and Co., Nova Scotia.*)
10,994. Extracting Black Colouring Matter from Pepper-corns, A. Dunderdale, Liverpool.
10,995. Working the Valves of Steam Engines, &c., H. R. Procter, Liverpool.
10,996. Checking Time, L. E. Scafe, London.
10,997. "The Juvenile Derby," R. McL. Young, Upton.
10,998. Pressing Bricks, &c., J. S. Pullan, H. Tuke, and R. Lancaster, London.
10,999. Blasting Cartridges, J. Boag, Glasgow.
11,000. Cure for Burns, C. Schuttyser, London.
11,001. Maintaining Fluid Circulation for Ventilation, &c., J. Gamgee, London.
11,002. Washing and Wringing Machine, D. Hutchins and G. Knowling, Kew Bridge.
11,003. Regulating the Supply of Air to Reservoirs, F. W. Crossley, London.
11,004. Electrical Propulsion of Tram-cars, M. H. Smith, London.
11,005. Automatic Lubricators, J. Bruun, London.
11,006. Pumps, R. Haddan.—(*A. Mosser and L. Chiari, France.*)
11,007. Staircase Lift, C. R. Bonne.—(*J. M. Plessner and F. Wolters, Germany.*)
11,008. Wire Rope, H. H. M. Smith.—(*A. S. Hallidie, United States.*)
11,009. Sewing Machines, J. Moss and C. B. Hunt, London.
11,010. Spring Roller Blinds, J. Mitchell, London.
11,011. Adjustable Photographic Tripod Stands, T. J. Collins, London.
11,012. Umbrella and Sunshade Bands, J. Hicks, London.

12th August, 1887.

11,013. Starting Tram-cars, &c., T. Charlton, Newcastle-on-Tyne.
11,014. Gravitation Railways, R. Thornton, South Shields.
11,015. Self-inking Writing Instrument, W. H. Lucas and W. T. and A. H. Morgan, Kew.
11,016. Button Fasteners, W. W. Tambs, Aston.
11,017. Taking-up Motions of Looms for Weaving, J. Leeming, Halifax.
11,018. Automatic Running Rein or Bridle and Nose-bag for Horses, G. P. Lempriere and J. H. Reddan, Birmingham.
11,019. Driving Machinery, F. Holgate and C. Fox, Burnley.
11,020. Wire-drawing Machinery, G. Christie and A. Dunlop, Glasgow.
11,021. Receptacle or Cases for Small Articles, F. Iles, Birmingham.
11,022. Valve for Water or other Fluids, T. Nixon, Sheffield.
11,023. Pin and Needle Case, S. R. Gold, Glyn-y-Coed.
11,024. Lubricating Oil, G. Gourlie.—(*T. Bell, Auckland.*)
11,025. Ore Separators, J. Coombs, London.
11,026. Connections for Cast Iron Pipes, B. R. Phillipson, Dublin.—*11th August*, 1887.
11,027. Frost Shoe for Preventing Horses from Slipping, R. Lamb, Yorkshire.
11,028. Ashes, Pans, and Cinder-sifters, E. Taylor, Blackburn.
11,029. Carding Machines, S. D. Keene, Providence, U.S.
11,030. Combination Bit for Horses, C. MacMahon, London.
11,031. Preserving Whole Meal Wheat, &c., G. W. Charter, London.
11,032. Pentograph Drawing Instrument, J. Reid, London.
11,033. Portable Letter-copying Press, F. Fanta, London.
11,034. Automatic Fountain, T. Sutherst, London.
11,035. Filters, R. Clayton, London.
11,036. Internally Stoppered Bottles, F. Foster, London.
11,037. Brush for Gin Saws, R. F. Spangenberg, London.
11,038. Washing Machines, A. J. Boult.—(*A. Aurich and A. Renger, Bohemia.*)
11,039. Preventing the Passage of Wind, &c., Beneath Doors, J. and R. W. Kenyon and J. Barnes, Manchester.
11,040. Medicinal Baths, T. Cooke and W. H. Boyens, London.
11,041. Lithographic Stones, R. Edwards, Liverpool.
11,042. Biers or Hearses, J. Lewis, Liverpool.
11,043. Spinning Wool, &c., J. J. Delmar, F. E. Tucker, and F. How, London.
11,044. Boxes and Stop-cocks, B. Waldron, London.
11,045. Window Fastenings, A. E. Harris and H. J. Luckock, London.
11,046. Inkstand, W. H. Milnes, London.
11,047. Couplings of Shafts, &c., of Four-wheeled Vehicles, J. G. Maythorn and G. O. Gooday, London.
11,048. Tramway Crossings, J. Kincaid and J. E. Waller, London.
11,049. Coat, W. Abbott and E. H. Mitchell, London.
11,050. Purifying Water, G. E. Stead and T. W. Duffy, London.
11,051. Preserving Alimentary, &c., Substances, G. F. Redfern.—(*A. Mosser and L. Chiari, France.*)
11,052. Tramway Vehicles, O. Ber and F. Walton, London.
11,053. Collapsible Boats, C. Henderson, Glasgow.
11,054. Communicating by Electricity between Trains, L. J. Albouy, London.
11,055. Signalling, P. R. Derriman, London.
11,056. Paper, J. L. Lewis, London.

11,057. Tool for Seizing Fibres, &c., C. Charpentier, London.
11,058. Musical Spinning Tops, J. S. Wallace, London.
11,059. Automatic Weighing, &c., Machines, H. L. Bucknall, London.
11,060. Automatic Deliverer Machines, M. Alexander-Katz, London.
11,061. Automatic Sale Machines, M. Alexander-Katz, London.
11,062. Automatic Feed Lubricators, R. Haddan.—(*M. Lindner, Germany.*)
11,063. Pianofortes, W. A. Bonella, D. S. and W. Witton, and E. H. G. Palmer, London.

13th August, 1887.

11,064. Cigarette or Cigar Holder, &c., A. Berkeley, London.
11,065. Bolt Fastener for Connecting Driving Belts, I. Jackson, Glossop.
11,066. Joint Connections of Tubulous Steam Boilers, C. C. S. Knap, Birmingham.
11,067. Construction and Working of Electric Railways, J. M. V. Money-Kent and S. Sharp, London.
11,068. Paint Restorers, &c., J. J. Speakman, London.
11,069. Endless Tobogganing Slide, Sloping Railway, and Skating Decline Elevated by Power, W. H. Duncan, Coalbrookdale.
11,070. Paradox Boiler, A. E. and E. Brayshay, London.
11,071. Tin-roller Brake Apparatus for Mules, C. V. Haworth, Manchester.
11,072. Screw Stocks, E. Engels and B. Wesselinaim, Manchester.
11,073. Instruments for Steering Steamers, &c., W. Alexander, Liverpool.
11,074. Railway Rails, R. W. Stavers, Newcastle-on-Tyne.
11,075. Marking Designs, &c., on Frames, J. M. Landou, London.
11,076. Superseding the use of Paper and Wood for Lighting Fires, H. Eldridge and E. Robottom, London.
11,077. Steam Pumps, J. Murrie, Glasgow.
11,078. Securing Sheets of Zinc, &c., to Roofs, T. R. Shelley, Smethwick.
11,079. Regulating the Tension of Woven Wire and other Mattresses, A. L. Bayley, Birmingham.
11,080. Drying Wheat, &c., after being Washed, B. A. and C. A. Baxter, London.
11,081. Mechanism for Placing Cop Tubes upon Spindles, J. B., G., and J. B. Swailes, London.
11,082. Strap Fastener or Buckle, A. Entwistle and W. Farnworth, London.
11,083. Calculators, C. Holmström, London.
11,084. Railway Signalling Apparatus, J. P. O'Donnell, New Malden.
11,085. Gas Regulators, S. and J. Chandler, London.
11,086. Adjustable Brackets for Bedsteads, &c., A. Westwood and W. A. Fenn, London.
11,087. Guiding Horses, W. Kennedy, London.
11,088. Gag Snaffle Bridles, W. Kennedy, London.
11,089. Wheel of Siren Breakwater, G. E. Skliros, London.
11,090. Lathes for Cutting Screws, N. K. Cherrill, London.
11,091. Friction Couplings Governed by Electricity, J. S. Raworth and H. M. Sayers, London.
11,092. Milk Pan, J. Llewellin, London.
11,093. Pneumatic Dredgers, W. Clark.—(*J. and E. Vernaudon, France.*)
11,094. Stone Breakers, J. A. Radley, London.
11,095. Adjustable Spanners or Wrenches, H. H. Lake.—(*W. E. Taft, United States.*)
11,096. Driving Gear for Velocipedes, P. A. Laurent, London.

15th August, 1887.

11,097. Buffers for Railways, &c., W. Parker, Sheffield.
11,098. Supplying Feed-water to Boilers, R. W. Hewett, Handsworth.
11,099. Tie-holder or Clip, J. J. Williams, London.
11,100. Letting-off Motion of Power Looms, J. Murgatroyd, Batley.
11,101. Spinning Wool, &c., S. B. Barker.—(*R. Gill, United States.*)
11,102. Fire Extinguishers, A. J. Jarman, London.
11,103. Fixing all kinds of Framing, F. W. Jones, Cardiff.
11,104. Machines for Drawing Corks, W. Vaughan, Birmingham.
11,105. Turning Over Leaves of Music, J. Sample, Newcastle-upon-Tyne.
11,106. Chimneyless Burner, H. Lucas, Birmingham.
11,107. Cupboards for Clothes, D. J. Luard, Paris.
11,108. Stopper for Mineral Water Bottles, W. H. Purchase, Redhill.
11,109. Preventing Smoky Chimneys, J. H. Carrett, Leeds.
11,110. Gloves, W. Adkins, Birmingham.
11,111. Lock Nuts for Bolts, &c., W. C. Lockwood and H. Carlisle, Sheffield.
11,112. Couplings for Wire-lined Hose, J. Moseley and B. Blundstone, Manchester.
11,113. Spindles, M. Lawton, Birmingham.
11,114. Lighting Cigars, &c., E. E. Atkins, Birmingham.
11,115. Lubricant, W. P. Kelly, London.
11,116. Trouser Stretcher, D. C. A. Thatcher, London.
11,117. Frost Shoe, R. Lamb, Ossett, R.S.O.
11,118. Self-acting Window Blind Apparatus, W. H. Nisbet and W. W. Virtue, Glasgow.
11,119. Axes, &c., J. Guest, Birmingham.
11,120. Matches and Pipe Lighters, T. W. Newey, Birmingham.
11,121. Hoisting Hook, B. J. Diplock and L. B. I. Hamilton, London.
11,122. Type Writers, G. Royle, Birmingham.
11,123. Dry Closets, D. McGregor, J. McArthur, jun., and J. Morrison, Glasgow.
11,124. Cyclostyle Printing Frame, G. F. Metcalfe, Leytonstone.
11,125. Tubular Steam Boilers, R. Mudgemarchant and J. R. Brushett, London.
11,126. Regulating the Temperature of Enclosed Spaces, O. G. Ladelle, London.
11,127. Teapots, &c., T. Cooke and W. H. Boyens, London.
11,128. Safety Lamps, J. Foster and J. S. Caldwell, Liverpool.
11,129. Electro-magnetic Telephones, H. Collett, London.
11,130. Self-feeding Eyeletting Machines, J. M., J. A. J., and S. A. Gimson, Leicester.
11,131. Lock-nuts, F. J. Talbot, Sheffield.
11,132. Multiple Bolts and Fastenings, F. J. Talbot, Sheffield.
11,133. Boiling Water, &c., during Sleep, R. Murrell, London.
11,134. Repeating Watches, H. O. Stauffer, London.
11,135. Designs in Imitation of Wood-cuts, H. Bogaerts, London.
11,136. Imitation Steel Engravings, H. Bogaerts, London.
11,137. Gas Motor Engine, F. W. Crossley and H. P. Hold, London.
11,138. Railway Couplings, G. W. Wilson and O. G. Wall, London.
11,139. Air-compressers, R. Johnson, Manningham.
11,140. Toothed Cylinders, H. le G. Moulton and W. H. Clarkson, London.
11,141. Steam Generators, H. H. Lake.—(*W. E. Kelly, United States.*)
11,142. Casting Metal Bars, H. H. Lake.—(*B. Atha, United States.*)
11,143. Pulling Hairs from Skins, E. Schroeder, London.
11,144. Safety Valves, L. S. Dulac, London.
11,145. Miniature Billiard Tables, &c., J. Köstner, London.
11,146. Screen, R. W. Boyd, London.
11,147. Work Basket, D. Hart, London.
11,148. Points for Tramways, J. Kincaid, London.
11,149. Reflectors, J. and E. Castle, and E. Braithwaite, London.
11,150. Brakes for Vehicles, H. H. Lake.—(*L. Rouvaux, Belgium.*)
11,151. Electric Arc Lamps, J. L. Wolfgang and F. Grünwald, London.

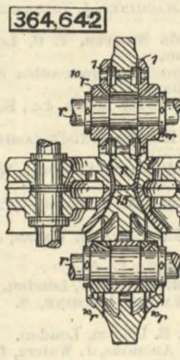
SELECTED AMERICAN PATENTS.

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

364,642. Rolls for Rolling Railway Ties, *Francois X. Georget, St. Louis, Mo.—Filed March 26th, 1886.*

Claim.—(1) A set of rolls for rolling railway ties, with passes of the respective shapes shown in the accompany drawings, and therein numbered from 1 to 17 inclusive, substantially as described. (2) The herein-described intermediate rolls with passes of the respective shapes shown in the accompanying drawings, and therein numbered from 9 to 14, inclusive, as described. (3) The herein-described finishing rolls

364,642

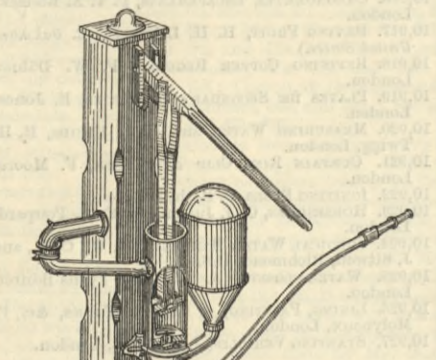


with passes of the respective shapes shown in the accompanying drawings, and therein numbered from 15 to 17, inclusive, as described. (4) A roll R for rolling iron, made in sections $r\ r^1\ r^1$, and having the annular chambers r^{10}, as described. (5) The rolls R R^1 R^2 R^3, in combination, said rolls R^2 R^3 being made in sections, and having one or more washers r^{12} interposed between the sections, as described.

364,655. Forcing Attachment for Lift Pumps, *Jacob Knopp, Beaver, Ohio.—Filed November 11th, 1886.*

Claim.—A pump attachment consisting of a cylinder and an air chamber connected to and supported by an intermediate section provided with a discharge nipple, and a bracket for attaching it to an ordinary pump, substantially as described. The combination of a

364,655

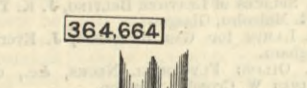


pump provided with a handle and a discharge spout, a detachable forcing attachment secured to the pump stock with its piston connected to the pump handle, and a detachable flexible conductor between the pump spout and the cylinder of the attachment, substantially as described.

364,664. Prepared Solder for Vent-holes, *E. Norton, Chicago, Ill.—Filed January 14th, 1887.*

Claim.—(1) A disc of solder for soldering vent-holes, having a projection or point to register with the vent-hole, substantially as specified. (2) A thin sheet disc of solder having its central portion depressed to form

364,664

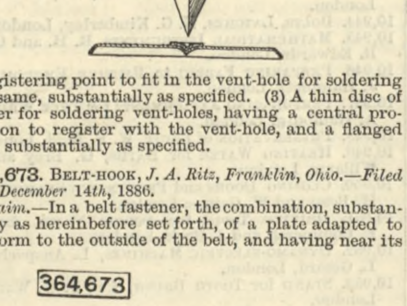


a registering point to fit in the vent-hole for soldering the same, substantially as specified. (3) A thin disc of solder for soldering vent-holes, having a central projection to register with the vent-hole, and a flanged rim, substantially as specified.

364,673. Belt-hook, *J. A. Ritz, Franklin, Ohio.—Filed December 14th, 1886.*

Claim.—In a belt fastener, the combination, substantially as hereinbefore set forth, of a plate adapted to conform to the outside of the belt, and having near its

364,673

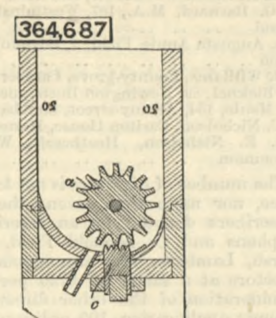


two opposite edges rows of short hooked teeth, the hooks inclining toward the centre, and bolts, such as shown, for clamping the plate to the belt.

364,687. Pulp-beating Engine, *Byron B. Tobie, Franklin Falls, N.H.—Filed August 30th, 1886.*

Claim.—(1) In a pulp-beating machine, an upwardly-extended tank A to contain a high column of pulp said tank being composed of side walls 20, but having no interior construction, combined with disintegrating or beating devices consisting of a cutting or grinding cylinder *a* and bed *c* located at the lower end of the tank A and extending horizontally for substantially the entire length of the tank, substantially as

364,687

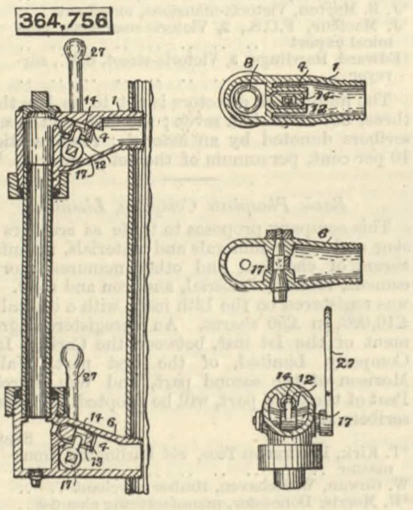


and for the purpose described. (2) In a pulp-beating machine, an upwardly-extended tank A to contain a high column of pulp, said tank being composed of side walls 20, but having no interior construction, and having a concaved bottom C, combined with disintegrating or beating devices consisting of a cutting or grinding cylinder *a* and bed *c* located at the lower end of the tank A and extending horizontally for substantially the entire length of the tank, substantially as and for the purpose described.

364,756. Safety Water-gauge, *A. H. Fowler, Buffalo, N.Y.—Filed September 16th, 1886.*

Claim.—(1) A self-closing valve set in a guide-way inclining from the valve-seat downward and provided with an opening, 14, in combination with a shaft set in bearings within the valve-case and having a handle, 27, for operating it, and an arm, 17, the end of which projects through the bottom of the valve-chamber 4 into the opening 14, and is made smaller than the opening, whereby the valve may be closed automatically by the force of the steam or water, or opened or closed by hand, substantially as and for the purposes

364,756

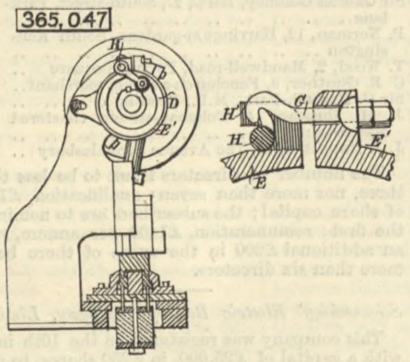


described. (2) A gauge for steam boilers, consisting of two valves, 12 and 13, set in inclined guide-ways within the valve-case and adapted to be open while in their normal condition and to be automatically closed by the force of the steam or water when the pressure is suddenly withdrawn from the front of the valves, substantially as specified. (3) The combination of the tube 8, the cases 1 and 6, to which the tube is secured, the inclined guide-ways and valves 12 and 13, and a steam-tight-fitting shaft provided with an arm for opening or closing the valves by hand, as and for the purposes described.

365,047. Automatic Brake for Power Presses, *J. H. Clapp, Chicago, Ill.—Filed February 11th, 1887.*

Claim.—(1) An automatic brake for power presses, consisting of a rigid disc upon the shaft, a band brake surrounding the same, with means to prevent its revolution therewith, and a lever fulcrumed upon the end of said brake, said lever having a friction roller upon one end in engagement with a cam formed upon said disc, while the other end is in engagement with a link connection attached to the opposite end of said brake, all combined substantially as and for the purposes set

365,047

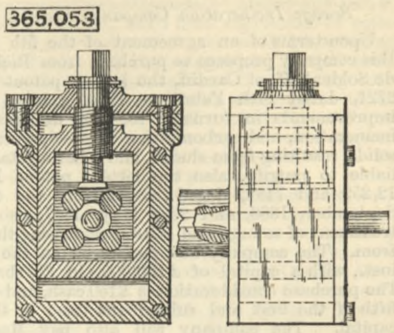


forth. (2) The combination, with a power press, of a disc rigidly attached to the shaft, a friction brake applied to its periphery, a lever fulcrumed upon one end of said brake and having its short arm engaging with a link attached to the other end, and a cam and friction roller for actuating the long arm of the lever, whereby said brake is alternately applied to and released from the disc as the shaft is revolved, substantially as and for the purposes set forth. (3) The combination, with the shaft of a power press, of the cam-grooved disc D, brake E E^1, with means for preventing its revolution, lever H H^1, having a friction roller engaging with said cam groove, and the hook bolt G, substantially as and for the purposes specified.

365,053. Device for Reducing the Ends of Tubes, *E. O. Daniels, Springfield, Ohio.—Filed January 28th, 1887.*

Claim.—In a reducing tool, the combination, with a frame and a follower, of a movable box carrying reducing rollers, and a movable block carrying reducing rollers, the follower being constructed to actuate the box in one direction and the movable block in the other direction, and a mandril concentrically located with respect to the rollers. In a reducing tool, the combination, with a frame having front and rear plates, a shank, and a mandril extending from said rear plate, and a follower mounted therein and having a shell-like portion exteriorly and interiorly screw-threaded in opposite directions, of a box fitted slidingly within the frame and engaged by the said exterior screw threads, and having a fixed recessed block carrying reducing rollers which extend into said recess, and a recessed block slidingly mounted in

365,053

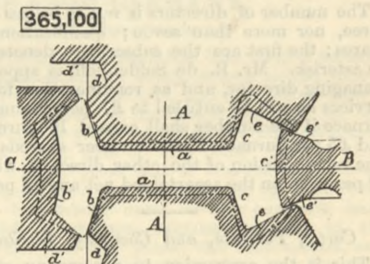


said box, having reducing rollers which extend into said recess, and having a threaded stem which enters the shell of the follower and is engaged by it.

365,100. Rolling Mill, *H. Sack, Duisburg, Germany.—Filed September 14th, 1886.*

Claim.—(1) In a mill for rolling beams with double flanges, the combination of a pair of horizontal rolls A A, each having working faces *a b c*, the end of the face *c* connecting with an outwardly inclined surface *e*, and the end of the face *b* connecting with a recess *d*, and the vertical wheels B C, the wheel B having a slightly convex periphery C^1, with inwardly

365,100

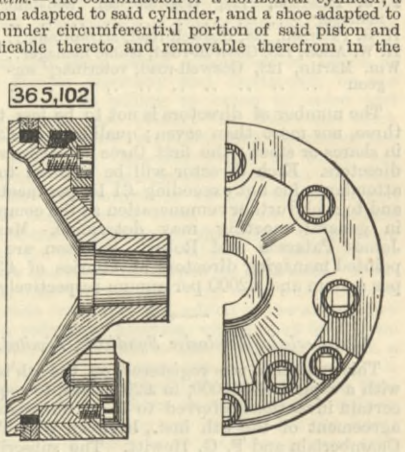


inclined surfaces e^1 e^1, and the wheel C having a slightly convex periphery b^1, with projections or flanges d^1 d^1 at each end, arranged to operate in the manner and for the purpose substantially as described. (2) In a mill for rolling beams with double flanges, the combination of a pair of horizontal rolls A A, with vertical rolls B and C, the working surfaces of the rolls A A terminating at one side in outwardly inclined surfaces *e*, overlapping the inwardly inclined surfaces e^1 of the wheel B, and at the other side connecting with recesses *d*, to receive the projections or flanges d^1 of the wheel C, substantially as described.

365,102. Horizontal Piston, *H. See, Philadelphia, Pa.—Filed March 19th, 1887.*

Claim.—The combination of a horizontal cylinder, a piston adapted to said cylinder, and a shoe adapted to the under circumferential portion of said piston and applicable thereto and removable therefrom in the

365,102

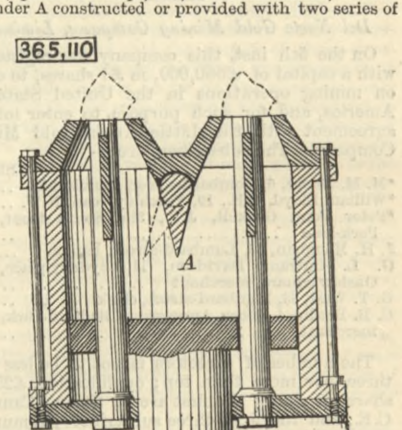


direction of the length of the cylinder, substantially as and for the purpose set forth. The combination of a piston, a removably applied shoe, a follower, packing segments, pins for maintaining said segments in their relative positions, springs for forcing said segments radially outward, and pins for maintaining said springs in proper circumferential distribution, substantially as set forth.

365,110. Means for Making Curved Pipe, *J. A. Whitney, Brooklyn, N.Y.—Filed September 25th, 1886.*

Claim.—In a machine for making curved pipes, plumbers' traps, &c., the combination, with the cylinder A, constructed or provided with two nozzles or dies, of means for varying simultaneously and in unison the flow of material to opposite sides of each of the said nozzles, substantially as and for the purpose herein set forth. In a machine for making curved pipes, plumbers' traps, &c., the combination, with a cylinder A constructed or provided with two series of

365,110



nozzles or dies, of means for varying simultaneously and in unison the flow of material to opposite sides of each one of each of the said series of nozzles, substantially as and for the purpose herein set forth. In a machine for making curved pipes, plumbers' traps, &c., the combination, with two annular dies, of the blade or wing F, a lever G, and a cam H, substantially as and for the purpose herein set forth. In a machine for making curved pipes, plumbers' traps, &c., the combination, with two annular dies, of the blade or wing F, a lever G, and a cam H, substantially as and for the purpose herein set forth.